S. HRG. 111–712

ELECTRIC VEHICLES

HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

TO

RECEIVE TESTIMONY ON POLICIES TO REDUCE OIL CONSUMPTION THROUGH THE PROMOTION OF ACCELERATED DEPLOYMENT OF ELECTRIC-DRIVE VEHICLES, AS PROPOSED IN S. 3495, THE PROMOTING ELECTRIC VEHICLES ACT OF 2010

JUNE 22, 2010

Printed for the use of the
Committee on Energy and Natural Resources

U.S. GOVERNMENT PRINTING OFFICE

62–351 PDF WASHINGTON : 2010

For sale by the Superintendent of Documents, U.S. Government Printing Office,
http://bookstore.gpo.gov. For more information, contact the GPO Customer Contact Center,
U.S. Government Printing Office. Phone 202–512–1800, or 866–512–1800 (toll-free). E-mail, gpo@custhelp.com.

COMMITTEE ON ENERGY AND NATURAL RESOURCES

JEFF BINGAMAN, New Mexico, *Chairman*

BYRON L. DORGAN, North Dakota
RON WYDEN, Oregon
TIM JOHNSON, South Dakota
MARY L. LANDRIEU, Louisiana
MARIA CANTWELL, Washington
ROBERT MENENDEZ, New Jersey
BLANCHE L. LINCOLN, Arkansas
BERNARD SANDERS, Vermont
EVAN BAYH, Indiana
DEBBIE STABENOW, Michigan
MARK UDALL, Colorado
JEANNE SHAHEEN, New Hampshire

LISA MURKOWSKI, Alaska
RICHARD BURR, North Carolina
JOHN BARRASSO, Wyoming
SAM BROWNBACK, Kansas
JAMES E. RISCH, Idaho
JOHN MCCAIN, Arizona
ROBERT F. BENNETT, Utah
JIM BUNNING, Kentucky
JEFF SESSIONS, Alabama
BOB CORKER, Tennessee

ROBERT M. SIMON, *Staff Director*
SAM E. FOWLER, *Chief Counsel*
MCKIE CAMPBELL, *Republican Staff Director*
KAREN K. BILLUPS, *Republican Chief Counsel*

CONTENTS

STATEMENTS

APPENDIX

ELECTRIC VEHICLES

TUESDAY, JUNE 22, 2010

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The committee met, pursuant to notice, at 10:04 a.m. in room SD–366, Dirksen Senate Office Building, Hon. Jeff Bingaman, chairman, presiding.

OPENING STATEMENT OF HON. JEFF BINGAMAN, U.S. SENATOR FROM NEW MEXICO

The CHAIRMAN. OK. We will go ahead and start the hearing.

Thank you all for coming.

Today we are looking into the issue of how to accelerate deployment of electric vehicles and specifically how the bill Senator Dorgan and others have introduced on this subject fits into a broader policy framework on this.

This has been a subject of great interest here in the committee and in the full Senate and will continue to be important as we look to reduce our oil dependency and greenhouse gas emissions from the transportation sector.

The significant benefit of using electricity to fully or partially power our vehicles, when it comes to oil security, is easy to see. Vehicles can achieve efficiencies of well over 100 miles per gallon, save consumers money in the process. The manmade disaster unfolding in the Gulf provides an obvious reason to reduce our reliance on oil.

But there are other significant environmental benefits of electrification as well, and as we bring more renewable sources into our electricity supply through market mechanisms such as a renewable electricity standard that we have got in the bill we have reported out of this committee or by directly pricing carbon pollution, we can multiple the benefits by using that sustainable power in our transportation sector as well.

This committee has previously supported research into the technologies found in these vehicles, as well as deployment programs such as the Advanced Technology Vehicles Loan Program, which supports the reopening or retooling of plants to produce electric vehicles in Tennessee and in Delaware and in California. Grant programs to support deployment are allowing plants to be built to produce next generation batteries in States such as Michigan and Indiana, and federally supported pilot programs to demonstrate the vehicles are beginning in several States.

However, to really achieve energy and environmental security gains, the country clearly needs and the manufacturers of the technology have to see a substantial market for these vehicles in order to justify their investments. First, it will require infrastructure in communities that will give consumers the confidence that electric vehicles will meet their needs. Second, consumers must be able to afford the early vehicles before manufacturers have achieved economies of scale and technology advances have reduced the costs of production. Senator Dorgan's bill contains a number of programs aimed at addressing both of these problems.

I should note that this bill is also a companion to a fuller bill that Senator Dorgan has proposed containing complementary tax provisions. That bill has gone to the Finance Committee.

There is a bill that I have introduced with Senator Snowe, S. 1620, that is similarly aimed at allowing consumers to realize the benefits of more efficient vehicles through a rebate at the point of purchase. I believe making the benefits of efficiency, as well as the costs of inefficiency, more visible to consumers at the time that they purchase a vehicle is an important part of the equation that the Senate will have to return to when it considers these policies.

[The prepared statement of Senator Landrieu follows:]

PREPARED STATEMENT OF HON. MARY L. LANDRIEU, U.S. SENATOR FROM LOUISIANA

Thank you, Mr. Chairman for holding this important hearing today. I have always been a supporter of alternative, more-efficient and less carbon-intense vehicles, and I think this discussion comes at an important time.

Our country, and in particular my state of Louisiana, is reeling from the impacts of what supplying our country with oil, mainly for our cars, can result in. Everyone knows I am a staunch supporter of the domestic oil industry, because as Americans we rely on this energy in our everyday lives—from driving our cars to work or helping to make consumer goods. I believe that if we are going to consume petroleum products, we must and can produce it safely at home.

I also believe that the risks—both environmental and geopolitical—are too high when we import oil from foreign sources.

However, as a country, we consume 20 million barrels of oil a day, importing more than half of that. While to some it is a laudable goal to end oil consumption immediately, this is not reality as our economy runs on oil. Without oil, most of us would not have been able to drive to work this morning. As such, it begs the question, how is the transportation sector going to survive without petroleum? If as a country we are going to reduce our dependence on foreign oil and begin to move away from petroleum transportation fuels, then we must get serious about implementing new technologies.

In the immediate future, we can promote more fuel efficient cars, such as the car being manufactured by the V-Vehicle Company. This car still has an internal combustion engine, but it gets nearly double the miles per gallon than current commercially available cars. In addition, it's affordable and the technology is available so it can be manufactured immediately.

More fuel efficient cars like the V-Vehicle model, are the current biggest bang for our buck as we wait for future technologies to become commercially available.

However, in the long-term, we must look past petroleum-fueled cars and instead look to alternative non-petroleum vehicles. In the future, one technology that holds a lot of promise is the plug-in electric vehicle. Electric vehicles can have several benefits to consumers including costing pennies to refuel per mile and having zero tailpipe emissions.

U.S. manufacturers are currently ramping up their capacity to produce electric vehicles, going from 50,000 plug-in electric vehicles batteries by the end of 2011, to more than 500,000 by December 2014.

However, this technology still has some kinks that need to be addressed. There are several areas that I have concerns with including: 1) Can these vehicles be economically affordable for the average American in the near future, and if not, should we invest in a more promising technology? 2) What will the added load on the grid

mean to our already feeble transmission infrastructure? 3) How will Americans dispose of the batteries and what impact will this have on our environment?

Regardless, no technology is perfect overnight and it will take ongoing research and development if we are going to make plug-in electric cars a reality. I believe that this is a worthy task the Federal government should support as it will be critical as we push this country toward a more energy secure future.

Thank you.

The CHAIRMAN. Let me call on Senator Murkowski for her comments, and then I also want to give Senator Dorgan a chance to make a statement since he is the prime sponsor on this bill.

Senator Murkowski.

STATEMENT OF HON. LISA MURKOWSKI, U.S. SENATOR FROM ALASKA

Senator MURKOWSKI. Thank you, Mr. Chairman. I appreciate the hearing this morning. I know that there is a great deal of interest in it, the issue itself. It is reflected here in the hearing room this morning, and out in the hallway, we have got a full crowd out there. So clearly an issue of great interest.

This legislation that would promote electric vehicles through a number of new plans and programs, significantly increase the Federal support for everything from the charging stations to the basic R&D.

I think all of us on this committee would agree that electric vehicles have great promise, great potential, and all of us want to see them take off and transform the auto industry.

We are very excited about the Nissan Leaf, Chevy Volt, and we are equally excited about the vehicles that will shortly follow, including those from new companies like Tesla and Fisker.

As we look for ways to increase our energy security, decrease the cost of energy and create new jobs, electric vehicles offer a unique opportunity to make progress on all three of these fronts at once.

So I would also like to commend Senator Dorgan for crafting some new policies beyond the tax credits and the subsidies that the Government already offers that could hasten their deployment.

I think there is a great deal to like in this bill. I think you will see reflected in my questions, though, that I do have a couple concerns. As I say, those will be reflected in the questions.

One is about whether or not we are perhaps tipping the playing field to advantage a technology that I think has certainly captured our attention and appropriately so. This is not new. In the Clinton administration, it was diesel hybrids that we were focused on. In the Bush administration, it was hydrogen and fuel cells. For the past several years, the focus has been on plug-in hybrids.

I am as hopeful as anyone that electric vehicles are here to stay, but I think we recognize, particularly in this committee, that sometimes when we try to pick the winners and losers, we do not do a very good job of it. So the question is, are we finally right? Even if we are, would it still be better to adopt an approach that promotes technologies equally and requires them to compete against one another? I think it is a fair question and one for good discussion.

I also raise the issue about the spending. I understand certainly that authorizations are different than the appropriations and that any tax credits added to this bill are likely to be offset. But I think

we do look at the price tag with a little bit of raised eyebrows. $4 billion to $6 billion is a lot. That is certainly out there on the table as we consider that.

But I am pleased that we have this before the committee and can have an opportunity to learn a little bit more about it.

Again, Mr. Chairman, thank you for holding the hearing and to you, Senator Dorgan, for your leadership on this.

The CHAIRMAN. Senator Dorgan, did you want to make an opening statement?

STATEMENT OF HON. BYRON DORGAN, U.S. SENATOR FROM NORTH DAKOTA

Senator DORGAN. Mr. Chairman, I would and thank you for the courtesy.

I along with Senator Alexander, and Senator Merkley have worked on this legislation for some while. We have introduced several versions, one that includes tax credits. That, of course, goes to the Finance Committee. The bill we're considering today has been referred to this committee.

Let me make a couple of comments and I will finish commenting on this issue of picking winners and losers.

I believe it was in the World's Fair in 1900 when Rudolph Diesel showed up. He had a new engine that would run on vegetable oil. A few years later, President Taft decided to get rid of horses at the White House and buy some cars. Among the cars he bought was the Baker electric car. So back a century ago, we were talking about a new engine that would run on vegetable oil and an electric car at the White House. Then a few years after that, Henry Ford developed the Model T and selected gasoline to run the internal combustion engine.

This Congress, in 1916, as a result to Henry Ford's decision, said to the American people, if you are out looking for oil and gas, God bless you. We want to incentivize you to do that, talking about picking winners and losers. We would like to give you very significant tax benefits if you go out looking for oil and gas. That was almost a century ago and it continues today because Congress decided that is was what we wanted to do in this country.

Now, the dilemma is that we use 25 percent of all the oil that we suck out of the planet every single day; meanwhile, we makeup only 10 percent of the population and possess only 3 percent of the known oil reserves. A lot of people, myself included, believe that our need for oil will lead to very vulnerable circumstances for the country's future.

We import between 12 million and 13 million barrels of oil a day and 70 percent of the oil that we use in our country, both imported and domestically produced, is used in the transportation sector.

So when you think about what is ahead of us, you have to consider what different approaches we might use with respect to transportation.

Now, I happen to support virtually all new approaches to transportation. Last year, the administration cut $190 million from hydrogen fuel cell research. I put the money all back in the subcommittee that I chair on appropriations. Why? Because I believe

that in the longer term hydrogen fuel cells are going to be very important.

But with respect to plug-in hybrids and electric vehicles, the question is do we want to begin to incentivize different approaches to moving our transportation fleet. I believe the answer is yes. We have come up with an approach that says, with respect to electric vehicles, let us develop a series of incentives to further battery technology. We would like to see somebody come up with a 400-mile to 500-mile battery. We set up deployment communities to serve as test beds for large scale deployment, which I think are very important. A series of similar incentives in a piece of legislation that will start moving in the direction that we think is important for the country.

The President has talked about having a million electric vehicles on the roads by 2015 in this country. You know, there is this old saying, if you do not care where you are going, you are never going to be lost. That can be true with a country. It is true when referring to whether we want to set aspirations and way points in the future to decide where we would like to head. We did that when we decided that the internal combustion engine should be fed with gasoline. So let us provide very significant centuries' worth of incentives for gas and oil. But in today's era, there seems to be two issues. No. 1, national security. Our economic security is threatened by being as vulnerable as we currently are because of our dependence on oil, which we have little control. No. 2, the issue of climate change.

Moving in the direction of an electric drive, vehicle fleet makes a great deal of sense, and I do not see it as picking winners and losers because, as I said, I support incentivizing a whole series of alternative approaches to transportation. But this, it seems, is going to be part of America's future.

One final comment. Every single night when we go to bed, we have opportunities to plug something in to an electric grid that is not being used. We built it. It is paid for and it is not being used. We can use the spare capacity during the evening hours which was built for prime use during the daylight hours. We can use the electric grid and not have to spend a great deal more for that infrastructure, which I think makes a lot of sense.

I am really pleased with this legislation. It is bipartisan. I think it will move us in the right direction.

I am pleased you are holding a hearing, Mr. Chairman.

The CHAIRMAN. All right. We have two very good panels here. The first is, of course, the administration, the Honorable David Sandalow, who is the Assistant Secretary for Policy and International Affairs in the Office of Policy and International Affairs in the Department of Energy. He is here to give us the administration's perspective on this legislation and the general subject of use of electric-drive vehicles in our transportation sector.

David, why do you not go right ahead?

STATEMENT OF DAVID SANDALOW, ASSISTANT SECRETARY, POLICY AND INTERNATIONAL AFFAIRS, DEPARTMENT OF ENERGY

Mr. SANDALOW. Thank you, Chairman Bingaman, Ranking Member Murkowski, Senator Dorgan, other members of the committee. On behalf of Secretary Steven Chu and the Department of Energy, I would like to thank you for the opportunity to appear today to discuss electric vehicles and legislation to promote them.

I would also like to extend a personal thank you to Pat Davis, the head of our vehicle technology program, who is right behind me, and all the fine civil servants at the Department of Energy who have been working for so long on these issues.

The Department shares the committee's goal of accelerating electric vehicle deployment as a way to address two critical challenges facing our Nation: reducing our dependence on petroleum and mitigating greenhouse gas emissions.

Mr. Chairman, this morning I walked out to my garage and unplugged my car from an extension cord. The battery in my car gets about 40 miles on a charge. So on my trip to work, which is about 5 miles, I use barely any gasoline.

On average in city driving, I get over 80 miles per gallon. I often go weeks or more without refilling the tank in my plug-in electric hybrid. The car is quiet, cheap to drive, and it has great pick-up.

Mr. Chairman, electric vehicles are the future. The only question is how soon.

The Department thanks the committee for the unprecedented $2.4 billion investment in our Nation's manufacturing capacity and infrastructure for electric vehicles provided through the American Recovery and Reinvestment Act. This is speeding our Nation's transition to electric drive while creating thousands of jobs. With Recovery Act funds, U.S. manufacturers are building the capacity to produce 50,000 plug-in hybrid electric vehicle batteries annually by the end of 2011 and 500,000 by the end of 2014. We are also deploying nearly 7,000 vehicles with Recovery Act funds and more than 16,000 electric charging points, as well as training code officials, technicians, engineers, and others who are critical to the successful transition to electrified transportation.

With that as the foundation, I am pleased to provide the Department's perspective on the Promoting Electric Vehicles Act of 2010, S. 3495, and I recognize, as you said, Mr. Chairman, there are companion bills before the chamber.

Mr. Chairman, with your permission, I would like to submit for the record my full written statement which has our views on the bill and will also provide technical comments.

Today I would like to offer just a few brief observations about the proposed act.

The Department of Energy supports the creation of a national program that includes technical assistance, work force training, and a targeted communities program to facilitate the rapid deployment of electric vehicles. We believe that such an effort will provide much needed resources, create models, and facilitate the local leadership needed for faster adoption of electric vehicles across the country.

We agree with the committee's decision to limit the number of targeted deployment communities to no more than 15 initially. Starting with a smaller number allows us to focus resources and build teams of experts that can support more widespread rollout by communicating best practices and lessons learned to other cities nationwide.

We are already examining ways to work more closely with the communities on vehicle electrification, by the way. On July 22, the Department of Energy will host a workshop to engage key stakeholders in a discussion of critical issues such as permitting and how to better understand the ways the Department can support local efforts to deploy electric vehicles and infrastructure.

The Department thanks the committee for recognizing the importance of work force training to the successful deployment and market penetration of electric drive vehicles and for including a training specific provision in the proposed national plug-in program.

This legislation also authorizes an R&D program focused on advanced batteries, electric drive components and other technologies. We support this authorization, and those priorities align closely with ongoing activities in our vehicle technologies program.

As for prizes, we support the concept of an Advanced Battery for Tomorrow Prize. We appreciate the committee's including of criteria to address battery size and cost, as well as range. Understanding that the prize seeks to push the envelope for state-of-the-art technology, we would like to note that today's vehicles generally do not require a 500-mile range and that based on input from our industry partners, we expect a 300- to 400-mile range will meet consumers' vehicle performance demands.

Mr. Chairman, my children are teenagers. They can scarcely imagine growing up in a world without personal computers, cell phones, or GPS devices. Now, I predict that some day one of my children will have one of their children look at them and say, you mean, you could not plug in cars when you were young? That is so weird.

The speed with which we make the transition to electric vehicles will depend upon the leadership of everyone in this room and around this country.

The Department of Energy thanks the committee for the opportunity to comment on this legislation, and we look forward to working with Congress to implement these programs.

I would be pleased to answer your questions, Mr. Chairman.

[The prepared statement of Mr. Sandalow follows:]

PREPARED STATEMENT OF DAVID SANDALOW, ASSISTANT SECRETARY, POLICY AND INTERNATIONAL AFFAIRS, DEPARTMENT OF ENERGY

INTRODUCTION

Chairman Bingaman, Ranking Member Murkowski, and other Members of the Committee, thank you for the opportunity to appear before you today to discuss electric drive vehicles.

The Department of Energy shares the Committee's goals for accelerating electric drive vehicle deployment as a way to address two critical challenges facing our nation—reducing our dependence on petroleum and mitigating greenhouse gas emissions.

Nowhere are these priorities more challenging than in the transportation sector, which accounts for two-thirds of our petroleum consumption and about a third of

our greenhouse gas emissions.[1] Electric drive will play a key role in meeting these challenges. Simply put, drivetrain electrification can dramatically reduce both petroleum use and greenhouse gas emissions—whether we're talking about hybrids or plug-ins that use biofuel and renewable electricity, full electric vehicles recharged with renewable electricity, or fuel cell vehicles that use renewable hydrogen.

The American Recovery and Reinvestment Act (P.L. 111-5) supported an unprecedented investment in our nation's manufacturing capacity and infrastructure for electric drive vehicles. With Recovery Act funds, U.S. manufacturers are building the capacity to produce 50,000 Plug-in Hybrid Electric Vehicle (PHEV) batteries annually by the end of 2011 and 500,000 PHEV batteries annually by December 2014. As you know—with more than 95 percent of today's lithium-ion batteries for consumer electronics made in Asia—this commitment to building U.S. manufacturing capacity is significant and provides us an opportunity to lead the world in advanced lithium-ion battery technology.

Recovery Act funds are also supporting the largest-ever coordinated deployment of nearly 7,000 electric vehicles and more than 16,000 electric charging points. The detailed operational data we collect through this deployment will provide important insights about vehicle usage, charging patterns, and potential impacts on our nation's electrical grid necessary for accelerating broader, long-term deployment of vehicles and infrastructure. I will also add Recovery Act funds are supporting a number of programs to educate code officials, first responders, technicians, and engineers who are critical components of the human infrastructure needed for the successful transition to electrified transportation, both in terms of consumer acceptance and public safety. All together, this $2.4 billion investment through the Recovery Act supports 48 competitively-selected and cost-shared electric drive vehicle projects in more than 20 states that will directly result in the creation of tens of thousands of jobs in the U.S. battery and auto industries.

With that as a foundation, I am pleased to offer the Department's perspective on the Promoting Electric Vehicles Act of 2010 (S.3495).

COMMENTS ON THE PROMOTING ELECTRIC VEHICLES ACT OF 2010

The Promoting Electric Vehicles Act of 2010 includes several important provisions to promote near-term deployment of plug-in electric drive vehicles, which complement and supplement the Department's ongoing activities, funded both through the Recovery Act and annual appropriations.

The Department recognizes the potential benefits of activities such as those proposed by the National Plug-in Electric Drive Vehicle Deployment Program, including technical assistance, workforce training, and a targeted communities program to facilitate the rapid deployment of plug-in vehicles. We believe that such an effort will create models, and facilitate the local leadership necessary for faster EV adoption across the country, and would be a natural extension of the activities being undertaken through our Office of Energy Efficiency and Renewable Energy, Vehicle Technologies Program's Outreach, Deployment & Analysis (VT/ODA) activities, such as Clean Cities. The targeted deployment program would offer communities of different sizes in various parts of the country an opportunity to execute various deployment approaches and develop best practices that can be shared nationwide to address critical questions about planning and managing vehicle and charging infrastructure deployment.

The Department appreciates that the community selection criteria includes an emphasis on diversity of climate and type of electric utility. Such diversity in pilot programs, particularly across electricity-generation sources, will be crucial for estimating the environmental impacts of expanded adoption of plug-in electric drive vehicles.

We also agree with the Committee's decision to limit the number of targeted deployment communities to no more than 15, initially. Starting with a smaller number would allow us to focus resources and build a team of experts that can support a more widespread rollout through communication of best practices and lessons learned to other cities nationwide. We are already examining ways to work more closely with communities on vehicle electrification and infrastructure deployment, particularly in connection with our Clean Cities Program. The coalitions that comprise the Clean Cities network bring together state and local governments, early adopter fleets, local utilities, infrastructure developers, and other key stakeholders in a community to advance the deployment of alternative fuel vehicles. These public private partnerships are proven and effective resources for sharing information at

[1] Transportation Energy Data Book: Edition 28, calculated from data in Table 1.13 and Table 1.16

the local level and are primed to support the rollout of electric drive vehicles and infrastructure. Through Clean Cities, we are planning a workshop, now scheduled for July 22, to engage key stakeholders in a discussion of critical issues such as codes, standards, and permitting of electric charging infrastructure and electric vehicle deployment best practices. Our goal is to better understand how the Department can support local community efforts to deploy EVs and infrastructure.

To maximize the effectiveness of the targeted communities program, the Department would seek to coordinate this effort with related ongoing projects to deploy electric drive vehicles and infrastructure. Our Recovery Act projects for transportation electrification are building critical expertise through large-scale vehicle and infrastructure deployment, collecting data on vehicle-grid interaction and producing valuable lessons learned that can support and help to accelerate future deployments in other communities. In addition, we appreciate the thoroughness and detail of the deployment community selection criteria as outlined in the legislation, which would help to ensure the selected communities stand up as models for deployment across the country.

Regarding the specified 120 days for applicants to submit proposals, we are concerned about asking communities to complete a significant amount of groundwork and coordination with multiple stakeholders prior to submitting their applications—much more than they're used to accomplishing. We believe 120 days may not provide enough time to complete that important work effectively. We ask that the Committee consider providing DOE the flexibility to establish the proposal deadline following some research to better understand community needs in this regard as long as we work within the specified 360-day timeframe for announcement of community selections.

The Department thanks the Committee for recognizing the importance of workforce training to the successful deployment and market penetration of electric drive vehicles, and including a specific provision in the proposed national plug-in program. The grant program for training first responders, code inspection officials, dealers and mechanics, and electricians responsible for charging point installation will complement and supplement Recovery Act projects and ongoing VT/ODA activities focused on these critical needs. Our recently-initiated Recovery Act efforts will provide valuable lessons learned and build a body of expertise to support implementation of the workforce training provision in this bill.

We also believe that the technical assistance component of the proposed national deployment program is vital to the successful rollout of electric drive vehicles. The Department is well positioned to disseminate information and provide training and technical assistance to communities seeking to accelerate EV deployment. As an example, and as noted earlier, the Clean Cities network is primed to share best practices and lessons learned about permitting and inspection processes, as well as other local ordinances and opportunities for code official and first responder training. I would like to note, however, that the Department plays a supporting role in the development of model codes and standards. In regard to this provision, we can bring value to the process because of our extensive experience working with code development organizations (CDOs) and standards development organizations (SDOs) to facilitate consensus around the development and adoption of vehicle-and infrastructure-related codes and standards. We are also working to enable the harmonization of codes and standards at an international level.

The Promoting Electric Vehicles Act includes several other significant provisions in addition to the National Plug-in Electric Drive Deployment Program; I will briefly comment on several of them here.

- The bill authorizes a R&D program focused on advanced batteries, electric drive components, and other technologies supporting the manufacture and deployment of electric drive vehicles and charging infrastructure. These priorities are aligned closely with ongoing activities in the Vehicle Technologies Program—specifically, our Batteries and Electric Drive Technology subprogram, which includes advanced battery R&D and advanced power electronics and electric machines, as well as our Vehicle and Systems Simulation and Testing subprogram, which includes work to examine vehicle and infrastructure interface issues through testing and evaluation.
- As for prizes, we support the concept of the "Advanced Batteries for Tomorrow Prize." We also appreciate the Committee's inclusion of criteria to address battery size and cost as well as range. Understanding that the prize seeks to push the envelope for state-of-the-art plug-in hybrid battery technology, we would like to note that today's vehicles do not require a 500-mile range and that based on input from our industry partners, we expect a 300-to 400-mile range to meet consumers' vehicle performance demands.

- We also understand and appreciate the Committee's interest in a technical advisory committee focused on plug-in hybrid vehicles. We place great value in independent reviews and external input to our program. You may be aware that the National Academy of Sciences National Research Council conducts independent biennial reviews of both our light-duty and heavy-duty vehicle research programs. We would like to suggest to the Committee that any new review functions be coordinated with other ongoing and planned review activities.

To conclude, the Department of Energy thanks the Committee for the opportunity to comment on this legislation and our ongoing related Recovery Act activities. We look forward to working with Congress to continue to implement these programs. They will accelerate the deployment of electric drive vehicles and infrastructure and help us achieve our national objectives for reducing petroleum use and greenhouse gas pollution.

The CHAIRMAN. Thank you very much. Let me start with a few questions.

One of our problems—and Senator Dorgan alluded to this a little bit in his statement, but one of our problems I have noticed over the years is that the Federal Government gets very enthusiastic about particular technologies to solve our energy problems, and we usually demonstrate the enthusiasm with a big event at the White House and we bring in everybody, all the CEOs of the car companies, and talk about how we are going to do something. Then the whole thing goes away after a few years, and we are on to the next project.

There are programs that are currently being administered by the Government to promote more development and use of electric vehicles. How can we be sure that we are not adding other things that will cancel out some of those? How can we keep the ones that are working? How can we have some continuity of focus in this area? What do you see as the provisions in this bill that would help us do that and the ones that might cause us to lose that focus?

Mr. SANDALOW. Thanks for the question, Mr. Chairman, and I noted that Ranking Member Murkowski asked a similar question. It is exactly the right one.

The Federal Government should stay away from picking technologies. For example, in this area, the Federal Government should avoid picking between, let us say, lithium-ion batteries and nickel metal hydride batteries or other types of specific chemistries and battery applications. Certainly in my view that would be unwise.

There are technology categories that require public investment, and electric drive broadly is one of those. In order for electric drive to thrive, we are going to need an infrastructure of people and engineers who know how to work with electric drive technologies. We are going to need charging points. We are going to need utilities to develop the different types of tools and regulatory structures that will make these cars work. So having Congress provide leadership in this direction and helping set the direction for the Nation for a broad technology category is, in my view, extremely appropriate.

As Senator Dorgan has already said in this hearing, 100 years ago Congress did the same thing with respect to oil and gas technology, and that led to extraordinary prosperity on the part of the Nation as that infrastructure was built up with Government support over the course of the past century. We need to do the same thing in the 21st century, which is invest in 21st century technologies, provide broad direction for technology categories, and in

my view, that is what this bill and the companion bills before you do.

The CHAIRMAN. Let me ask on the targeted communities. It seems to me we may be far enough along in the development of this technology that we should be going nationwide with deployment of the technology. The idea of having targeted communities that we are going to work with to see if they can sort of lead the way and everybody else will watch to see how well they do—we may be too far down the road toward having a real technology option for people here for us to be thinking about it that way.

What is your thought on the whole notion of targeted communities? Especially if we tell DOE to pick 15 targeted communities and none of them turn out to be in New Mexico——

[Laughter.]

The CHAIRMAN [continuing]. I am going to be hearing from a lot of communities in my State saying why are our tax dollars going to help these other places. Why is this not available to all of us?

Mr. SANDALOW. Thank you, Mr. Chairman. We should be going nationwide and we will be going nationwide with this technology. I predict that consumers and drivers all over this Nation are going to be buying electric cars when they are widely available. At the same time, with Federal programs, we need to start somewhere. There will not be unlimited funds. Ranking Member Murkowski has already referred to the cost constraints that we must face in implementing this and any other program. So in doing that, our view is it is wise to focus on a limited number of areas since there is essentially no choice and try to create the knowledge base and the tools in those areas that the rest of the Nation can learn from.

In this bill before us, there are, I think, very wise provisions that would balance the different types of communities that are selected regionally, geographically, in terms of size of the communities, and by other factors. I think those are exactly the type of criteria that should be used as we implement a program like this.

The CHAIRMAN. Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman.

I would venture to say that I am probably not going to have any communities in Alaska either that are going to be the targeted communities. We need a little bit of range up there.

But I will tell you that we have been plugging our cars in for a long time. If you do not plug them in, you cannot start them in the wintertime when it is too darned cold out there. I think some of our northern neighbors know that as well.

Mr. Sandalow, I wanted to ask you about what is going on internationally in so far as electric vehicles. How does what we are proposing here compare to other international efforts? Are the type and the scope of the policies here in this country less or roughly on par with what is happening in other parts of the world?

Mr. SANDALOW. Thank you for the question, Senator Murkowski, and it is an extremely important one.

In my job in the past year, I have had the opportunity to visit China, in particular, a number of times, as well as other countries, and I believe it is important for us to focus on the fact that the rest of the world is moving out quickly on this technology. In China, there is an electric vehicle deployment program that has recently

grown from 13 cities to 22 cities, and that country is investing extremely heavily in battery technology. They are, in fact, selling, they tell us, over 20 million electric scooters every year in that country and planning to make the transition to electric vehicles in the years ahead. So this market is moving out quickly.

The question before us is whether the United States will lead in this technology. I believe we have the opportunity to do that if we make the types of investments and work together in the way suggested by this bill in the years ahead.

Senator MURKOWSKI. You mentioned that in China they have seen an increase in the number of targeted communities that they have done. Is this typically how you see the rollout of the electric vehicles coming into countries in different areas, is there are targeted communities where you start it first, going to the chairman's question about why not go nationwide?

Mr. SANDALOW. It is a great question, Senator. This is a new technology. So this is just starting to happen in other countries. But in Israel and in Denmark and some places where electric vehicles are beginning to be rolled out, yes, they do happen in relatively concentrated places, and you start in relatively concentrated places and then branch out. That is not inconsistent with widespread use of the technology, but focusing resources in a few places I think in my opinion can help the widespread dissemination of this approach.

Senator MURKOWSKI. That is all for now, Mr. Chairman.

The CHAIRMAN. Senator Dorgan.

Senator DORGAN. Mr. Chairman, thank you very much.

I think we are always going to need oil and gas. This is not a case of deciding that they are not valuable resources. If we move toward an electric fleet of transportation vehicles, it will substantially reduce our reliance on foreign oil, which I think is very important. It will improve both our energy security and national security.

I am wondering if you might have a grandchild someday who will ask you, Grandpa, what is that noise under that hood, and you will say, well, that is an internal combustion engine running on gasoline, because the new electric fleet does not make substantial sounds.

I do not know how fast this moves. I do think Senator Murkowski asked the question that others will ask about picking winners and losers, and I am going to ask you about that in just a moment.

In the appropriations bill that I wrote last year on energy and water, I required DOE to contract with the National Academies to perform a study on all alternative transportation fuel options and then to provide policy suggestions and options that would lessen our dependence on foreign oil, a comprehensive road map. I did that because we do not know where this will end up, but we do have a notion of the kind of technologies that are now becoming available. This unbelievable investment in new battery technology can move us from last place or second or third place to first place. So last year's appropriations bill will require that we look at all technologies available.

But let me ask you the question about when we introduced the legislation dealing with electrified fleets and the infrastructure required to support such fleets. Senator Murkowski mentioned that she was worried that such legislation wiould pick winners and losers. I said, we have historically provided incentives for similar things. I would like to get your opinion on the idea of this, picking winners and losers, because I think this will be a prevalent concern.

Mr. SANDALOW. Senator, I think it is extremely important that we invest in a broad range of technologies in this area, and with this committee's support, the Department of Energy is currently investing not just in electrification but also in biofuels and in hydrogen and in natural gas technologies and in improving the efficiency of internal combustion engines. But that should not prevent us from investing heavily in leading technological approaches such as electric drive.

If I could on this note, I would like to quote Senator Lamar Alexander, who has been a leader on this issue and, of course, a cosponsor of your legislation, who said, "The single best way to reduce America's use of oil is to electrify our cars and trucks." Now, I think we need to invest in a range of technologies, but we need to focus in on those that have extraordinarily high potential and that in my opinion is electric drive.

Senator DORGAN. I support all the things you have just described. I mean, I think we should do all of them and do them well.

The National Research Council put out a study late last fall that had what I consider to be very unrealistic expectations for battery costs, it projected very high battery costs, and very low potential penetration rates for vehicles. I assume you have access to the same kind of numbers. What is your assessment of this report which was not very positive?

Mr. SANDALOW. We share concerns about that report, Senator. I am familiar with it, and I think the numbers in that report were unrealistically high and they are inconsistent with some of the data that we have received in the course of our work. We believe both that the costs of batteries today are lower than were set forth in that report and that the rate of improvement of battery technologies will be faster, particularly if we invest in it in the ways suggested in this bill and others.

Senator DORGAN. If nothing else happens, accepting that some other countries are moving toward an electrified fleet, in those countries, they will still use the internal combustion engine. My notion is that as China and India look at the rest of the world and decide, you know what, we need to be driving here. We need to be driving something. So you have very low-priced cars made available with more and more people wanting those cars, perhaps there will be as many as 300 million to 400 million additional vehicles on the road in the years ahead, all looking for a gas station once a week. Is that not ominous for a country like ours that requires a lot of oil from elsewhere to come into our country, 70 percent of which will be used in the transportation fleet? Does that not just drive us to say, you know what, things are going to change. They are changing already. They are going to change not for the better, but for the worse. Meanwhile we have other alternatives available

right now. We have an infrastructure that has been built to produce peak power and it is largely unused at night when we can use it to plug in our vehicles. Your notion of that?

Mr. SANDALOW. There is no question, Senator. We spend hundreds of billions of dollars a year in this country to buy foreign oil. I believe the figure in 2008 was $380 billion or close to it. It is an extraordinary threat to our national security, and one of the best ways to reduce threats to our national security is to change our vehicle fleet so that we are not dependent on that type of oil.

Senator DORGAN. Mr. Chairman, the one thing that is certain to all of us is that we understand change is very hard, and yet, inevitably the thing that we will all experience all of our lives is change. But when you talk about these kinds of things, picking ideas and moving forward, change is very, very hard to accomplish because we live in a circumstance wedded to what we do. I just think this is such an important subject for us in terms of national security, economic security, and also protecting our climate.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator Burr.

Senator BURR. Thank you, Mr. Chairman.

Welcome, Mr. Secretary.

There is a likelihood North Carolina will be an area that is picked and the tremendous amount of money going into North Carolina right now on battery technology, much of which is coming from the Department of Energy in the over $2 billion that was available under the stimulus package.

Let me ask you. S. 3495 authorizes another $1.5 billion in battery R&D. At what point will we have filled the coffers sufficiently with technology money to believe that we can reach that critical mass in the technologies that we need for this to really penetrate the market?

Mr. SANDALOW. Senator, I was visiting Davidson with my 17-year-old——

Senator BURR. A very good pick.

Mr. SANDALOW. Thank you—when by coincidence the President showed up in Charlotte to announce a battery grant at a facility there. So I am familiar with what is happening in your State. I think it is a tremendous opportunity all over the country to create jobs in this area.

I would not want to pick a specific number for research dollars at this point. I do not think we know. That is something that will emerge over time. But one thing I am confident of is that investment in this area will pay dividends for the American people. As we drive down the costs of battery technologies, it is going to speed the dissemination of these vehicles. It is going to reduce our dependence on oil, and it is going to create jobs. In the past the United States has thrived when we have had focused efforts on research and development that have led to extraordinary results. That is the type of thing we can do in this area, and I think bills like this will help us get there.

Senator BURR. Even health care, the research and development that goes on on the research bench is sometimes weighed against commercialization of that product, that breakthrough because that

researcher is going to have to go out and find more research money. Now, I am not suggesting that we are in the same situation on the battery.

But we have got three major challenges, as I see it, to electric penetration, two of which would be range and cost. What is the number that we have got to hit for the range that you bring in enough of the American people that you have now affected the manufacturing cost? At what price point does it need to be for that critical mass to be met?

Mr. SANDALOW. These are big questions and important ones.

A couple of points on this, Senator. There will be different driving habits. So I think with respect to the range, there is no one single answer. There are some people who—like me, I drive 5 miles back and forth to work every day. I have got a car that I basically use for that purpose and almost nothing else. There are lots of Americans who drive cars in that way. I think the figures are that most Americans drive 30 miles or less every day. But then lots of Americans are out there driving hundreds of miles every day in big States.

Now, for the Americans who drive short distances, one type of technology might be better. For the Americans who drive longer distances, other types of technologies might be better. So I do not think there is any one single——

Senator BURR. Should our strategy not be how do we get enough market penetration through electric vehicles that, one, it affects the manufacturing cost and we are bringing that down, so we are addressing point No. 2. We are reducing the costs where it is more affordable for more people. Would that not in itself fuel additional R&D at the company level to try to figure out how to address the range so that you are pulling different customers in the door?

Mr. SANDALOW. There is no question. Two points on that.

First, with respect to cost, one point that is worth remembering and emphasizing is that it costs much less to drive a mile on electricity than it does on gasoline. That electric car that I am driving around—it costs me about the equivalent of 75 cents a gallon to drive. Now, the upfront purchase price of the car is higher. We need to get that upfront purchase price down. But driving on electricity is much, much cheaper because electric motors are more efficient.

You raised the issue, Senator, of the balance between Government funding and private funding in this area, and that is an extremely important one. There is certainly an extremely important role for private sector commercial investment in research and development. But the public sector also has a role in doing the type of research that is pre-commercial, the advanced research that no individual country can benefit from. That has been the model over many decades. We will not get where we need to go if all the research and development in this area is simply in the private sector because there is advanced research and development that needs to be done. So we need to be doing that in our public sector as well.

Senator BURR. I agree with you totally. I think that as we head into this, which is an incredibly important sector, we have also got to figure out up front where is it we are trying to get to. We are not just out trying to fuel the research bench with public and pri-

vate money. We are trying to have replacement vehicles over the combustible engine for some portion of America, and from a national security and economic security standpoint, long-term it means the majority of Americans preferring these platforms, and that the combustion engine is on its way out as we know it today.

I want to make sure our policies send us in the right direction and just do not send us in one direction that has no specific area then that we are pivoting to.

Senator DORGAN. Would the Senator yield on that point?

Senator BURR. I would be happy to.

Senator DORGAN. I think generally speaking most that have been working in this field feel that you need to get a battery capability for a 300- to 400-mile range. We have a prize in this legislation for a 500-mile battery. That, of course, is what we have as an aspiration to develop in the future. But I think most people feel you are going to need to have a 300- to 400-mile range with the battery.

Mr. SANDALOW. If I might also. The Department has established some targets for battery costs as well, and we are looking to try to get battery costs down to $300 per kilowatt hour, for example, which we think will support a commercial market of pretty substantial size.

The CHAIRMAN. Senator Stabenow.

Senator STABENOW. Thank you very much, Mr. Chairman.

First, I think, as I understand it, it is actually a very important day today because I think we need to say happy birthday to Senator Murkowski.

Senator MURKOWSKI. No.

Senator STABENOW. That was on my schedule as being your birthday today. So we will——

Senator MURKOWSKI. It was last month.

Senator STABENOW. Oh, well, they made a mistake. Here I was trying to celebrate your birthday today. I was ready to sing. We will not sing. I was ready to sing. With that, we will take that off the schedule today, singing for Senator Murkowski.

[Laughter.]

Senator STABENOW. So, Mr. Chairman, thank you very much for your leadership on this issue and to Senator Dorgan as well.

Yesterday I attended an opening groundbreaking for a battery facility in Midland, Michigan. Dow Kokam, which is a partnership, and it is one of 16 different facilities in Michigan that is now involved in battery manufacturing for these vehicles. It would not have happened without Senator Dorgan's leadership on appropriations and Senator Bingaman's. So thank you to both of you for that.

When we look at this bill, which I wholeheartedly agree with the goal of this bill, one of the things, Mr. Chairman, that I want to work with you on and work with the sponsors on is to make sure that—and I know you share this, but making sure that we are, in fact, incentivizing purchasing of the manufacturing of these products in this country so that these are American made and we are not incentivizing folks coming in from overseas who already have their own incentives in their own country. So I am looking at this with an eye to this as we go through it.

My question first, though, relates to how we incentivize, in addition to what is being talked about in this bill, and I think there are some important questions as to how we do this. We have got to get started doing a few communities or incentivizing something across the country. We know we have to get started somewhere.

But one of the places that we can really get started much more aggressively I believe than where are is in our own Federal purchasing. I believe that is a piece in the bill as well. So pointing to the General Services Administration now between the post office and the agencies of government and the military, we have over 651,000 vehicles used by the Government. We did a small piece in the Recovery Act, but that alone could make a huge difference in creating the market.

So I am asking, do you believe that we are, in fact, doing enough in this legislation and doing enough in general compared to what we purchase every year and what we could be doing to jump-start not just infrastructure in individual communities but the market as a whole?

Mr. SANDALOW. Thank you for the question, Senator.

We can do a lot with Federal procurement of vehicles. This bill moves us in the right direction on that front. The Federal Government, the last time I looked, buys over 60,000 vehicles a year. There are tremendous opportunities, as you suggest, to use Federal purchasing power in order to make a transition in this market. So I look forward to working with you, with members of the committee to move forward on those provisions in this bill and do whatever we can to improve the ability of the Federal Government to use its purchasing power to promote the transition toward electric vehicles and other types of advanced technologies.

Senator STABENOW. Do you need legislation in order to be able to do that? Or is that something that the administration can make a commitment to and proceed on right now?

Mr. SANDALOW. The administration is already making steps in this area with a number of purchasing decisions. This type of legislation is extremely helpful, Senator, and it sets the direction of Congress. It makes the intent of Congress clear on that and provides authorities which will be very helpful to us in doing exactly that.

Senator STABENOW. Obviously, as you mentioned, the price on your vehicle was higher, even though you are saving money in the long run, higher than you would like it to be. We provide tax incentives and so on. But again, it is just like with computers. It is just like with anything else. The more people who are purchasing it, the more the price comes down. So I think we have a tremendous ability in our marketing—our own ability in the Federal Government to bring down those prices.

Finally, I would just ask as we look at how we incentivize, I believe that we absolutely have to incentivize the electric vehicles as very much a part of our future. But what about multiple electric drive pathways such as fuel cell electric vehicles, other kinds of options so we are going to a broader range around electric vehicles? I do not believe that is in this bill, and I wondered if you might speak to having a broader view in terms of the electric vehicle.

Mr. SANDALOW. We should certainly be investing in a broad range of electric drive technologies, and that would include not just batteries but fuel cells and other types of approaches. I think the consensus view of most experts is that battery-drive vehicles will be on the market sooner than those using fuel cell technologies. So I think it is appropriate to focus in that direction. But we need to be looking at all different pathways to reduce our dependence on oil.

Senator STABENOW. Thank you, Mr. Chairman.

The CHAIRMAN. Senator Corker.

Senator CORKER. Mr. Chairman, thank you. I appreciate the testimony of the Secretary. I am going to actually wait for the second panel. I am trying to juggle financial reform and this. So thank you.

The CHAIRMAN. We have all had a chance to ask questions. Thank you very much for your testimony, and we will allow the second panel to come forward at this point.

The second panel is made up of Fred Smith, the Chairman, President, and CEO of FedEx Corporation in Memphis, Tennessee; Kathryn Clay, the Director of Research with the Alliance of Automobile Manufacturers here in Washington. Brian Wynne is the President of the Electric Drive Transportation Association here in Washington. David Friedman is the Research Director with the Clean Vehicles Program of the Union of Concerned Scientists from Oviedo, Florida. Alan T. Crane is the Senior Program Officer with the National Research Council here in Washington. Thank you all very much for being here.

We will have our usual procedure here. We will just take the written statement that each of you have prepared and submitted and make that part of the record. If each of you could take 5 or 6 minutes and summarize the main points you think we need to understand from your testimony, that would be very appreciated, and then we will have questions.

Why do we not start right here with Mr. Smith and go right across the table? Thank you for coming.

STATEMENT OF FREDERICK W. SMITH, CHAIRMAN, PRESIDENT AND CEO, FEDEX CORPORATION, CO-CHAIRMAN, ENERGY SECURITY LEADERSHIP COUNCIL, AND MEMBER, ELECTRIFICATION COALITION

Mr. SMITH. Mr. Chairman, thank you very much for having me here. Senator Murkowski, Senator Dorgan, other members of the panel.

I will, as you asked, just summarize my testimony.

I think it is important to state how I got involved in this because I think it bears on the question.

A number of business and retired military officers came together several years ago because we shared the concern that the Nation had an enormous economic and national security problem in our reliance on imported petroleum, as Senator Dorgan expressed so well. It was headed by General P.X. Kelley, former Commandant of the Marine Corps, on the military side and myself as the co-chair on the business side. It encompassed a number of major users of petroleum like FedEx Corporation. We operate 670 airplanes, 85,000

vehicles, burn a billion and a half gallons of fossil-based fuel a year. So this was a very significant issue.

The report that we produced with that committee was a central part of the Energy Act of 2007 which called for maximizing domestic oil production and reinstating new fuel efficiency standards. It was from that work that we concluded that electrification of light-duty transportation offered the greatest promise to significantly reduce petroleum usage in general and our dependence on imported petroleum from hostile parts of the world.

An electrification coalition was put together and that coalition produced a study called The Electrification Roadmap whose recommendations and conclusions were then analyzed by the University of Maryland. The results were really quite profound because if we keep on a business-as-usual trajectory and assuming a reasonable GDP growth over the next 25 years, our light vehicle fuel consumption will increase from a little less than 10 million barrels of fuel per day to about 14 million barrels of fuel per day by 2035.

With the adoption of The Electrification Roadmap proposals, which parallel in the main Senator Dorgan's legislation, accompanied with the advantages of the new fuel efficiency standards, those numbers by 2035 decreased to 4 million barrels a day. That is an incredible swing.

Now, we believe that sometimes things are so self-evident that you have to jump on this horse, and the reality is the battery technology that has been developed for our telecommunications and IT world is now capable of providing vehicles which have an adequate range in utility. In that regard, we have a number of all-electric vehicles that we are testing in California at the moment. We brought it to Washington not too long ago. But let me give you some numbers on that which I think gets to some of the points that Senator Burr made.

This is a vehicle that is manufactured by a joint venture between Navistar and Modec, which is a European company. It is made just west of Chicago in a Navistar plant. It is powered by A123 system batteries. I believe they are made in Michigan. They could be in the Indiana plant, but I think they are made in Michigan.

That vehicle has about 2 tons of payload. It has 100 miles of range per day, which is perfectly adequate for light-duty pick-up and delivery operations. It costs about 20 percent per mile to operate compared to a diesel alternative. So there is an 80 percent benefit in operating costs.

The issue is its acquisition cost, and the acquisition cost is roughly 80–85 percent higher than the diesel equivalent.

Our belief is, based on talks with battery manufacturers here and overseas, including in Japan and China, there is a high likelihood that the cost of those batteries will be halved over the next 3 to 5 years. Now, 70 percent of that Navistar-Modec vehicle's cost I just mentioned to you is represented by the battery. So if you get to that point where you brought the cost of those batteries down and hopefully have significant improvements in the power generation as well, the economics of this are compelling. So you reduce the amount of petroleum used in the economy, reduce the amount of CO_2 emitted. You obviously produce a great opportunity for American manufacturing jobs.

We think the recommendations in Senator Dorgan's bill to put these deployment communities in place—they do not mitigate the fact that you can get these benefits of the tax credits anyplace in the United States, but to get those cost performance metrics to the level I mentioned, you have to have scale production, and the best way to do that is what is represented in the legislation in question here in our opinion.

So we feel very strongly that similar to certain technologies that just have such compelling advantages over their predecessors like gas turbines and aviation, replacing the reciprocating engines, that the electrification of light-duty transportation falls in this category, and we would strongly recommend for the national security and national economic risks articulated by Senator Dorgan that this legislation move forward.

Thank you.

[The prepared statement of Mr. Smith follows:]

PREPARED STATEMENT OF FREDERICK W. SMITH, CHAIRMAN, PRESIDENT AND CEO, FEDEX CORPORATION, CO-CHAIRMAN, ENERGY SECURITY LEADERSHIP COUNCIL, AND MEMBER, ELECTRIFICATION COALITION

Good morning, Chairman Bingaman, Ranking Member Murkowski, and members of the Committee. I would like to thank you for giving me this opportunity to speak to you regarding the Promoting Electric Vehicles Act of 2010, a bill that I think represents a tremendously important step forward in our nation's effort to end the very real and pressing threats posed by our dependence on petroleum.

I am proud to serve both as co-Chairman of the Energy Security Leadership Council and as a member of the Electrification Coalition, two organizations dedicated to facing these threats head on.

The Energy Security Leadership Council, formed in 2006, is a coalition of business executives and retired national security leaders who believe that our dependence on oil, much of it imported from unstable and hostile regimes, poses an unacceptable economic and national security threat.

The Electrification Coalition was formed in 2009, and is made up of a group of business leaders who represent the entire value chain of an electrified transportation sector and who are committed to promoting policies and actions that facilitate the deployment of electric vehicles on a mass scale.

I became involved in these organizations for a single reason: it is my belief that after terrorism and the proliferation of weapons of mass destruction, our increased dependence on petroleum represents the biggest single threat to our nation's economy and national security.

I can speak to this issue personally. FedEx delivers more than 7 million packages and shipments per day to more than 220 countries and territories. In a 24-hour period, our fleet of aircraft flies the equivalent of 500,000 miles, and our couriers travel 2.5 million miles. We accomplish this with more than 275,000 dedicated team members, 670 aircraft, and some 70,000 motorized vehicles worldwide.

FedEx's reliance on oil reflects the reliance of the wider transportation sector, and indeed the entire U.S. economy. Oil is the lifeblood of a mobile, global economy. We are all dependent upon it, and that dependence brings with it inherent and serious risks.

In 2008, when oil prices spiked, Americans consumed nearly 20 million barrels of oil a day—one-fourth of the world's total. We imported 58 percent of the oil we consumed, leading to a U.S. trade deficit in crude oil and petroleum products that reached $388 billion—56 percent of the total trade deficit.

A year later, with oil prices averaging just $62 per barrel and oil consumption down, the United States still ran a $200 billion trade deficit in crude oil and petroleum products. At current prices and demand levels, the trade deficit in crude oil and refined products is set to return to pre-crisis levels near $300 billion.

At the crux of America's oil dependence is the energy demand of the transportation sector. Transportation accounted for almost 70 percent of American oil consumption in 2008. Cars and trucks were 94 percent reliant on oil-based fuel for their energy, with no substitutes immediately available in anything approaching sufficient quantities.

The volatility of oil prices affects every American. At the beginning of 2001, oil prices were steady at $30 per barrel. Over the subsequent five years, prices steadily rose, reaching $75 per barrel in June of 2006. After retreating slightly, benchmark crude prices jumped 50 percent in 2007, from $60 per barrel in January to more than $90 in December. In 2008, oil prices soared rapidly, eventually reaching their all-time high of more than $147 per barrel on July 3.

We are all aware of the sharp financial burden on U.S. households that faced—and still face—resets in their adjustable rate mortgages. But it is important to understand that increases in energy costs have been on an equivalent, or even greater, order of magnitude for the entire American economy. A typical subprime borrower with a poor credit history who bought a $200,000 house in 2006 with a 2 year/28 year ARM with a 4 percent teaser interest rate for the first two years would have seen monthly mortgage payments increase from about $950 a month before the reset to about $1,330 after the reset—an increase of about $4,500 a year. In the meantime, between 2001 and 2008, the average retail price of gasoline increased from $1.46 to $3.27, costing typical households $1,990 a year in increased fuel expenses. And that increase in energy costs affected all U.S. households—not just the one household in 20 that held a subprime mortgage.

This burden, multiplied across millions of households, was a major contributor to the ensuing economic slowdown. We saw an explosion in home ownership, with many purchases being made by people who had heretofore not qualified for mortgages. When the price of oil and the price of gasoline began to rise, and inflation on commodities began to take hold, and interest rates began to increase, you had a tremendous diminution in purchasing power and cash flow, which contributed to people having to walk away from their mortgages. The rise in oil prices was the match that lit the fuse of the mortgage mess and the subsequent recession. The U.S. economy lost more than 700,000 jobs between December 2007 and the beginning of September 2008, and the unemployment rate increased from 4.5 percent to 6.1 percent—all before the financial crisis truly hit later in September.

And the steps we usually would take to help strengthen the economy and create jobs in times of weakness are just as easily overcome by oil price volatility. The total effect of changes to the federal tax code from 2001 to 2008 code was a decrease in annual federal income and estate taxes by about $1,900 for the median household. But a typical household's energy costs rose more than that. In other words, every penny that the most Americans saved due to federal income and estate tax cuts over those eight years was spent on higher gasoline bills.

All told, U.S. families and businesses spent more than $900 billion on refined oil products in 2008, representing 6.4 percent of GDP. Today, prices are off their highs. But for how long? Oil is back near $80 per barrel. Many of the underlying fundamentals that pushed oil prices up are still present today, and once demand—temporarily reduced due to the recession—begins to pick up again, prices are likely to follow. Our oil dependence could strangle an economic recovery just as it is beginning to take hold.

The threat to American national security is equally as urgent. The vulnerability of global oil supply lines and infrastructure has driven the United States to accept the burden of securing the world's oil supply. Much of the infrastructure that delivers oil to the world market each day is exposed and vulnerable to attack in unstable regions of the world. According to the U.S. Department of Energy, each day more than 50 percent of the world's oil supplies must transit one of six maritime chokepoints, narrow shipping channels like the Strait of Hormuz between Iran and Qatar. Even a failed attempt to close one of these strategic passages could cause global oil prices to skyrocket. A successful closure of even one of these chokepoints could bring economic catastrophe.

To mitigate this risk, U.S. armed forces expend enormous resources patrolling oil transit routes and protecting chronically vulnerable infrastructure in hostile corners of the globe. This engagement benefits all nations, but comes primarily at the expense of the American military and ultimately the American taxpayer. A 2009 study by the RAND Corporation placed the cost of this defense burden at between $67.5 billion and $83 billion annually.

Oil dependence also constrains U.S. foreign policy. Whether dealing with uranium enrichment in Iran or a hostile regime in Venezuela, American diplomacy is distorted by the need to minimize disruptions to the flow of oil. Too often, oil dependence requires us to accommodate hostile governments that share neither our values nor our goals, putting both the United States and its allies at risk.

Finally, petroleum consumption poses a long-term threat to global environmental sustainability. Curbing emissions is a global issue, and there is not yet an international consensus on a long-term stabilization objective or on the changes in emissions trajectory needed to meet such a goal. International discussions are increas-

ingly centered on a stabilization level that ranges between 450 and 550 parts per million (ppm) CO_2 equivalent (CO_2-eq). In a recently released report, the International Energy Agency assessed the make-up of U.S. new passenger vehicle sales that would be required to meet a 440 ppm target. The analysis found that by 2030, more than 60 percent of new vehicle sales would need to be based on some form of electrification, ranging from traditional hybrids to pure electric vehicles.

We cannot continue down this path. We cannot continue to send untold billions of dollars and jobs overseas to pay for our addiction. We cannot continue to send men and women into harm's way to protect an increasingly vulnerable supply line. We cannot continue to put our future in the hands of hostile nations or fanatical terrorists who can turn off our crucial oil lifeline at the drop of a hat.

There is a solution. The lynchpin of any plan that is serious about confronting oil dependence must be the transformation of a transportation system that today is almost entirely dependent on petroleum. The solution can be found in something that nearly every single one of you has either on your belt or on the table in front of you. The lithium ion batteries that power our cell phones and laptop computers can one day form the nucleus of an electrified transportation sector that is powered by a wide variety of domestic sources: natural gas, nuclear, coal, hydroelectric, wind, solar, and geothermal. No one fuel source—or producer—would be able to hold our transportation system and our economy hostage the way a single nation can disrupt the flow of petroleum today.

Electricity represents a diverse, domestic, stable, fundamentally scalable energy supply whose fuel inputs are almost completely free of oil. It would have clear and widespread advantages over the current petroleum-based system:

1) Electricity is Diverse and Domestic: Electricity is generated from a diverse set of largely domestic fuels. Among those fuels, the role of petroleum is negligible. In fact, just 1 percent of power generated in the United States in 2008 was derived from petroleum. An electricity-powered transportation system, therefore, is one in which an interruption of the supply of one fuel can be made up for by others. This ability to use different fuels as a source of power would increase the flexibility of an electrified light-duty vehicle fleet. As our national goals and resources change over time, we can shift transportation fuels without having to overhaul our transportation fleet again. In short, an electrified transport system would give us back the reins, offering much greater control over the fuels we use to support the transportation sector of our economy. Moreover, while oil supplies are subject to a wide range of geopolitical risks, the fuels that we use to generate electricity are generally sourced domestically. All renewable energy is generated using domestic resources. We are a net exporter of coal, which fuels about half of our electricity. Although we currently import approximately 16 percent of the natural gas we consume, more than 90 percent of those imports were from North American sources (Canada and Mexico) in 2008. And in fact, recent advancements in the recovery of natural gas resources from unconventional reservoirs like shale gas, coal bed methane, and tight gas sands have led to wide consensus that our domestic undiscovered technically recoverable reserves are well in excess of 1,000 trillion cubic feet. We do import a substantial portion of the uranium we use for civilian nuclear power reactors. Forty-two percent of those imports, however, are from Canada and Australia.

2) Electricity Prices are Stable: Electricity prices are significantly less volatile than oil or gasoline prices. Over the past 25 years, electricity prices have risen steadily but slowly. Since 1983, the average retail price of electricity delivered in the United States has risen by an average of less than 2 percent per year in nominal terms, and has actually fallen in real terms. Moreover, prices have risen by more than 5 percent per year only three times in that time period. This price stability, which is in sharp contrast to the price volatility of oil or gasoline, exists for at least two reasons. First, the retail price of electricity reflects a wide range of costs, only a small portion of which arise from the underlying cost of the fuel. The remaining costs are largely fixed. In most instances, the cost of fuel represents a smaller percentage of the overall cost of delivered electricity than the cost of crude oil represents as a percentage of the cost of retail gasoline. Second, although real-time electricity prices are volatile (sometimes highly volatile on an hour-to-hour or day-to-day basis), they are nevertheless relatively stable over the medium and long term. Therefore, in setting retail rates, utilities or power marketers use formulas that will allow them to recover their costs, including the occasionally high real-time prices for electricity, but which effectively isolate the retail consumer from the hour-to-hour and day-to-day volatility of the real-time power markets. By isolating the consumer from the price volatility of the underlying fuel costs, electric utilities would be providing to drivers

of grid-enabled vehicles (GEVs)—vehicles propelled in whole or in part by electricity drawn from the grid and stored onboard in a battery—the very stability that oil companies cannot provide to consumers of gasoline.

3) The Power Sector has Substantial Spare Capacity: Because large-scale storage of electricity has historically been impractical, the U.S. electric power sector is effectively designed as an 'on-demand system.' In practical terms, this has meant that the system is constructed to be able to meet peak demand from existing generation sources at any time. However, throughout most of a 24-hour day—particularly at night—consumers require significantly less electricity than the system is capable of delivering. Therefore, the U.S. electric power sector has substantial spare capacity that could be used to power electric vehicles without constructing additional power generation facilities, assuming charging patterns were appropriately managed.

4) The Network of Infrastructure Already Exists: Unlike many proposed alternatives to petroleum-based fuels, the nation already has a ubiquitous network of electricity infrastructure. No doubt, electrification will require the deployment of charging infrastructure, additional functionality, and increased investment in grid reliability, but the power sector's infrastructural backbone—generation, transmission, and distribution—is already in place.

5) Electric Miles are Cleaner Than Gasoline Miles: Vehicle miles fueled by electricity emit less CO_2 than those fueled by gasoline. Several well-to-wheels analyses conclude that vehicles powered by the full and proportionate mix of fuel sources in the United States today would result in reduced carbon emissions. As renewable power increases its share of the electricity portfolio, and to the extent that new nuclear power comes on line, which I believe is important, the emissions profile of the U.S. power sector and the GEVs powered by it will continue to improve over time. Moreover, to the extent that GEVs are charged overnight using power from baseload nuclear or off-peak renewable power, their emissions footprint can be nearly eliminated. In 2007, the Natural Resources Defense Council and the Electric Power Research Institute published a well-to-wheels analysis of several different automotive technologies fueled by a range of sources commonly used to generate power. Their analysis concluded that using a PHEV would reduce carbon emissions as compared to a petroleum-fueled vehicle even if all of the exogenous electricity used to charge the PHEV was generated at an old coal power plant. Whereas a conventional gasoline vehicle would be responsible for emissions, on average, of 450 grams of CO_2 per mile, a PHEV that was charged with power generated at an old coal plant would be responsible for emissions of about 325 grams of CO_2 per mile, a reduction of about 25 percent. Emissions attributable to the vehicle could be reduced to as low as 150 grams of CO_2 per mile if the exogenous power was generated at a plant without carbon emissions and ranged between 200 and 300 grams of CO_2 per mile if the power used was generated using other fossil fuel generation technologies. In other words, no matter where the power consumed by a PHEV is generated, the overall level of emissions attributable to its operation is lower than that of a conventional gasoline vehicle. The EPRI/NRDC study findings were consistent with a 2007 MIT study that examined the same issue.

In short, high penetration rates of GEVs could radically minimize the importance of oil to the United States, strengthening our economy, improving national security, and providing much-needed flexibility to our foreign policy while clearing a path toward dramatically reduced economy-wide emissions of greenhouse gases.

No other alternative to petroleum can claim these widespread advantages. This is not to say that other alternatives have no role to play in a post-petroleum transportation sector. On the contrary. Natural gas, for example, may be used successfully in fleet vehicles, particularly those that can be centrally refueled, such as taxis, buses, specialized harbor and airport vehicles, and refuse-collection trucks. Even more importantly, natural gas will play a crucial role in providing electricity, a role in which it can be far more efficiently deployed than in actual vehicles. Other alternatives may also offer advantages in niche uses. But none offers the array of advantages that electricity does.

The logical next question is how we can successfully devise and deploy an electrified transportation system.

Here's what we need to avoid: it has now been more than 10 years since traditional hybrids were first introduced in the United States. And despite government support and record high gas prices for part of that time, there are still only 1.6 million of them on the road out of more than 250 million vehicles in the light duty fleet.

We cannot let electric vehicles turn into another niche product. We cannot allow their use to be limited to environmentalists and technological enthusiasts. To make

our nation's investment worthwhile—and, more importantly, to truly combat our oil dependence—we must put ourselves on the pathway toward millions, then tens of millions, and then hundreds of millions of electric cars and trucks.

It is not as simple as flipping a switch. Electrification on a mass scale is an enormously complex undertaking. The issue is not simply one of putting electric cars into showrooms. At the most basic level, the first commercially available EVs and PHEVs will be significantly more expensive than their internal combustion engine counterparts. The existing tax credits help offset that cost, but they hardly represent a transformative policy framework that will give consumers the necessary confidence to adopt a fundamentally new technology. For electrification to appeal to consumers, it will truly 'take a village.'

For example, drivers will want to know that installing a charger in their garage will be a seamless and simple process that isn't bogged down by weeks of red tape. For EV drivers, they will want access to some amount of public charging infrastructure so that they can feel confident as they complete a Saturday full of errands and shopping—or take the family on the highway for the great American road trip.

The proactive engagement and support of utilities will be absolutely critical. Smart charging will make EVs and PHEVs an asset for the grid, but dumb charging will make them a liability. One analysis by EPRI found that plugging in just one PHEV to charge at 220 volts overloaded 36 of 53 transformers examined during peak hours and 5 of 53 transformers during off-peak hours. We are all excited about the benefits of using EVs and PHEVs to fill valleys in utility load curves, but this will only work if consumers have the ability to receive information that incentivizes them to charge their cars at night. Yet, most public utility commissions don't encourage or allow time of use pricing.

The bottom line is that, for this technology to succeed, the vehicles will need a network of support—both in terms of regulations and infrastructure. Without that, they will be relegated to niche product status. Consumers will have poor experiences, many of the 3,000 utilities in the U.S. will play an absentee role—at best—in the process, and we will have invested billions of dollars in a battery industry that finds stronger roots in Europe (where fuel prices are higher) and in China (where the public imperative is already stronger). We have to recognize that such a network of support does not currently exist in most places in the U.S.

That is where this crucial legislation comes in.

This bill would initiate a competition in which specific geographic areas would vie to be selected as large-scale deployment communities: areas in which all of the elements of an electrified transportation system are deployed simultaneously and at scale, thereby providing a crucial first step toward moving electrification beyond a niche product into a dominant, compelling, and ubiquitous concept. These deployment communities would be selected on a competitive basis. The most attractive regional bids would demonstrate a clear path to successful integration of GEVs, including:

—A supportive regulatory environment that facilitates concepts like utility investment in upgraded physical and IT assets; time of use pricing; and a seamless process for permitting and installing level II EVSEs in residential consumer garages.

—Support and participation from a broad swath of stakeholders, including state and local governments, utilities, utility regulators, large local employers, universities and others.

—A diversity of business plans, allowing innovators and entrepreneurs to explore the most effective and efficient models for deployment.

In sum, successful bids should be those in which all of pieces have been brought together—autos, infrastructure, favorable regulatory environment, interested consumers—to ensure that large scale deployment of GEVs has the best chance of success.

Once selected, deployment communities would be eligible for amplified, targeted, and temporary financial incentives for consumers, infrastructure providers and utilities. The bill envisions in between five and 15 deployment communities in the first phase of the program. Within five years of the bill's enactment, the Secretary of Energy would be required to produce a report evaluating its success and justifying a decision to either expand to a second phase of additional cities or end the program. If fully implemented, the legislation would aim to deploy a total of 700,000 grid-enabled electric vehicles and their infrastructure in the first deployment communities over a five-year period.

We believe this approach is critical to avoiding the pitfalls of the past. These deployment communities would:

1) Drive Economies of Scale: Concentrating resources in a limited number of geographic areas will allow participants in the GEV value chain to take advantage of economies of scale, particularly with respect to the deployment of charging infrastructure. Utilities will incur fixed costs to support the operation of GEVs; those costs will be more affordable if spread over a greater number of vehicles. Power providers also can reduce the cost of charging infrastructure through economies of scale. While it is unclear how many public vehicle chargers will be necessary for a GEV transportation system to operate smoothly in a given community, it is clear that some public charging facilities will be needed. Previous pilot studies demonstrate that the cost of installing charging facilities can be reduced significantly when groups of facilities are installed at once. Furthermore, these geographic concentrations will stimulate demand for grid-enabled vehicles at a rate that is likely to be far greater than if the vehicles are simply purchased by early adopters scattered around the United States. Early on in the process, this higher level of demand will simply be the result of magnified consumer incentives. Subsequently, as individual metropolitan areas gain exposure to GEVs and confidence increases, adoption rates should be measurably expedited.

2) Demonstrate Proof of Concept Beyond Early Adopters: By demonstrating the benefits of grid-enabled vehicles in a real world environment, this deployment plan will make consumers, policymakers and industry aware of the tremendous potential of electrification of transportation. In general, consumers are probably unaware that GEVs have evolved to the point where they can meet most individuals' daily driving needs. In addition, electric drive vehicles generally have faster acceleration and operate more quietly than internal combustion engine vehicles. They hold out the promise of offering drivers a wide range of features, based on the electronic package in the vehicle, that are beyond our imagination today in the same way that iPhone applications would have been beyond our imagination a decade ago. The problem is that consumers are not aware of the opportunities presented by GEVs and are not yet convinced that they can operate reliably and affordably at scale. Concentrating investments and other efforts in a limited number of communities will accelerate the opportunity to demonstrate that grid-enabled vehicles can meet drivers' needs. In addition, these projects will demonstrate that a community is capable of putting the infrastructure in place, operating the vehicles over their lifetimes, and disposing of them after their useful life has ended, all in a manner that profits the participants in the value chain.

3) Facilitate Learning by Doing: While GEVs present a great opportunity, their deployment also raises a number of questions. Deploying large numbers of GEVs in concentrated areas will allow for the collection of information and experience that is needed to successfully deploy GEVs nationwide. It will help automakers learn how much consumers are willing to pay up front for a car that costs less to operate and has a lower total cost of ownership over its lifetime. It will allow utilities and charging station providers to learn when and where drivers want to charge their vehicles. It will allow utilities and other aggregators to learn who can best sell power to drivers and what types of rate structures meet both drivers' and utilities and aggregators' needs. It will help determine whether there is a viable business model for public charging infrastructure. It is clear that for GEVs to succeed there must be a model in which each party in the value chain is able to operate profitably, or in which the government determines that, as a matter of public policy, certain aspects of the system should be publicly supported in a manner that facilitates further competition. Deploying GEVs in a series of geographic regions around the country where resources can be concentrated and data can be collected and studied will ultimately accelerate wide-scale GEV deployment. Therefore, rather than allowing the market to develop scattershot across the country, it is critical that the market be encouraged to develop at a deliberate pace in clearly identified geographic regions in which a large number of vehicles can be deployed in a relatively short period of time.

Now, let me go into this idea of deployment communities a little more in depth. First, I'd like to talk about the competition.

In order to be selected, a community will need to present a comprehensive proposal, similar to bids to host the Olympic Games. Such a proposal would need to show capability and buy-in from a wide range of public and private players, including local governments, utilities, major employers, and more.

Cities and communities throughout the nation will be eligible to compete for selection as a deployment community. And the bill makes it clear that in selecting de-

ployment communities, DOE should seek areas that are diverse regionally, geographically, climactically, in terms of their urban and suburban composition, size, typical commuting patterns, and type of electric utility.

We believe we would also see an important diversity in the business models that innovators and entrepreneurs would present to explore the most effective and efficient models for deployment. Again, the advantage of a competitive, market-based plan like this is that the best ideas have the opportunity to rise to the top.

We believe the result of passing this legislation will be a great competition, a race to the top as communities fight to present the most fertile ground for an exciting new technological rollout. Even those that are not ultimately selected will have, in order to compete, taken steps that will ultimately make the adoption and deployment of electric vehicles and infrastructure more achievable within their borders.

We've already seen cities and other localities across the country taking the first steps toward electrification, whether it is installing charging infrastructure, buying the vehicles for city fleets, or some combination of both and more. They see the benefits and are eager to take the next step. If we pass this legislation, I think we will see cities once again, as they have in the past, playing the role of experimenters and leaders in this exciting new technology.

Incidentally, let me address a concern that others have brought up about this very aspect of the deployment community idea: that it overly concentrates resources in a small number of communities.

I strongly disagree with this criticism.

First, these plans do nothing that would limit or impede the current nationwide incentives for electric vehicles. Today, a maximum tax credit of $7,500 on qualified electric drive vehicles exists nationwide. Additional credits exist for infrastructure. This bill does not in any way impact the maximum vehicle tax credit available to consumers nationwide. What we are talking about is added incentives, which will spur added demand. In fact, the goal of this legislation—700,000 vehicles—represents higher penetration rates than the total currently announced North American electric vehicle production capacity for 2015.

Second, the benefits accrue far beyond the deployment communities themselves. While money will flow into these communities, they should more correctly be thought of as funnels through which a substantial portion of the funds will flow on their way elsewhere around the country. Much of the money that flows through deployment communities will end up in the towns and cities where the vehicles and charging infrastructure and their components are manufactured. When a factory reopens in a depressed area to build or support these vehicles—as we've already seen in places like Elkhart, Indiana and Livonia, Michigan—that is a real and tangible benefit for hardworking Americans.

Third, if this program succeeds, it will drive down costs for electric vehicles for consumers throughout the nation. It will also set the nation on a path toward greater energy security and economic prosperity through sharply reduced oil dependence. This effort is about building a new transportation system from the ground up in a fiscally responsible, competitive fashion. That's good for the entire nation.

This leads us to another criticism: that what this bill proposes is just another demonstration project that may in fact end up being counterproductive, showing that electric vehicles and plug-in hybrid electric vehicles are not ready for prime time.

My response to that is simply that it will not happen.

Again, we are talking about 700,000 electric vehicles here, representing a significant percentage of all vehicles within the deployment communities. That is not a pilot project. That is a carefully-planned rollout for a major new technology at scale. All of the major automakers who have committed to electrification have adopted similar targeted rollouts, choosing specific communities, so clearly they see the value in careful planning.

And let's look at the alternatives. Vehicles deployed in small pilot programs will likely end up solely in the hands of enthusiasts, whether environmentalists or people simply interested in new technology. While they should be able to get these vehicles, it is not enough. These vehicles must penetrate the market sufficiently to demonstrate that they can meet the needs of average drivers or they risk being relegated to niche status, as happened to hybrids, in which case their deployment would be too limited to make any meaningful headway toward our shared goal of reducing oil dependence. On the other hand, a widespread national rollout without careful planning will stall electrification before it has a chance to succeed. This approach is the happy medium, the one that allows us to build toward true penetration and scale in a responsible manner.

The bill we are discussing today recognizes a simple fact: electrification will not move past niche product status without careful policy coordination designed to over-

come early obstacles. Grid-enabled vehicles require a network to thrive—a network that includes regulatory support, some amount of infrastructure, and progressive utilities. There are very few communities where such an environment exists today. And this says nothing of the higher costs of purchasing a GEV and consumers' general uncertainty in adopting an unfamiliar technology.

A targeted regional deployment program featuring a competitive selection process will sharply increase the number of places where a supportive GEV network exists. Strong financial incentives for vehicles and infrastructure in these regions will drive high concentrations of cars onto the road in a short period of time and help achieve scale in battery manufacturing. The program will drive businesses and investment into deployment communities and help create jobs. The consequences of this approach will be to associate GEVs with renewed economic growth in deployment communities while setting the stage for a broader rollout in phase two.

Finally, let me say this: we understand that this is a challenging time for suggesting increased government expenditures for any project, no matter how worthwhile. We also, however, believe that certain aspects of the threat of oil dependence and the solutions we recommend make this a unique issue.

First is the urgent national security threat posed by our dependence on oil. While we cannot and should not ignore costs, threats to national security have always occupied a unique place of priority in our budget considerations. And make no mistake: the dangers posed by our oil dependence are not theoretical. Our safety and security are threatened by oil dependence, and every single day that we do not act is another day that we remain vulnerable.

Second is the economic cost of inaction. In the midst of a well-supplied oil market and weak oil demand growth in developed economies, the United States is still on pace to run a $300 billion deficit in crude oil and petroleum products in 2010. At the same time, most analysts expect the medium and long term to be characterized by rapid oil demand growth in emerging markets coupled with weak increases in global oil production capacity. The result will be a return to tight oil markets and volatile oil prices in the future. The IEA expects this scenario to play out by 2014. Other analysts expect the crunch to come by 2011. In either case, the United States cannot wait to act.

Finally, the environmental catastrophe unfolding in the Gulf of Mexico is making clear once again yet another aspect of the danger posed by our dependence. The longer we remain addicted, the more oil we will have to produce from more and more technically and environmentally challenging areas. The only way to turn from that dangerous path is to end our dependence. And the only way to do that is by ending oil's chokehold on our transportation system.

Other energy policies have their strengths and may very well be worthwhile on their own merits and in the pursuit of their own goals, but if they do not include a detailed, well-defined pathway to a post-petroleum transportation sector, then—for all of their other potential benefits—they will not have a significant impact on the economic and national security dangers posed by our oil dependence. If we do not answer that crucial question, then we are not addressing energy security in the way that we must to secure our future.

The public is demanding action. Electrification is truly bipartisan not just here in Washington but across the country. Americans often agree on challenges more than solutions, but that is not the case here. This proposal is popular, and it is popular for a reason.

This is no longer a question of technology. The technology is here, which is not something we can say with as much confidence about many of the other potential alternatives to petroleum. People are rushing to sign up to get in on the first wave of Nissan LEAFs. The Chevy Volt, the CODA, and other electric vehicles are on their way as well. But the technology is not enough. What we really need is the sustained commitment that will lead to a true transformation. It's simply a matter of organization, and—more importantly—a matter of national will and a matter of execution.

Here is what I know, as the leader of a company that both depends on and helps to strengthen the mobility upon which our global economy is built: If we support this new path, if we build these deployment communities that are so crucial to jumpstarting a new, national transportation system, then that is a game changer. It is a game changer for businesses like mine, for employees, for consumers, for the economy, and for the country. A new future is ours for the taking, but only if we choose it and support it.

Thank you for your attention.

The CHAIRMAN. Thank you very much.

Kathryn, go right ahead. We are glad to have you back here with the committee. Kathryn, of course, worked for Senator Domenici on the committee staff for many years.

STATEMENT OF KATHRYN CLAY, PH.D., DIRECTOR OF RESEARCH, ALLIANCE OF AUTOMOBILE MANUFACTURERS

Ms. CLAY. Thank you, Mr. Chairman. It is very nice to be back.

Mr. Chairman, Ranking Member Murkowski, Senator Dorgan, and other members of the committee, good morning. My name is Kathryn Clay, and I am the Director of Research for the Alliance of Automobile Manufacturers. The alliance is a trade association made up of 11 car and light-duty truck manufacturers, including BMW, Chrysler, Ford, General Motors, Jaguar/Land Rover, Mazda, Mercedes-Benz, Mitsubishi, Porsche, Toyota, and Volkswagen. On behalf of the member companies of the alliance, I would like to thank you for giving me the opportunity to speak with you about S. 3495, the Promoting Electric Vehicles Act of 2010 sponsored by Senators Dorgan, Merkley, and Alexander.

Automakers share the goals of reducing greenhouse gas emissions and enhancing energy security. We support a national economy-wide approach that will result in emissions reductions from all sectors with the least negative economic impact for the Nation.

At the same time, we recognize our responsibility as automakers to help reduce emissions from the transport sector and to reduce our dependence on foreign oil. We have demonstrated our commitment by supporting the One National Program for greenhouse gas emissions and fuel economy standards for light-duty vehicles for the years 2012 through 2016 that was announced—the final version—earlier this year. The Energy Independence and Security Act of 2007, which originated in this committee, required a 40 percent increase in fuel economy standards by 2020. The One National Program accelerates this pace by 4 years, reducing oil consumption by a further 1.8 billion barrels and lowering greenhouse gas emissions by an additional 950 million metric tons. Building on this commitment, automaker CEOs recently stood with the President announcing support for a new process for further standards from 2017 through 2025.

As part of this, automakers are committed to advancing electric mobility to meet these aggressive standards. Our member companies have announced plans to launch a range of electric drive vehicles, including plug-in hybrid, extended-range hybrid, better electric and fuel cell vehicles in the coming model years.

Before turning to the specific legislation at hand, let me address an issue that is critical to the deployment of electric drive vehicles in general, and that is the issue of how upstream emissions will be treated in future rulemakings with regard to electric drive vehicles.

Until we significantly alter how we produce electricity in our Nation, including upstream emissions and the vehicle greenhouse gas standards will mean that electric vehicles will rate only marginally better than conventional internal combustion engines and comparatively worse than the conventional hybrids we have on the roads today. As a result, including upstream emissions creates a huge disincentive for producing electric vehicles versus less costly and

less game-changing technologies. This approach would also be unfair in that it would treat plug-in vehicles differently than other end uses of electricity, making vehicle manufacturers uniquely responsible for utility emissions, emissions over which automakers have no control.

Turning now to the legislation, while we share the goal of the bill to promote electric drive vehicles and support many of the bill's provisions, we do disagree with key elements of the approach taken in S. 3495 and at this time cannot support the bill as written. Let me explain why.

Our first major concern is that the legislation does not include fuel cell electric vehicles and related hydrogen infrastructure. The flexibility to invest in multiple electric drive pathways is important because hybrid, better electric, plug-in hybrid, and fuel cell vehicles each offer unique benefits in different vehicle segments.

Our second major concern is that the deployment community approach would create a few big winners and far too many losers among communities across the Nation that have already expressed an interest in participating in the transition to electric drive. Trying to prejudge the market brings tremendous risk, and the problem is compounded if we make just a few large bets, particularly at such an early stage of electric vehicle deployment. A more inclusive approach would maximize the chances of success for our public investments overall even if this means that individual communities would receive lower levels of total funding on a case-by-case basis.

The most efficient solution is to provide the Department of Energy's existing programs with significant funding increases to support a comprehensive national program. Key elements should include transportation electrification efforts already started through Recovery Act funding and the Clean Cities program.

Let me close by noting the alliance support for a particularly important provision in our view included in the bill that would better align our Federal efforts across many agencies with our national goals for electric vehicles. Establishing an interagency electric drive working group would bring needed coordination to Federal programs and we further would recommend that the administration move as quickly as possible to follow this recommendation included in the legislation and to designate a single point that would serve as the lead office or lead official to direct the activities of the working group.

We in the auto industry look forward to working with this committee and with the bill's sponsors to address the infrastructure and consumer acceptance issues that will be so important to the ultimate success of electric drive vehicles and their contributions to our national goals.

Thank you.

[The prepared statement of Ms. Clay follows:]

PREPARED STATEMENT OF KATHRYN CLAY, PH.D., DIRECTOR OF RESEARCH, ALLIANCE OF AUTOMOBILE MANUFACTURERS

Chairman Bingaman, Ranking Member Murkowski, and Members of the Committee, good morning, my name is Kathryn Clay and I am the Director of Research for the Alliance of Automobile Manufacturers. The Alliance is a trade association made up of eleven car and light truck manufacturers including BMW Group, Chrysler LLC, Ford Motor Company, General Motors, Jaguar/Land Rover, Mazda, Mer-

cedes-Benz USA, Mitsubishi Motors, Porsche, Toyota, and Volkswagen Group. On behalf of the member companies of the Alliance, I would like to thank you for giving me the opportunity to speak with you about the industry views of S. 3495, the Promoting Electric Vehicles Act of 2010 sponsored by Senators Dorgan and Merkley. We commend the sponsors for their leadership on the issue of electric drive vehicle deployment. The Alliance looks forward to working with the Bill's sponsors, and the members of this Committee, to address important concerns we have with the legislation in its current form.

Automakers share the goals of reducing greenhouse gas emissions (GHG) and enhancing energy security. We continue to support a national approach for an economy-wide GHG emissions reduction program that will result in GHG emissions reductions from all sectors at the lowest cost with the least amount of negative economic impact.

At the same time, we recognize our responsibility as automakers to reduce emissions from our sector, and to reduce our dependence on foreign oil. We have demonstrated our commitment to this principle through our support of the One National Program to impose GHG emissions standards and increase fuel economy standards for light-duty vehicles for the years 2012 through 2016. This landmark agreement accelerates by four years the pace set in the Energy Independence and Security Act of 2007, which required a 40 percent increase in fuel economy standards by 2020. As a result, we will reduce our nation's oil consumption by 1.8 billion barrels and lower GHG emissions by approximately 950 million metric tons. Moreover, automaker CEOs recently stood with the President in support of a process for new standards from 2017 through 2025.

Meeting the diverse and challenging requirements of the transportation sector will only be possible through a portfolio of advanced powertrain technologies. Continued improvements to the efficiency of the internal combustion engine will play a significant role. But in the coming decades, the vehicle fleet will be much more technologically diverse, with growing proportions of flex fuel, clean diesel and electric drive vehicles on our nation's roadways.

However, achieving the ambitious target of an economy-wide 83 percent reduction of GHG emissions by 2050 will require electric drive vehicles to play a critical role, with hybrid, battery electric, plug-in hybrid and fuel cell vehicles offering unique benefits in different vehicle segments. For this reason, we believe the legislation should allow manufacturers, fuel providers, and communities the flexibility to invest in multiple electric drive pathways, including fuel cell electric vehicle and related hydrogen infrastructure. In addition, we must recognize that future successes of electric drive vehicles will be enhanced by growth in today's hybrid electric vehicles, by establishing technical expertise and manufacturing capacity for batteries, motor and other key electronic components, and driving down their costs through production scale.

In order for electric drive vehicles to contribute meaningfully to our transportation future, long term and consistent federal policies are needed to transition from a low volume niche market to sustainable high volumes. Achieving widespread acceptance of these technologies requires focused efforts to align regulatory efforts; develop a supporting infrastructure; provide research and development; and provide incentives for consumer adoption and remove other market barriers. Unfortunately, S. 3495 falls short of establishing the necessary elements for a comprehensive and sustainable approach. The Alliance submitted numerous comments to improve on the Bill that were not adopted. As a result, the Alliance is not able to support the Bill as written.

As an industry, we have significant concerns about an approach that would limit investments to a handful of communities, particularly at such an early stage of electric vehicle deployment. This creates a small number of communities that would "win" and receive significant federal dollars while the rest of country loses out. Attempts to prejudge the market bring tremendous risks, and the problem is compounded by making just a few large bets. We need a long term "building block" approach that will lead to a sustainable future for electrification—not a program that pits one community against another or one state against another in a limited competition for federal funding.

Opening up the grant program to a larger number of communities, with wide regional representation, would avoid limiting automakers' potential customer base for these vehicles and maximize the chances of success for our public investments overall—even if this means that individual communities would receive lower levels of total funding.

Automakers need consistent regulatory policies to move us toward our collective goal to expand penetration of electric vehicles on U.S. roads. One issue especially critical to this discussion is how upstream emissions will be treated in future poli-

cies and rulemakings. Until the U.S. enacts a comprehensive climate program that significantly alters how we produce electricity, electric vehicles will be only marginally better from a total greenhouse gas perspective than conventional internal combustion engines, and less beneficial than hybrids given the mix of fuels used to generate our current (and near term) supply of electricity.

As a result, basing policy on including upstream emissions creates a huge disincentive for producing electric vehicles versus other less costly (and less game-changing) technologies. This approach would also be unfair in that it would treat plug-in vehicles differently than other end-uses of electricity, making vehicle manufacturers uniquely responsible for upstream emissions—emissions over which automakers have no control. This precedential policy would create an unlevel playing field among the regulated community and create additional barriers that will be counter-productive to market penetration of electric vehicles; a direct deterrent to the very goals that the legislation is trying to avoid and overcome.

We believe that any strengthening of consumer incentives should be integrated into the existing program which currently provides up to $7,500 per vehicle and is based key on performance parameters related to battery size captured in existing law. This federal incentive promotes all types of plug-in electric vehicles equitably across all potential consumer segments. A single federal incentive program will avoid confusion and promote greater certainty with customers irrespective of where they live. Examples of strengthening the existing incentive include making it available to consumers at the point of sale, along with increasing the amount and number of vehicles to which it applies.

Another measure lacking in the bill is ongoing funding for U.S. facilities for the production of critical electric drive components such as electric motors, electric drive transmissions, and advance battery components. Almost all of these critical components continue to be manufactured overseas and imported into the U.S. trading our dependency from foreign petroleum to critical electric drive components. We need legislation that focuses on long term investment in the U.S. to adequately compete with developing countries for the production of these components.

The Bill would also ban landfill disposal of advanced technology batteries, which is not justified at this time. Provisions for the safe recycling and eventual disposal of advanced technology batteries need to be developed based on the best science. We propose that, in place of a ban, the recycling study required by the bill should be expanded to address recommendations for appropriate disposal of these batteries.

A key way to move forward on infrastructure planning and consumer outreach is to build on the success of the existing Department of Energy programs. This work to expand electric vehicle infrastructure, particularly through the transportation electrification efforts started through Recovery Act funding and the electric drive vehicle activities under the Clean Cities program, should receive significant funding increases to support an expanded, sustained effort to enhance our national readiness for electric drive vehicles.

For any technology to be successful it must be consumer driven, and a national program that helps the consumer with the most pressing need, residential charging, offers the best opportunity for sustainable growth and deployment of electric drive vehicles. Business models must be developed that will allow the private sector to deploy charging infrastructure in the full range of residential situations including high rise buildings, garden apartments, and town houses. A range of innovative solutions to address the challenges facing both residential and workplace charging should be funded and we believe the most efficient solution is to provide the Department of Energy's existing programs with significant funding increases to support a comprehensive, national program.

S. 3495 would establish an Interagency Electric Drive Working Group to align federal programs with our national goals for electric drive vehicles. The Alliance supports this position, and believes that a strengthened interagency process would provide greater coordination of federal expenditures related to electric drive technologies and of regulatory efforts across the federal government. We further recommend that the Administration designate a lead official with the responsibility, and budget authority, needed to direct the activities of the working group. The Bill would also establish an Electric Fuel Task Force, which the Alliance believes would enable the private sector to engage collaboratively with the administration to address the challenges to large scale deployment of plug-in electric drive vehicles.

Automakers are committed to advancing electric mobility. Our member companies have already announced plans to launch plug-in hybrid, extended range hybrid, battery electric, and fuel-cell vehicles in the coming model years, and are hard at work developing the next generation of electric-drive vehicles that will follow. We look forward to working with the Committee, Senator Dorgan, and Senator Merkley to address the infrastructure and consumer acceptance issues that will be so important

to the ultimate success of these vehicles, and their contribution to our national goals.

The CHAIRMAN. Thank you very much.

Mr. Brian Wynne with the Electric Drive Transportation Association. Thank you for being here.

STATEMENT OF BRIAN P. WYNNE, PRESIDENT, ELECTRIC DRIVE TRANSPORTATION ASSOCIATION

Mr. WYNNE. Thank you, Mr. Chairman, Senator Murkowski, members of the committee. I am Brian Wynne, the President of the Electric Drive Transportation Association. I am pleased to be here today to discuss S. 3495 and want to express our appreciation for the committee's ongoing support for electric drive and recognition of its role in a cleaner, more secure transportation future.

The Electric Drive Transportation Association, founded in 1989, is the cross-industry trade association promoting the advancement of electric drive technology and electrified transportation. EDTA members include leading and emerging vehicle, battery, and component manufacturers, as well as electricity providers, smart grid and infrastructure developers, and others. Collectively, we are building the advanced vehicles, green jobs, sustainable transportation options and energy independence that comprise the electric drive future.

This committee has historically led the way on electric drive, most recently with the 2007 energy bill which established important programs and incentives to provide investments in electric drive, many of which were funded in the 2009 Recovery Act.

Industry is rapidly moving forward with plug-in electric drive vehicles and component production, creating the green jobs that are the foundation of a thriving 21st century economy. Plug-in electric drive vehicles are available today and multiple models of cars and trucks are entering the market in the next 2 years, including the GM Volt, the Nissan Leaf, the Mitsubishi i-MiEV, Toyota's plug-in Prius, the Smith battery electric, Ford Transit Connect plug-in hybrid trucks, Coda, Tesla, and THINK, all bringing battery electric sedans to the market—and others.

In nearly every State, collaborative efforts between utilities, electricity infrastructure providers, governments, and automakers are already underway, developing vehicle and infrastructure plans.

As set out in our action plan, EDTA supports a comprehensive push toward electric drive, including a national initiative to promote plug-in electric drive vehicles. We believe that regional deployment efforts are important as part of such a national effort.

S. 3495 would establish a 5-year, $100 million national program to advance nationwide adoption of electric drive vehicles and also authorizes a $4 billion investment in 5 to 15 deployment communities that would receive up to $5 million each. Both the national and localized deployment programs include important elements for advancing plug-in deployment, including stakeholder involvement, technical assistance, grid integration planning, and work force training.

However, we believe that a greater emphasis on the national effort and a larger group of deployment communities will be more ef-

fective in building the national fleet than concentrating Federal resources in such a limited number of communities.

Collaborative, localized deployment efforts are already underway with others planned. Plug-in vehicles are already in the national market and vehicle makers are moving forward with efforts to build national markets in the next 2 to 3 years. We would like to see the national electric drive effort support all of these efforts as they need it.

Additional items that we support in plug-in electric drive legislation that I would like to highlight in this statement include, first, an emphasis on private in addition to public recharging infrastructure. Industry studies confirm that at least initially most charging of plug-in vehicles will be done at primary residences overnight. The next greatest opportunity for charging is at the workplace during the day. We believe that meeting these recharging needs should be an explicit priority for national and localized deployment efforts. We support directing additional research and technical assistance toward facilitating residential and workplace charging.

Second, we support incentives for expanded investment in U.S. vehicle and component manufacturing which will help to bring the vehicle cost down while building U.S. competitiveness in global markets.

Third, we support the bill's program to integrate plug-in electric drive in Federal fleets with funds for purchasing vehicles, as well as transparency and accountability for their use. We would also like to see a comprehensive approach that recognizes all of the electric drive technologies, including fuel cells and hybrids.

Finally, we strongly support the bill's emphasis on consumer education and work force training which are also very important to a national effort to build a diverse national fleet of electric drive vehicles.

We appreciate Senator Dorgan's history of leadership on all electric drive and his effort to achieve the right balance between national and more localized efforts. As the bill moves forward through this committee, we would like to work with the chairman and Senator Dorgan to ensure that finite Federal resources are apportioned in the most effective way to ensure the achievement of the goal that we share, a diverse national fleet of electric drive vehicles.

I thank you for the opportunity and look forward to your questions.

[The prepared statement of Mr. Wynne follows:]

PREPARED STATEMENT OF BRIAN P. WYNNE, PRESIDENT, ELECTRIC DRIVE TRANSPORTATION ASSOCIATION

Good morning, Chairman Bingaman, Senator Murkowski, members of the committee. I am Brian Wynne, President of the Electric Drive Transportation Association. I am pleased to be here today to discuss S. 3495 and want to express our appreciation for this Committee's ongoing support for electric drive and recognition of its role in a cleaner, more secure transportation future.

The Electric Drive Transportation Association (EDTA), founded in 1989, is the cross-industry trade association promoting the advancement of electric drive technology and electrified transportation. EDTA members include leading and emerging vehicle, battery and component manufacturers, as well as electricity providers, smart grid and infrastructure developers, and others advancing diverse technologies that will displace oil with electricity in transportation. Collectively, we are building the advanced vehicles, green jobs, sustainable transportation options and energy independence that comprise the electric drive future.

Looking beyond the price of gas, the cost of oil dependence is increasingly unsustainable. The dollars spent on imported oil, the chronic—and acute—environmental impacts, as well as the economic and security challenges created by a transportation sector almost entirely dependent on a single fuel. These are all costs that we have been paying, and ignoring, for too long.

We are here today because, as a nation, we have recognized the cost is too high. We need to embrace other options for the transportation sector. EDTA believes that a comprehensive effort to move away from oil dependence must include a national fleet of electric drive vehicles—that is battery electric, hybrid, plug-in hybrid and fuel cells—in cars, trucks, low speed and non-road vehicles.

With the leadership of this Committee, the Energy Independence and Security of 2007 established important programs and incentives to promote investments in electric drive, many of which were funded in the 2009 Recovery Act. The Administration has also declared an ambitious goal for plug-in vehicles—1 million on the road by 2015.

Industry is rapidly moving forward with plug-in electric drive vehicle and component production, creating the green jobs that are the foundation of a thriving 21st century economy. Plug-in electric drive vehicles are available today and multiple models of cars and trucks are entering the market in the next two years, including the Volt from GM, the Nissan Leaf, the Mitsubishi i-MiEV, Toyota's plug-in Prius, the Smith battery electric and Ford Transit Connect plug-in hybrid trucks and Coda's and Tesla's battery electric sedans.

In nearly every state, collaborative efforts of utilities, governments and auto makers are already underway, developing vehicle and infrastructure plans.

Based on the industry's work, with the support of key federal policies, we are standing on the cusp of transformational market entry of plug-in vehicles. And the choices made here can make the difference in how quickly we achieve our goals. Building on what we have achieved, what we have learned and what is required to realize the goal of an electric drive future; EDTA has identified in our Action Plan the key "next step" actions for policymakers to achieve our shared goal of a diverse national fleet of electric drive.

Moving forward, areas of critical emphasis for federal policy accelerating electric drive include: reducing market hurdles to address cost and infrastructure concerns; expanding U.S. manufacturing capacity for advanced vehicles and components; establishing coherent regulatory policies for vehicles and infrastructure; accelerating technology breakthroughs and promoting public and private outreach and education.

EDTA supports a comprehensive push toward electric drive including a national initiative to promote plug-in electric drive vehicles. We believe that regional deployment efforts are important, as a part of such a national effort.

S.3495 would establish a 5 year, $100 million national program to advance nationwide adoption of electric drive vehicle and also authorizes a $4 billion investment in 5 to 15 "deployment communities" that would receive up to $500 million each. Both the national and localized deployment programs include important elements for advancing plug-in deployment, including stakeholder involvement, technical assistance, grid integration planning and workforce training.

However, we believe that a greater emphasis on the national effort and a larger group of deployment communities will be more effective in building the national fleet than concentrating federal resources in such a limited number of communities.

Collaborative localized deployment efforts are already underway, with others planned. Plug-in vehicles are in the national market and automakers are moving forward with efforts to build national markets in the next 2 to 3 years. For instance, GM has already made plans for expanded national distribution in 2011.We would like to see the national electric drive effort support all of these efforts in real time.

We appreciate Senator Dorgan's history of leadership on all electric drive and his effort to achieve the right balance between the national and more localized efforts. As the bill moves through this Committee, we would like to work with the Chairman and Senator Dorgan to ensure that finite federal resources are apportioned in the most effective way to ensure the achievement of the goal we share: a diverse national fleet of electric drive vehicles.

Inside the national and deployment programs, we would like to work with you to ensure specific emphasis on private, in addition to public, recharging infrastructure. Diverse vehicle configurations (battery electric and plug-in hybrids with varying ranges) and diverse consumer needs will require flexible private and public recharging options. Industry studies confirm, however, that most charging of plug-in vehicles will be done at primary residences over night. The next greatest opportunity for charging is at the workplace during the day. We believe that meeting these recharging needs should be an explicit priority for national and localized de-

ployment efforts. We support directing additional research and technical assistance toward facilitating residential and workplace charging.

We also support expanded investment in U.S. vehicle and component manufacturing, which will help to bring vehicle costs down while building U.S. competitiveness in global markets.

Title I of S. 3495 also promotes the adoption of plug-in electric drive in federal fleets with funds for purchasing vehicles as well as transparency and accountability for their use, which EDTA strongly supports. We would also like to see a comprehensive approach that recognizes all of the electric drive technologies, including fuel cells and hybrids, which will provide flexibility for meeting fleet needs while reducing oil consumption and helping to build markets for advanced vehicles, components and infrastructure.

Consumer education and workforce training are also very important to a national effort to build a diverse national fleet of electric drive vehicles and we support their inclusion in national and community deployment programs.

The following are comments on selected provisions of the bill:

Definitions

In Section 3 definitions, the definition of charging infrastructure excludes property that is "a building or the structural components of a building." While this is the current definition language in the federal tax credit for investment in alternative fuel refueling property, it is an exclusion that inhibits investment in electric recharging. Particularly in residential applications, recharging infrastructure will often be integrated into a building's structure. The exclusion should not be applied to electricity recharging infrastructure in the definition included here. We are also working to revise the tax credit language to reflect the scope of electric recharging.

Title II

In Title II, S. 3495 authorizes $1.5 billion for advanced energy storage and other electric drive research and development, including secondary use application development and demonstration. We strongly support the expanded support for plug-in electric drive technologies and infrastructure, including grid integration advances.

In the context of a comprehensive energy bill, we would also support a broader reauthorization of DOE's Vehicle technology programs, along the lines of Senator Stabenow's bill, S. 2843, that would advance electric drive research, development and deployment across platforms and configurations.

Title III

Title III establishes a utility planning process for plug-in electric drive vehicles under the Public Utility Regulatory Policies Act. As fuel and power providers, utilities need to identify demand and energy management and smart grid integration strategies. Protocols for the interaction of utilities and charging infrastructure entities will also need to be identified. The key is establishing the right balance between national standards for charging technologies and flexibility in business models. Our members are currently reviewing the Section 301 federal regulatory directives to ensure that these are achieved.

Regarding the bill's provisions prohibiting disposal of advanced batteries used in plug-in electric drive in landfills, we believe that this is more appropriately a study to identify specific environmental risks and the best options for safe recycling and ultimate disposal before an outright ban is imposed on all advanced batteries. In the interim, promoting secondary uses of automotive batteries and advanced materials will ensure that these batteries remain in use beyond their automotive life and their valuable components are recovered

EDTA has called for the establishment of coordinated efforts between government agencies and between agencies and the multiple public and private stakeholders advancing electric drive. We support S. 3495's establishment of a Technical Advisory Committee and Inter-agency Task Force to ensure that initiatives and investments that comprise the national effort are compounding efforts, advancing the overall goal of electrification.

This is a critical moment for the industry and for advancing a transformative energy policy that displaces oil with electricity—in the near and long term. EDTA supports and is pleased to work with the Committee as you identify the best ways to achieve a national fleet of electric drive vehicles.

The CHAIRMAN. Thank you very much.

Next is Mr. David Friedman. He is Research Director with the Clean Vehicles Program of the Union of Concerned Scientists. So please go right ahead.

STATEMENT OF DAVID FRIEDMAN, RESEARCH DIRECTOR AND SENIOR ENGINEER, UNION OF CONCERNED SCIENTISTS, OVIEDO, FL

Mr. FRIEDMAN. Thank you, Mr. Chairman and members of the committee. As you mentioned, I am a research director and also a senior engineer with the Union of Concerned Scientists.

First, let me start off by saying that by 2050 we can effectively end the use of oil and other petroleum products to fuel the vehicles that run on the Nation's highways. We cannot end our oil addiction overnight, and it will take significant investment, but we do not really have any other choice. The oil disaster in the Gulf is only the most recent reminder of the cost of our oil dependence. Oil prices spiked 5 times in the last 40 years, and each time our economy suffered either a recession or a significant drop in growth. Our dependence on oil also harms our health and our economy through everything from local gasoline leaks to poor regional air quality and global climate change.

Electric drive vehicles must be part of a path that effectively ends our addiction to oil by at least 2050. But these technologies are not a silver bullet. The problem of our oil dependence is too big and too complex to be addressed by anything but a mix of vehicle technologies, low-carbon fuels, and better travel choices for consumers.

Effectively ending our oil addiction for highway vehicles by 2050 does mean that nearly every car and truck on the road must run on renewable electricity, hydrogen, or sustainable, low-carbon biofuels by the middle of this century. All of these technologies have suffered from our lack of a comprehensive, long-term policy. The result has been a mix of approaches over the past 40 years that has shifted from synthetic fuels to methanol to batteries to corn ethanol to fuel cells to cellulosic ethanol and now back to batteries. This cycle strands investments and fundamentally fails to deliver energy independence. Breaking this cycle will require both a comprehensive set of energy and climate policies that put a price on carbon and establish national requirements to effectively end America's oil addiction by 2050 and sufficient funding for research, development, and large-scale deployment of electric drive technologies.

The Electric Vehicle Deployment Act is a significant down payment on this second step. Senator Dorgan and your cosponsors, Senator Alexander and Merkley, are to be commended for a bill that provides many of the resources needed to move these vehicles into the deployment fast lane.

By increasing funding available for research, vehicles and infrastructure, and by making tax credits more accessible, the act will help address many of the technology and market hurdles that still need to be overcome, including the high cost of first generation plug-in hybrid and battery electric vehicles.

Further, the bill's focus on a limited number of deployment areas helps ensure that taxpayer dollars will be used more efficiently. It simply makes more sense to spend money in an area that will serve tens of thousands instead of tens or hundreds of vehicles.

Now, the potential impact of this bill will be further improved with some modifications and integration into a comprehensive na-

tional policy. The bill should be modified to provide an even playing field for all electric drive technologies, including expanding the coverage of the deployment community funds to include fuel cell electric vehicles and infrastructure in phase one and making vehicle and infrastructure tax credits more compatible between fuel cells and battery electric vehicles.

The Senate bill clearly leaves the door open to support for fuel cell vehicles in phase two, but by then, State efforts on hydrogen risk atrophy while international efforts begin to accelerate. If the United States is to compete with Japan, Germany, and South Korea, which all have announced efforts to significantly ramp up fuel cell production, and if we are to ensure that electric drive vehicles are available in parts of the economy not well suited to batteries, we should not make a similar mistake now that was made 5 years ago when we failed to increase support for batteries and recharging infrastructure when hydrogen had all the buzz.

The Senate bill should also be modified to further limit the number of deployment communities at least in the first few years. The 15 deployment communities in the Senate bill risk cutting the funds for one individual community in half. A smaller number to start also reduces the number of mistakes that would be repeated in parallel by so many different deployment efforts.

Finally, the Senate and House electrification bills should be merged into a comprehensive national policy. Putting a cap on carbon will not only change the way we use energy, it also will provide revenue that we can return to consumers to invest in electric drive vehicles and infrastructure. This provides an alternative to the annual appropriations cycle which risks significant funding uncertainty especially with the current focus on deficits.

We must also establish a national oil savings plan that requires savings of at least 7 million barrels of oil per day by 2030 and that requires the effective elimination of oil use by 2050. We will not end our oil addiction if we continue the cycle of passing new, but limited energy bills every few years.

Finally, we must establish a robust renewable electricity standard to ensure that plug-in vehicles will not only cut oil use but will also dramatically lower emissions. As you have heard, without a more renewable grid and renewable hydrogen, electric drive vehicles will not deliver reductions in heat-trapping gases compared to a conventional hybrid.

Now, vehicle standards must count those emissions. The whole purpose of vehicle standards is to reduce the carbon emissions associated with vehicles. That is not the right place to incentivize these advanced technologies, but this bill does provide the exact type of incentives we need to move that technology forward.

Thank you.

[The prepared statement of Mr. Friedman follows:]

PREPARED STATEMENT OF DAVID FRIEDMAN, RESEARCH DIRECTOR AND SENIOR ENGINEER, UNION OF CONCERNED SCIENTISTS, OVIEDO, FL

Mr. Chairman and Members of the Committee, I appreciate the opportunity to testify before you today. I am a research director and senior engineer with the Union of Concerned Scientists (UCS). UCS is a leading science-based nonprofit that has been working for a healthy environment and a safer world for over 40 years.

By 2050 we can effectively end the use of oil and other petroleum products to fuel the cars, trucks, and buses that drive on the nation's highways. We cannot end our addiction to oil overnight and it will take significant investment on the part of industry, consumers and government, but we don't really have any other choice. The disaster in Gulf of Mexico is only the most recent reminder of the cost of our oil dependence on our economy. Oil prices spiked 5 times in last 40 years and each time our economy suffered either a recession or a significant drop in growth. Oil was not always the sole cause, but it was always a significant contributor, including in the case of our most recent economic turmoil. In 2008 we were facing record high oil prices and the resulting expense of sending more than one billion dollars a day to other countries just to buy oil and other petroleum products. Our dependence on products made from oil also harms our health and our economy through everything from local gasoline leaks to poor regional air quality and global climate change. The stress on our nation will only grow worse as the world economy recovers and demand for petroleum products accelerates, along with rising oil prices.

Electric drive vehicles, such as plug-in hybrids, battery electric vehicles, and fuel cell electric vehicles must be part of a path that effectively ends our addiction to oil by at least 2050. But these technologies are not silver bullets. The problem of our oil dependence and its associated impacts are too big and too complex to be addressed by anything but a mix of vehicle technologies, low-carbon fuels, and better travel choices for consumers.

If we look only at vehicles and fuels, effectively ending oil addiction for highway vehicles by 2050 means that nearly every car and truck on the road must run on renewable electricity, hydrogen, or sustainable, low-carbon biofuels. That in turn means that, by 2040, at the latest, nearly every new light duty car or truck and most heavy duty trucks sold must run on electricity, hydrogen, or biofuels. Figure 1* shows one example of a similar roadmap from the International Energy Agency. In this case, worldwide progress is about 10 years behind where the United States could be if we take a leadership role. Figure 2 shows an example of a technology portfolio from recent work by the National Academy of Sciences. In this case, gasoline use is dramatically reduced and ultimately eliminated by 2050 through the combination of improved vehicle efficiency from conventional technology and hybrids, aggressive adoption of biofuels, and vehicle electrification. While it will take many decades to address our oil addiction and our changing climate, policies must be put in place today if a future without oil is to become a reality.

All of these technologies have suffered from our lack of a comprehensive, long term set of policy solutions. The result has been a mix of policy approaches over the past forty years that has shifted from synthetic fuels to methanol to batteries to corn ethanol to hydrogen fuel cells to cellulosic biofuels and now back to batteries. This cycle of shifting policy prescriptions must be broken. The rise in financial and policy support for one technology typically comes with a fall for the others, stranding investments and making it difficult for industry and venture capitalists to make long term investments of their own. Breaking this cycle will require at least two major steps:

1. A comprehensive set of energy and climate policies that put a price on carbon and establish national requirements to effectively end America's oil addiction and cut the emissions of heat trapping gases by at least 80 percent by 2050.
2. Sufficient funding for research, development, and large-scale deployment of technologies that require little or no petroleum and are responsible for little or no heat-trapping emissions.

The Electric Vehicle Deployment Act of 2010 is a significant down payment on the second step. This bill builds on tax credits, grants and other resources provided under the American Recovery and Reinvestment act to support plug-in hybrid vehicles and battery electric vehicles. Senators Dorgan, Alexander and Merkley are to be commended for working with the Electrification Coalition on a bill that provides many of the resources needed to move these vehicles into the deployment fast lane:

- By increasing the funding available for research, vehicles and infrastructure, the Electric Vehicle Deployment Act of 2010 will help address many of the technology and market hurdles that still need to be overcome. Upcoming plug-in hybrid and battery electric vehicles will cost $15,000 to $20,000 more than comparable cars, with home recharging costing $1,000 to $2,000 per household. While these vehicles will be able to save their owners as much as $8,000 over the vehicle life by purchasing electricity at a cost equivalent to less than $1 per

*Figures 1 and 2 have been retained in committee files.

gallon (compared to today's nearly $3 per gallon for gasoline), consumers will still face a significant cost gap that will make them less likely to try the new technology. The upfront costs can come down, but only with added research and with increased production volumes, both of which will be more limited without this bill. Increasing the amount of money available and making tax credits refundable or transferable opens the door to more resources to increase those production volumes.

- By directing efforts to support training of service and safety personnel, and changing local codes, standards and zoning requirements, the bill will help remove non-financial barriers. Further, the bill's focus on a limited number of deployment areas helps ensure that taxpayer dollars will be used more efficiently. If the deployment of electric vehicles—even plug-in hybrids that require less support—is more spread out, more infrastructure will be needed, more people will need to be trained in service and safety, and more state and local codes, standards, and zoning requirements will need to be changed. All of these needs require money, and it simply makes more sense to spend that money in an area that will serve tens of thousands instead of tens or hundreds of vehicles.
- By opening the door to longer term national technology deployment goals, the bill will help provide increased certainty to industry, investors, utilities, fuel providers, and local, state and regional policymakers.

To give us a better chance of getting on a path that can effectively end our oil addiction and cut heat-trapping gas emissions 80% by 2050, some changes can be made to the Electric Vehicle Deployment Act of 2010 and it's House companion, the Electric Drive Vehicle Deployment Act of 2010. These bills must also be integrated into a comprehensive national climate and energy policy that puts a price on carbon. The needed steps should include:

- Expanding vehicle and infrastructure support for fuel cell electric vehicles in Phase 1 of the program. Fuel cells do have some existing support, thanks in large part to leadership from Senator Dorgan, and the Senate bill clearly leaves the door open to additional support for these vehicles in Phase 2, but without additional support for deployment by then state efforts on hydrogen risk atrophy while international efforts begin to accelerate. An industry survey by the California Fuel Cell Partnership points to plans to deploy nearly 3,500 fuel cell vehicles, mainly in southern California. The vehicle levels are expected to rise to about 25,000 between 2015 and 2017. But at the same time, tax credits for fuel cell cars were cut in half this year and, along with hydrogen infrastructure tax credits, they expire by 2014, just as efforts are ramping up. Meanwhile, Japan, Germany, and South Korea have all announced efforts to significantly ramp up fuel cell vehicle production in the coming years.[1] If we are to compete across the spectrum of electric drive vehicles that will be needed,[2] the Senate bill should be modified to provide an even playing field for all electric drive technologies including:

  1. Expanding the coverage of the deployment community funds to include fuel cell electric vehicles and the necessary hydrogen infrastructure in Phase 1. Delaying support for hydrogen and fuel cell electric vehicles will guarantee that they will always be the "technology of the future." Had we expanded funding for plug-in vehicles five years ago when hydrogen had the buzz, we would be must better prepared for upcoming deployment. We should not make the same mistake now that the media attention is focused on batteries.
  2. Eliminating the cut in the fuel cell vehicle tax credit and shifting it from an expiration date of 2014 to a per-manufacturer cap of 300,000 vehicles as provided for plug-in vehicles.
  3. Shifting the expiration date for hydrogen infrastructure tax credits to at least 2017 to coincide with the charging infrastructure tax credits.

---

[1] Japan is targeting about 2 million fuel cell vehicles by 2025. Given that their market is about 1/3rd of ours, that would be equivalent to about 6 million fuel cell vehicles by 2025 in the US. Hyundai-Kia report plans to reach 100,000 fuel cell vehicles in 2020, the sales equivalent of about 1 million fuel cell vehicles in the US. Reports also indicate Germany is targeting around 600,000 fuel cell vehicles by 2020, or the U.S. equivalent of about 2 million vehicles.

[2] Without dramatic breakthroughs, battery electric vehicles will be best suited to smaller vehicles and vehicles that primarily drive for relatively short distances in stop and go traffic. Plug-in hybrids dramatically expand the applicable range, but also benefit most from more urban driving and will continue to require petroleum until breakthroughs are achieved in biofuels. Fuel cell electric vehicles are well suited to filling in the gaps left by today's batteries, though progress is still needed to bring down costs and develop infrastructure.

4. Adopting the refundable and transferable provisions included for plug-in vehicles.

- Further limiting the number of deployment communities, at least for the first few years. As with the House companion, the Senate bill can help the set aside financial resources be used more effectively by limiting the total number of deployment communities. By allowing for up to 15 deployment communities, the Senate bill risks cutting the available funds for an individual community in half and losing some of the advantages of the bill's cluster approach. Further, starting with a smaller number of communities allows more learning, reducing the number of mistakes that would be repeated in parallel by so many different deployment attempts.
- Integrating the Senate and House electrification bills into a comprehensive national climate and energy policy that includes a price on carbon, creates a national oil savings plan, and provides strong incentives to deploy renewable electricity above current projections, including a robust national renewable electricity standard.

1. Financing the electrification of transportation will require significant resources and tying much of that financing to the annual appropriations cycle risks significant funding uncertainty, especially with the current focus on deficits. Industry will be less likely to partner with communities if the funding needed for even larger scale deployment is left in doubt. Putting a cap on carbon will not only spur investments in cleaner technology and changes in the way we use energy, but it will provide revenues that we can invest in clean energy jobs. Covering the transportation sector can generate $20-$40 billion each year that can be returned to consumers to help them purchase electric drive vehicles and home recharging or refueling infrastructure, among other investments in transportation.

2. If our ultimate goal is to end our oil addiction, we cannot continue the cycle of passing a new energy bill every few years. To provide certainty to industry and to empower agencies across the federal government, the Senate should establish a national oil savings plan that requires savings of at least 7 million barrels per day by 2030 and that requires the effective elimination of oil use by 2050. This plan should provide the President with sufficient authority to achieve these goals.

3. The success of electric drive is inherently tied to moving our grid to renewable electricity. Recent analysis from the Argonne National Laboratory shows that, with today's electricity mix, plug-in hybrid and battery electric vehicles do not deliver reductions in heat-trapping gases compared to a conventional hybrid.[3] Because these vehicles do provide reductions compared to today's cars, their expansion in the next decade or two will yield carbon benefits. But, if the grid is not significantly cleaner by 2030, when conventional hybrids will need to be ubiquitous, plug-in vehicles won't deliver carbon benefits. A strong cap on carbon and a robust renewable electricity standard can help ensure that plug-in vehicles will not only cut oil use but also help to dramatically lower emissions. Further, the expansion of renewable electricity can go hand in hand with the creation of a supply of renewable hydrogen for fuel cell electric vehicles. Hydrogen can be used to buffer intermittent renewables to both lower the cost of clean electricity and expand the fuel mix.

The U.S. needs to move away from a piecemeal approach to transportation, energy, and environmental policy and instead adopt a comprehensive set of policies that will tap into both the near term and long term solutions that are available now or on the drawing boards. This will require a longer term perspective and a combination of consistent, significant, and sustained policies. Yes, we do need to rethink our transportation system, but in doing so, we will not only dramatically lower global warming pollution, we will save consumers billions, create new jobs in America and ultimately cut our addiction to oil. The Electric Vehicle Deployment Act of 2010 is an important part of this comprehensive set of policies.

The CHAIRMAN. Thank you very much.

The final witness is Mr. Alan Crane with the National Research Council. Go right ahead.

[3] Elgowainy, et. al., "Well-to-Wheels Analysis of Energy Use and Greenhouse Gas Emissions of Plug-In Hybrid Electric Vehicles," AND/ESD/10-1, June 2010.

STATEMENT OF ALAN T. CRANE, SENIOR PROGRAM OFFICER, NATIONAL RESEARCH COUNCIL

Mr. CRANE. Thank you, Mr. Chairman, members of the committee. My name is Alan Crane and I was the study director for the report on plug-in hybrids that Senator Dorgan mentioned, also its predecessor report on hydrogen and fuel cells. These studies were intended to estimate the maximum practical rate at which alternative vehicle technologies could grow in the marketplace, the resources that would be required to make that possible, and the oil consumption and greenhouse gas reductions that might result.

I would respectfully request that the plug-in report be included in the record for the meeting. Thank you.

The CHAIRMAN. We will include that.

Mr. CRANE. I should note that this report did not consider fuel cell vehicles. It was limited to hybrids. It did not consider full electric vehicles, just the plug-in hybrids.

We also examined biofuels and advanced fuel efficiency of conventional vehicles to compare the benefits of different approaches. None of these technologies, as has been mentioned, is likely to solve the problem all by itself, but collectively, as Dr. Friedman mentioned, they have the potential for eliminating oil use in the light-duty fleet by 2050.

In the interest of conserving time, I would like to turn to the findings and conclusions at the end of my testimony, and I will elaborate on them slightly.

To begin with, battery vehicles, whether they are hybrids or full electric, certainly have the potential to become very important, even a major component of the light-duty fleet, but that is not at all certain. There are several factors that may seriously limit the growth unless large subsidies are continued.

For instance, battery costs are still high. You mentioned you think that our costs are higher than most. Actually the current costs are right in the middle of all the estimates we have seen once they are adjusted to the same basis. There is a lot of uncertainty as to how far and how fast battery costs will come down. We are probably on the high side, but still lower than several other estimates in the literature.

Durability is also a major question. The range on the vehicle drops as the batteries degrade, which is usually about 2 percent per year. If you have to replace the battery pack, that is going to be very expensive.

Fuel savings are modest relative to the cost increment. A hybrid electric vehicle can do almost as well as a low-mileage plug-in hybrid, a 10-miler, say. As has been mentioned, the carbon savings are even smaller.

Then a question that we could not really get into but was looming over everything was on the number of people who are able to plug in their vehicle and willing to take the time to do it.

With that as a lead-in, our conclusion No. 1, the lithium-ion battery technology has been developing rapidly. The costs are still high, and we did not see the likelihood of dramatic cost reductions unless there are some real breakthroughs in technology. Many of the projections that show a rapid drop depend upon manufacturing economies of scale. We noticed that lithium-ion batteries are al-

ready made in huge quantities in very efficient factories. The vehicles are not going to be radically different from that. So we suspect that technology will be a more important factor than economies of scale.

The cost to a vehicle manufacturer we thought for right now would be—for instance, for the Volt, would be $14,000 to $18,000, somewhere in that range. That is more than a conventional non-hybrid vehicle. Most of that would be in the battery pack, and a 10-mile plug-in would be somewhere around $6,000, again about half of that for the battery pack. These are big numbers and they have to make you wonder whether people will find them worthwhile.

In addition, some homes will require upgrade of their power, particularly in the garage. We did not include that in our estimates of the cost transition.

We think that plug-in—the 40 miles of Volt types could become cost effective by 2040 or thereabouts. The shorter-mile ones would get there a lot sooner, but they will not save all that much fuel.

We have also mentioned the rate at which we assumed that the plug-ins could achieve penetration into the market. We said 40 million by 2030 was about the maximum. That is far faster than any other major technology has penetrated. So we do not think that is conservatively low. We think it is pretty optimistic.

The factors that would interfere with that, the high cost of the battery, the modest gasoline savings, the limited availability of places to plug in, and other attractive opportunities for consumers are likely to keep this lower.

Then the plug-ins—you need tens of millions of them out there. That is true of just about any new technology in order to have a real impact on the fleet. We have upwards of 300 million vehicles in the fleet. It needs to be a high fraction of them to make a real impact on oil use. But certainly by 2050, we can start making a big difference.

Then the carbon savings, again, will depend upon how much we can decarbonize the fleet—decarbonize the generating mix we have in this country. I would add nuclear power to what Dr. Friedman mentioned.

Finally, we cannot emphasize too much that we need to keep our options open. This has been said before. There are a lot of options for the future for cutting oil use. This is a major one, but there are others. Keep pushing on all of them.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Crane follows:]

PREPARED STATEMENT OF ALAN T. CRANE, SENIOR PROGRAM OFFICER, NATIONAL RESEARCH COUNCIL

Good morning, Mr. Chairman and members of the Committee. My name is Alan Crane. I was the study director for the National Research Council report Transitions to Alternative Transportation Technologies—Plug-in Hybrid Electric Vehicles and its predecessor report Transitions to Alternative Transportation Technologies—a Focus on Hydrogen. The National Research Council is the operating arm of the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine of the National Academies. The National Academy of Sciences was chartered by Congress in 1863 to advise the government on matters of science and technology.

These two studies were requested by the U.S. Department of Energy to estimate the maximum practical rate at which alternative vehicle technologies could grow in the marketplace, the resources that would be required to make that possible, and the oil consumption and greenhouse gas emissions reductions that would result. Today I shall talk mainly about the Plug-in report which was released in final form recently. I would like to respectfully request that this report be included in the record.* Plug-in hybrid electric vehicles (PHEVs) and hydrogen fuel cell vehicles (HFCVs) have many similarities, and I shall provide some comparisons. I should note that the report did not consider full electric vehicles.

The committee that conducted these studies also examined biofuels and advanced fuel efficiency of conventional vehicles to compare the benefits of different approaches. One of the most important conclusions of the committee in both reports is that a balanced portfolio of R&D options is critically important for the long-term future. None of these technologies by itself is likely to solve our oil problem, but collectively they have the potential to essentially eliminate oil use in the light duty vehicle fleet by 2050. However, achieving this objective will require a broad, well-funded R&D program and a long-term commitment to deployment by the federal government and industry.

PHEVs and HFCVs differ from the biofuels and advanced efficiency options in that they probably will be too expensive, at least at first, to simply be mandated by standards. Government subsidies will be required to push them into the mass market.

PHEVs can get an earlier start than HFCVs because batteries are more nearly ready for mass production than fuel cells, and fewer infrastructure changes are required. The committee estimated that the maximum practical penetration rate for PHEVs would result in 4 million on the road in a fleet of about 275 million light duty vehicles in 2020, growing to 40 million on the road in 2030. This would require a rate of growth about twice that of conventional hybrid electric vehicles over the past 10 years.

Batteries are by far the costliest component of PHEVs, and the rate at which costs can be reduced is uncertain. All proposed PHEVs will use lithium-ion (Li-ion) batteries, similar to the technology now used in laptop computers, power tools, and other small devices. Several Li-ion chemistries are under development with the objective of optimizing performance for automotive propulsion. None yet meet all essential goals for cost, battery life, and weight. Cost is expected to be the most difficult goal.

The incremental manufacturing cost of a PHEV with a 10 mile range on its batteries alone (PHEV-10) over an equivalent conventional vehicle (non-hybrid) would be about $6000 now. A PHEV-40 (40 mile range) would cost about $16,000 more. These current costs are based on batteries ordered several years ago for installation in vehicles built in 2010 and 2011. Battery costs will decline significantly, but some of the other costs required for PHEVs (e.g. power electronics and electric motors) probably less so. Total incremental costs for PHEV-10s are expected to decline to less than $4000 and for PHEV-40s to about $10,000 by 2030.

Dramatic cost reductions are not very likely without breakthroughs in battery technology. Lithium-ion batteries are already manufactured in great quantities, and those designed for vehicle applications are not greatly different from those for laptops. Thus cost reductions from manufacturing economies of scale will be limited. While the committee's estimates of future costs are higher than some (but not all) others, that may be because the committee assumed that durability and safety goals had to be met before cost goals. Today's lithium-ion batteries typically last three to four years, but at least 10 years will be required for a truly viable commercial PHEV. Batteries with shorter lifetimes would be less expensive, but would require replacement.

DOE's R&D program is focused appropriately on cost reduction and performance improvement and on looking for breakthroughs. At this point, however, it is not clear what sorts of breakthroughs might become commercially viable. Furthermore, even if they occur within the next decade, they are unlikely to have much impact before 2030, because it takes many years to get large numbers of vehicles incorporating new technology on the road.

In addition to costs, the necessity of charging the batteries essentially every day to deliver their promised fuel savings may be a constraint on PHEV growth. It is not clear how many people have a safe source of power, preferably in a garage, and the willingness to plug it in regularly.

---

*Report has been retained in committee files and can be found at http://www.nap.edu/catalog/12826.htm.

If PHEVs meet the maximum practical penetration rate, the savings in oil and carbon emissions will be significant. PHEV-40s could cut gasoline use by 55 percent by 2050, and PHEV-10s by 40 percent, relative to a reference case with no PHEVs or increased efforts on other technologies. However, much of this improvement could also be gained from improved efficiency of conventional vehicles and hybrid electric vehicles (HEVs). The high efficiency scenario analyzed by the committee, with a high fraction of HEVs, also showed a reduction of 40 percent in gasoline use. A PHEV-10 is expected to save 19 percent of the gasoline that an equivalent HEV would use, while a PHEV-40 would save 55 percent. µIn comparison, HFCVs directly reduce gasoline use because the hydrogen will be produced from natural gas or other non-oil sources.

PHEVs show less improvement in GHG emissions than in gasoline consumption because of the additional emissions from electricity generation. If carbon emissions from the electric sector are limited, the reductions would be greater, potentially almost following the rate of reductions in gasoline use.

The PHEV projection considered only the impact of a given number of PHEVs regardless of cost. PHEVs will be expensive relative to conventional vehicles, but they are cheaper to operate (driving costs per mile are less than for conventional vehicles), and eventually vehicle costs may decline sufficiently to achieve life-cycle cost competitiveness. A transition period with substantial policy intervention and/or financial assistance for buyers from government and possibly manufacturers will be necessary until the higher costs of PHEVs are balanced by their fuel savings.

Transition costs will depend on how fast vehicle costs decline. At the rate considered to be optimistic by the committee, subsidies of over $400 billion could be required for PHEV-40s. However, if DOE's ambitious goals for battery cost and durability are met by 2020 only $24 billion would be required. Higher oil prices also would lower transition costs. PHEV-10s would achieve competitiveness sooner than PHEV-40s, but the oil savings would also be less. This analysis was based on battery packs that would be required for mid-size cars which are likely to be smaller than the average that will be used in the entire fleet.

Because of uncertainties in battery pack costs at this point in the initial commercialization of PHEVs, the committee feels that it is important that the cost issues be reevaluated in 3 or 4 years after industry has some commercial experience with the technology.

Following are the major conclusions of the committee. These are explained more thoroughly in the summary of the report.

1. Lithium-ion battery technology has been developing rapidly, especially at the cell level, but costs are still high, and the potential for dramatic reductions appears limited.
2. Costs to a vehicle manufacturer for a PHEV-40 built in 2010 are likely to be about $14,000 to $18,000 more than an equivalent conventional vehicle, including a $10,000 to $14,000 battery pack. The incremental cost of a PHEV-10 would be about $5,500 to $6,300, including a $2,500 to $3,300 battery pack.
3. PHEV-40s are unlikely to achieve cost-effectiveness before 2040 at gasoline prices below $4.00 per gallon, but PHEV-10s may get there before 2030.
4. At the Maximum Practical rate, as many as 40 million PHEVs could be on the road by 2030, but various factors (e.g., high costs of batteries, modest gasoline savings, limited availability of places to plug in, competition from other vehicles, and consumer resistance to plugging in virtually every day) are likely to keep the number lower.
5. PHEVs will have little impact on oil consumption before 2030 because there will not be enough of them in the fleet. More substantial reductions could be achieved by 2050. PHEV-10s will reduce oil consumption only slightly more than can be achieved by HEVs.
6. PHEV-10s will emit less carbon dioxide than nonhybrid vehicles, but save little relative to HEVs after accounting for emissions at the generating stations that supply the electric power.
7. No major problems are likely to be encountered for several decades in supplying the power to charge PHEVs, as long as most vehicles are charged at night.
8. A portfolio approach to research, development, demonstration, and, perhaps, market transition support is essential.

This concludes my statement. Thank you for the opportunity to testify. I would be happy to address any questions the Committee might have.

The CHAIRMAN. Thank you and thank you all for your excellent testimony.

Let me start with a few questions. Mr. Smith, let me start with you. You, I think, indicated that your FedEx fleet of vehicles is about 85,000, and I think someone had mentioned that the Federal Government—I believe maybe Mr. Sandalow mentioned that the Federal Government purchases about 60,000 vehicles a year.

In your effort as a large fleet operator and owner, what are you doing at FedEx with regard to transitioning to electric vehicles that you believe the Federal Government ought to be doing?

Mr. SMITH. Senator, we several years ago, along with the Eaton Corporation and the National Resource Defense Fund, developed the first walk-in pick-up and delivery hybrid truck. We now have about 400 of them. We will have about 400 of them at the end of the year.

The problem with that vehicle is that its capital acquisition costs are significantly over a conventionally powered diesel truck, and you have to get up to about $4.50/$5.00 a gallon in diesel cost to get an ROI. Now, there are some exceptions where you have to have low emission-vehicles to meet regulatory standards like California. So we will be putting the hybrid trucks out there.

The reason they are so high in expense are, one, the battery cost, but in addition, the hybrid obviously has two power plants. It has the conventional power plant and it has an electric power plant. So for pick-up and delivery operations, I suspect that in most cases—now, perhaps not in Montana or upstate Maine where you have long distances between stops, but in most urban environments, the all-electric plug-in has a greater potential than the other technologies. As I mentioned, we have about 15 all-electrics in Europe made by Modec, and we have got about a half a dozen. We have taken delivery on prototypes that are a JV by Modec and Navistar built in Illinois and powered by A123 battery systems.

The things that are in this legislation will move the production costs of the lithium batteries significantly down the cost performance curve. The operating costs of the all-electric is so compelling compared to the diesel powered. It is about 20 percent per mile of what the diesel powered vehicle is. So it is strictly a matter of getting to scale production and hopefully having some of these technical breakthroughs on the battery technologies.

In talks with people overseas and here and at ARPA Energy with some of the programs they have got going over there, I think the potential for increased price performance on the batteries is pretty significant in the next few years. So we respectfully disagree with the information that was put in the Research Council's report.

The CHAIRMAN. Let me ask one other question. Dr. Clay, let me ask you. You, I think, in your testimony talk about the need for funding for production of components of electric vehicles. We put in law this section 136 in the 2007 energy bill, and it is intended to provide help to component suppliers. Why is that not adequate to meet the need for component suppliers for electric vehicles, just like it does other vehicles?

Ms. CLAY. Thank you, Mr. Chairman. In fact, yes, the alliance does support the provision that is in your legislation that passed out of committee that would extend and replenish that section 136 program. Our feeling is that would be sufficient and would meet the points that were made in our written testimony.

The reason we included them in our written testimony was because this was introduced as standalone legislation, we felt that that was a very important component of meeting the overall need to produce electric vehicles, anticipating that this legislation might be folded into a larger energy package that would have your provision in the underlying text would be sufficient.

The CHAIRMAN. Thank you very much.

Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman.

In the focus on electrification, I think just about all of you at one point in time have discussed the need to reduce our emissions, and yet we recognize that we are in a Nation where—I was trying to get he exact figure here in terms of how much of our electricity is produced today in this country by coal, by fossil fuels, and a recognition that in certain parts of the country, we moved to electrification where our source for electricity is coal. Have we really reduced the level of emissions? Dr. Clay, you mentioned it. Mr. Crane, you mentioned the push to decarbonizes the fleet, and I think it is an important part of the discussion.

Mr. Smith, I would ask you. Within your nationwide fleet, I think you mentioned California was one State, one area, where you are focusing. But in your decision as to where you are deploying your electric fleet vehicles, do you look to the electricity source as part of your business judgment decisions, or is that factored in at all?

Mr. SMITH. No, it is not factored in. But I would point out, Senator, our studies would indicate that plug-in electric vehicles, even if powered by coal power plants that have not been modified to clean up the emissions on a so-called well-to-wheel basis produce significantly less CO_2 emissions than conventionally powered vehicles. Now, if the power source is hydro, geothermal, nuclear, solar, wind, so much the better. But there is a net benefit even with coal-powered plants.

Senator MURKOWSKI. Let me ask—and I mentioned in my opening statement the point about the technology-neutral perspective. Again, I think most of you have discussed some aspect of that.

This legislation is set to authorize about $6 billion for the electric vehicle technologies. Recognizing that you are going to be seeing a—I mean, that is a substantial increase in funding. How do you believe that this will affect or impact the development of other technologies, whether they are—some of you mentioned, I think, the hydrogen, certainly natural gas, the advanced internal combustion. Is this a situation where by directing funding in this area, we lose the push in other areas? Or as Senator Dorgan has said, we need to make sure that we are doing it all, that we support the hydrogen vehicles, that we push evenly. I am throwing this out to all of you. Mr. Friedman and then Mr. Wynne.

Mr. WYNNE. Senator, I would be delighted to answer that question. I think it is really an excellent one.

One of the reasons why ETA changed its name several years back was because of the fact that we are really pushing a technology here. It is not just vehicle-centric. This is technology-centric. So anything that we can do to advance the component manufacturing—for example, there are many components that are shared

in the electric drive train. So we think of electric drive—fuel cells are just a different way to create the electricity. They do so on board utilizing hydrogen as a carrier. It is important to understand the way those dots connect over time, that this is not really an either/or situation.

Having said that, we have made massive advances with battery technology and energy storage has always been the game here. We all know that electric motors are better than combustion engines. They are much more efficient, and increasingly because we have hybridized with faster microprocessor speeds and software, we can get more than one drive train to work better, to work together, and optimize the energy use in that vehicle. You have the opportunity to apply a technology over multiple applications. Electrification of the fleet I think gets us to where we want to go over time.

The last point simply is that because hybrid technology is very flexible, you can utilize it with other biofuels, et cetera, and even natural gas.

Senator MURKOWSKI. Mr. Friedman, you wanted to jump in.

Mr. FRIEDMAN. Yes, thank you Senator. I think both yourself and Senator Dorgan are right. We do have to, A, incentivize all of these technologies and ensure that there are resources out there for all of them. I think with a relatively small change to Senator Dorgan's bill, we could add hydrogen fuel cell vehicles and infrastructure into the mix early on. But this really has to be thought of as a down payment. We need a national investment to get ourselves off of oil and to eliminate carbon emissions. I think your argument before about the concern over near-term emissions really reinforces our need for a strong, renewable electric standard and to put a cap on carbon.

In the near term, I am not very concerned. As Chairman Smith mentioned, in the near term, the emissions will be better than conventional vehicles. But by 2030, there should be a hybrid car in every single garage, and that needs to be the new status quo. So we are going to need clean electricity in order to get there.

We did a study, a Climate 2030 Blueprint, that said that we could nearly decarbonize our electricity sector by about 70 percent by 2030 through a combination of cap and trade and complementary policies. With that full sweep, we could actually save households on the order of $900 a year by that, and that is money that can be reinvested in a lot of these technologies to electrify our future and to green our electric grid.

The CHAIRMAN. Senator Dorgan.

Senator DORGAN. Mr. Chairman, thank you.

Let me first deal with this hydrogen fuel cell issue. Because I chair the subcommittee on appropriations that funds all these things, let me just say to you we have a well established hydrogen fuel cell technologies program that received $174 million last year. I and Senator Domenici on this committee were strong supporters. I am a strong supporter of hydrogen fuel cells. I have no problem if somebody wants to add something here with respect to hydrogen fuel cells, but I do not want anybody to suggest we are not doing anything on that front. I added back all hydrogen fuel cell funding last year and will again this year. We want to promote all alternative transportation technologies, and hydrogen fuel cells are im-

portant. But I don't think the technology will be available for rapid near-term deployment. The technology that is ready for rapid near-term deployment is electric vehicles. So I do not want to talk about that anymore. We have strong support for hydrogen fuel cell vehicles.

But let me ask Mr. Smith. Some people say—and as you know politically it is increasingly said—Government is the problem not the solution. Why do you not get out of the way, Government? So let us assume that you are out there running FedEx and you decide—you know what? We do not need Government. If I want an electric vehicle, I will go try and persuade somebody to build one. If I need a battery that goes enough miles for my fleet, I will try to persuade somebody to build one. Is that a satisfactory approach, or is this the kind of larger, game-changing thing that needs direction, needs policy choices that only the Government can really make, along with the support of the private sector?

Mr. SMITH. I think the Government needs to be involved, Senator, for two very important reasons.

The first, as I mentioned in my remarks, this is an enormous national security problem. I mean, we have two shooting wars going on, and there is no question that at least in part they were precipitated by our dependence on imported foreign petroleum, great cost in money to the country, but far more importantly, over 5,000 of our youngsters' lives were lost in these situations.

So other than nuclear proliferation and weapons of mass destruction getting in the hands of terrorists, it is our biggest single national security issue. As was mentioned in testimony, five times since the first Arab oil embargo, the country has been thrown into recession because of precipitous run-ups in fuel prices. In 2008 in the summer, a barrel of oil went up to $147 a barrel. It literally was the match that lit off the financial meltdown. So that is reason No. 1.

The second reason is that the Government many times in the past has funded a technology that had great potential societal benefit but where the private sector simply could not put the funds in because the return on investment was too uncertain or the horizon was too far out or the funds required were too great. Two of them come to mind.

One of them, which we are utilizing right now in front of us, is the Internet. I mean, that was funded by the Defense Advanced Research Projects Agency as a distributed communications system in the event of a nuclear war. Who could have imagined what could have come from that?

But my other favorite example is aviation. I mean, today we take it for granted that you can put 100 tons of cargo on one of our triple 7s and fly it nonstop from Hong Kong to Indianapolis or Memphis, which we do every day. Just go back in the early part of the 20th century and look at the airplanes that were being flown and think about someone looking at those fabric-covered Jennies and DH–4s and things like that and fast forward to a triple 7 airplane.

The Government funded the R&D in the aviation business by paying for air mail contracts, and finally in the middle part of the 1930s, the Douglas Aircraft Company finally made an airplane, the DC–3, C–47 in military terminology, that could make money with

a passenger payload and some air express on it. But absent the Government moving toward that, it is very unlikely that aviation would have reached that in the near term.

So given the national security issues and a market that is not a free market, the prices in the oil market are set by a cartel, OPEC, which if they did what they do in the United States, it would be found to be illegal.

So national security issues, and the role of the Government in funding promising R&D where there is a general consensus that if we really get this right, like commercial aviation or battery technology. So I think it is very appropriate for the Government to be involved in this.

Senator DORGAN. Mr. Chairman, might I ask one additional question?

The CHAIRMAN. Sure.

Senator DORGAN. Let me just say that the aviation technology has, in very large part, come from Federal investment into military airplanes. It migrates to the commercial sector from all of the major manufacturers.

Mr. Crane, the battery costs that you used in your study, which was not very positive toward electrification, seemed very high. Nissan has announced pricing now for their electric Leaf, all-electric Leaf, $32,780 before the tax credit. So the Leaf is now going to be priced at $32,780 and has a 2-kilowatt-hour battery which, according to the estimates you used, would have cost $42,000, which is more than the price of the entire car, by far. So does that imply or suggest somehow that the battery estimates you have produced is off the mark?

Mr. CRANE. We did not look at the Leaf or what Nissan was doing, and I do not know their pricing policy. They are quoting prices not costs, and the two are not necessarily closely coupled.

I just saw the Smart 2 is bring out an electric vehicle later this year which will have a range of 82 miles, I think. That is a tiny, little, bouncy thing you see around town. The lease they are asking is like $599. That is up on the luxury car level. Yet it is a relatively small battery. Again, I do not know what their pricing policy is, but that is not a real auspicious omen for electric vehicle costs.

So we may be wrong. I do not know. I think we had reasons for coming up with what we did, though.

Mr. FRIEDMAN. Senator Dorgan, a quick addition. One of the new things in that report is a calculation of the costs if the Department of Energy goals are met, which I think is more in line with what some of what Nissan is talking about. The report shows that if that happens, the costs go down dramatically. If I am right, I think it shows that they could become cost effective or break even by about 2025, much earlier, if those technology goals are met. So there is clearly the potential for much lower costs as the technology research progresses.

The CHAIRMAN. Senator Corker.

Senator CORKER. Thank you, Mr. Chairman, and thank you for your testimony and I certainly welcome Mr. Smith who is a major employer in our State and someone who has I know worked with Senator Dorgan and many others to advance energy in this country.

I am going through the financial reg right now and it is amazing to me the things that get added onto a bill in the name of financial regulation. It is an amazing thing that occurs, and I have noticed, in listening to all the panelists, that in lieu of maybe focusing on just plug-in electric only, that maybe many of the panelists feel like that other things should benefit from this, other types of technologies. My guess is by the time a bill gets to the floor and parochial issues take place, this bill may end up looking very different than it might coming out this committee. I know it is going to be linked up at some point with a credit bill. I know this is not in the jurisdiction of this committee.

But I wondered, Mr. Smith, if you might add some cautionary advice, if you will, to the committee as it relates to this and its narrow focus. I know there have been comments made about picking winners and losers. I know you are as much a free market person as there is in this country. Senator Dorgan I think will use your comments in other venues down the road, I might add, about Government involvement that might involve other aspects of Government involvement.

But do you want to make some editorial comments regarding how narrow this should be and what we should protect against as this bill moves to the floor?

Mr. SMITH. Senator, good to see you. It is a very important point that you make.

I go back to the comments I made about the formation of the Energy Security Leadership Council. That group came together because the CEOs and the retired generals and the admirals felt that we should focus on one particular problem, the dependence of the United States on imported petroleum from hostile parts and unstable parts of the world. So the recommendations that we came up with were very focused and very narrow, and as I mentioned, I think were a big part of the 2007 Energy Independence Security Act, as I recall it.

In this particular case, the Electrification Coalition, which grew out of the ESLC, is focused on one thing and one thing only, and that is to incent the scale production of electric vehicles to reduce the petroleum inputs in our economy and thereby reduce our dependence on foreign petroleum. I think once you start making it a Christmas tree, you really reduce the potential advantages of moving this technology which is not theoretical. I venture to say everybody in this room has a communications device, a BlackBerry, an iPhone, a Droid or whatever the case may be that is powered by this exact technology.

I am reminded of a favorite story by Dr. Hans Selye who was a Nobel laureate, and he used to tell the story about himself when he was a young researcher, how irritated he would get that his Petri dishes would be gunked up with this green stuff when he was not just pristine about it, and of course, what he was looking at was penicillin. But he just could not make the conceptual leap that that stuff in his Petri dishes was something that was very beneficial. A few years later, Dr. Fleming did introduce penicillin to the world and it revolutionized medicine.

So I think the incredible focus on battery technology by many different entities around the world, China, Korea, Japan, the United

States, makes it a much more likely technology to get behind and move forward like aviation in the example I did.

So I feel very strongly the pure R&D on fuel cells and those sort of things should be funded in a pure R&D manner. But the electrification bill should be toward electrifying light-duty transportation. Period.

Senator CORKER. So the vision, especially coming from where I come from, of baseload nuclear energy in the evenings when it is not being utilized as much charging electric batteries is just a vision that excites me. It excites you. It excites Senator Alexander. It excites many of us that want to see that happen.

At the same time, you know, in years past in my previous life, I invested in technologies where you are trying to change human behavior. That is very difficult. I wondered if you might share thoughts. You know, you look at hybrid electric, and you are really not having to change a human being's behavior because they know they have the ability to use gasoline or fossil fuel to charge the battery. In this particular case, though, it is a big difference. I mean, the fact is you have got that umbilical cord if you are all tied to the plug-in.

Do you have any comments there about concerns changing human behavior as it relates to electric vehicles only and moving away from hybrids which seem to me to be picking up a lot of steam? I guess me, not being one to want to pick winners and losers, I have some degree of concern regarding us picking the sole winner in this legislation.

Mr. SMITH. Senator, I think there will be a mix of hybrids and plug-in electrics, but the hybrids that will be popular in the years to come—I would hazard a guess that they will be much more like the Chevy Volt which has a primary electric power plant and a small reciprocating engine to perform the function of a generator. So if you need to drive your car, as the Secretary did, to work 5 miles a day but occasionally go on a 250-mile trip, that kind of technology would be probably what you would want to have. But if you have two cars or another vehicle that satisfies your daily urban requirements, my guess is that the plug-in electric would be there. So I do not think they are mutually exclusive.

Then if the prize is achieved that is in this legislation and you get a 500 mile an hour battery, then you do not need the generator, the belt and suspenders approach, of the hybrid.

I would say this much. The Electrification Coalition—we have done quite a bit of research on how people think about this technology today, and I was very shocked that the receptivity of the public for electric plug-ins and hybrids is enormous now and possibly because of every day you turn on the TV and see what is unfolding in the Gulf and Afghanistan or what have you. But I really think a combination of those technologies will be the issue. It will not be just one or the other.

The CHAIRMAN. Senator Wyden.

Senator WYDEN. Thank you, Mr. Chairman. It has been an excellent panel.

Let me give you my assessment of this and start with you, Mr. Smith. You have been doing some very important work in this area. Here is how I come at it.

I mean, 70 percent of fuel is used in the transportation sector. So this is the ball game. To me, instead of going out and picking these winners and losers, which is what we have been talking about today, you ought to target a variety of different types of electric vehicles for the same reason Willie Sutton targeted the banks. I mean, that is where the money is. That is where the action is.

I very much support your agenda, Mr. Smith, and what you are talking about. To try to drive down the cost for you and everybody else in this space, I have proposed expanding the Energy Department's existing program in this area, loans and grants, to help vehicle manufacturers in a variety of areas. We would include trucks, buses, street cars, and even motorcycles. Does this not make sense from two standpoints? One, it gets the Government out of the business of picking winners and losers in this space, which to me makes sense, but it also is going to expand the capacity of vehicle manufacturers in this case which ought to drive down your costs and the costs for everybody else. Is that a correct assessment?

Mr. SMITH. Senator, first of all, I am familiar to some degree with your work on promoting the infrastructure tax credit on the buses and things of that nature, and I commend you for it. I think that is very important and we support your efforts.

The whole key in this thing gets down to a single point in my opinion, and that is driving the price performance of the batteries up. Period. The charging stations, the permitting, the things of that nature, they are all important, but they pale in comparison to that one point. So anything that moves toward scale production is what needs to happen here.

That is why the Electrification Coalition supports these deployment centers because we believe that is the fastest way to get economies of scale and get these adoption rates up where they are not just a niche in one city or another or a small group of people, but where you have a very large adoption rate in the deployment communities similar to the Race to the Top in the school system where you apply for it and you compete for it. We think that is the fastest way to get there.

But whatever moves scale production and price performance of battery technology forward, including some of your initiatives, we support.

Senator WYDEN. Thank you, and I very much support what you are saying in terms of the deployment, infrastructure as well. This is all about getting to scale production, and it seems to me we have just got to get more players into this. I mean, the Union of Concerned Scientists just released a new report on fuel economy for trucks, which concluded that medium- and heavy-duty trucks make up only 4 percent of the motor vehicles on U.S. highways. So that is going to be very important, but let us get the biggest number of players into this in order to get that scale of production that you in my view correctly argue for.

Let me ask a question of you, Mr. Wynne, and you, Mr. Friedman. In addition to this question of expanding the pool of areas that the Federal Government really targets, different vehicles in addition to trucks, buses, street cars, motorcycles, in addition to the deployment stations, I think we have got a tremendous opportunity in terms of incentives for energy storage. As you know, I

have introduced a major piece of legislation to create a tax credit for energy storage systems connected to the grid as well as buildings and factories and homes. Senator Dorgan is a sponsor of this. Senator Murkowski is a cosponsor.

Now, this is a Finance Committee issue as well. I serve on the Finance Committee, as does Senator Bingaman. We want to provide tax credits for smart grid enabled charging equipment for electric vehicles. If you would, Mr. Wynne and Mr. Friedman, I would like to have your position on this legislation because we are very interested in working with you. I put storage right up there with what Mr. Smith has talked about in terms of deployment arrangements, scale of production issues, and storage is going to create a pretty good market as well. I mean, I envision storage, when you look at energy, a lot of people buying low and selling high, which is about as good as it gets in the American economy. So your positions on the storage legislation, Mr. Wynne and Mr. Friedman.

Mr. WYNNE. Senator, we commend you for that legislation. I think your pointing to what is particularly beneficial about electrifying transportation, which is that we have, as has been already pointed out, an enormous supply of fuel that is not being utilized properly.

Just to come back to the point about the grid, you know, the grid increasingly is going to benefit from renewable technologies, and energy storage, particularly for intermittent renewables such as wind and solar, becomes exceedingly important. So utilities, if they look far enough down the road—and of course, utilities invest on a very, very long timeline—are viewing electric transportation as energy storage on four wheels, which is extremely important. Closer in, you have major utilities, who understand that we are heading into a climate-constrained environment, beginning to invest in centralized storage. They can utilize the same large format lithium-ion batteries in order to create that centralized storage. That can help us get down to scale and get down the cost curve a lot faster.

It is not a very large leap from there to utility companies understanding I am going to sell the fuel here. Why not own the battery? Why not lease the battery to the customer and then utilize that battery in secondary applications for stationary storage and amortize its cost over a much longer lifetime? That will get us down the cost curve even faster.

Other kinds of business arrangements like that I think are very, very exciting. I think your bill will certainly promote that and we thank you for that.

Senator WYDEN. I am over my time. Can Mr. Friedman just respond, Mr. Chairman?

The CHAIRMAN. Mr. Friedman.

Mr. FRIEDMAN. Thank you very much.

I think you are absolutely right that storage is an incredibly important issue, and we do need more support in that direction with bills like yours, as well as actually in the electrification bill. There is money and research provided to look at what happens to car batteries at the end of their life. There is still significant value in those batteries. They may not be applicable for vehicles anymore, but those could actually be turned into the very storage technologies you are talking about. Hydrogen and batteries could be

well adapted to intermittent renewables to lower their costs and to expand their use. We do have to be careful noting, when we attach vehicles to the grid, it will put a little bit more wear on that battery. So we need to plan for that and keep the technology moving.

Finally, on your first point about the portfolio technologies, I want to thank you for your past support.

Senator Dorgan, I definitely want to right a wrong. I mean, you have been an incredible leader on hydrogen for decades, and that is incredibly appreciated. You helped us deliver significant increased fuel economy standards in 2007. So my comments about moving to the deployment side of hydrogen in no way reflect negatively on your heroic leadership in the past.

Senator WYDEN. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much. I think this has been great testimony and a very useful hearing.

Senator Dorgan, since you are the main sponsor on the bill we have been talking about here, why do you not make any closing comments you would like to make? Then we will conclude the hearing.

Senator DORGAN. I will do that ever so briefly.

Thank you, Mr. Friedman, but heroic leadership really overstates almost anything that happens in the Congress by anybody, I might say.

[Laughter.]

Senator DORGAN. Let me again come back to the question of picking winners and losers because I think it is so important. We hear it all the time and is usually an excuse for doing nothing. Just do not pick. God forbid that we should have a plan in America for where we want to be and what we want to do in the future. I mean, we can let happen whatever happens and be satisfied with it, which is the notion of some.

I was sitting here thinking about these things. We built an interstate highway to connect America, which was a really important thing to do. If you are in western North Dakota, there is a town called Sentinel Butte, a wonderful little town—it is out by the Bad Lands. It has 80 people, and about 30 miles away is Beach, North Dakota, which has about 1,200 people. Between, we have a four-lane highway, Interstate 94, connecting Sentinel Butte to Beach. I mean, price that out for a moment. What did it cost to build a highway connecting a city with 80 people and another one with 1,200 people? But that is not the reason it was built. It was built to connect New York to Seattle, and it happens to connect these two little towns in North Dakota.

So the question is what is our grand design here? What do we want to achieve for the country? It comes back to the point we have made incessantly here. We are unbelievably vulnerable and dependent on foreign oil, and it does not take a rocket scientist to know that if 25 percent of all the oil we suck out of the earth every day has to come to our country and we only produce 10 percent of the world's oil, and we have 3 percent of the known reserves in the world, that none of that adds up very well. So how do we make a change and how do we move in a different direction?

As you said, Mr. Smith, if ultimately we do not have better batteries, then all this is just talk. It is not going to happen. But I

am a big supporter of ARPA–E, for example. I mean, I am a big believer. You invest in the new science and research and technology, and you open up a vista of opportunities. I am absolutely convinced that our future is going to be vastly different than our past because we are going to make significant investments and yield dramatic dividends from those investments.

So I start down this road understanding that we have already made dramatic changes and improvements in battery technology and I think will in the future as well. This is just a start.

Mr. Chairman, I wanted to say two things quickly.

One, I think the testimony is really excellent today. This legislation is not written in stone. I mean, it needs to be changed here and there and modified reflecting the interests of people who have suggested good improvements.

Also, I want to thank you for holding the hearing because, as we move down the road, hopefully with the energy bill that we wrote a year ago, I think after 10 or 12 weeks of markup, hopefully we will get to have that on the floor of the Senate. Perhaps we could consider adding some provisions from this authorization bill as well. This hearing I think is central to that. So I thank you, Mr. Chairman, for your leadership as well.

The CHAIRMAN. Thank you for introducing the bill and your leadership on this over a long period of time.

Thank you all for testifying.

That is the end of our hearing.

[Whereupon, at 11:59 a.m., the hearing was adjourned.]

APPENDIX

RESPONSES TO ADDITIONAL QUESTIONS

RESPONSES OF DAVID B. SANDALOW TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. I understand the appeal of a limited number of communities initially in order to develop good data on consumer needs and the issues that must be addressed for wider deployment. At the same time, if the private sector is going to make substantial investments in these technologies they'll need some certainty of widespread deployment in the near future. How do we address these seemingly competing concerns?

Answer. The Administration looks forward to working with Congress to consider the efficacy and efficiency of these and other measures in the context of comprehensive energy and climate legislation to protect our nation from the serious economic and strategic risks associated with our reliance on oil, to create jobs, and to cut down on the carbon pollution that contributes to the destabilizing effects of climate change.

Auto companies continue to make their own decisions and plans regarding electric vehicle rollouts. Companies that have announced their plans are focusing initially on certain regions that best suit their individual needs.

Starting with a smaller number of cities in a targeted deployment program may help accelerate future efforts to ramp up technology adoption across the country. By focusing resources, the Department can work with communities to build a robust team of local leaders that can communicate and help transfer best practices and lessons learned to other cities for faster deployment in other cities nationwide. Success in a limited number of initial communities will then provide confidence for manufacturers to broaden vehicle deployment to other parts of the country.

Question 2. Mr. Crane's testimony refers to the Department's "ambitious" goals for battery life and cost. Can you give us any insight on how research is progressing in these areas? Do you believe the goals are likely to be met in the target time frames?

Answer. Over the past three years, estimates for plug-in hybrid electric vehicle (PHEV) battery life have improved from 1,000 deep cycles to more than 2,500, and the estimate of full system cost has decreased from more than $1,200/kWh to between $700 and $950/kWh, based on useable capacity of the battery. Recent cost models developed by Tiax, LLC and Argonne National Laboratory estimate that a Li-ion battery cost of $300/kWh (the Department of Energy's FY 2014 target) is within reach.[1] DOE anticipates that part of the needed cost reduction will be achieved through high volume production supported by Recovery Act funding, as well as design improvements from experience. Two independent sources have estimated that increasing PHEV battery production from 10,000 to 100,000 batteries per year will result in a 30-40 percent cost reduction.[2] The remaining cost reduction will be achieved through the use of higher energy materials, under development though DOE's research programs, which will lead to smaller, lighter—and therefore less expensive—systems.

---

[1] B. Barnett et al, TIAX, PHEV Battery Cost Assessment, DOE Annual Merit Review, May 19, 2009, http://www1.eere.energy.gov/vehiclesandfuels/pdfs/merit_review_2009/energy_storage/es_02_barnett.pdf; P. Nelson et al, ANL, Factors Determining the Manufacturing Costs of Lithium-Ion Batteries for PHEVs, 24th International Electric Vehicle Symposium (EVS-24), Norway, May 2009; Santini et al, ANL, Comparing Four Battery Cost Models, 2001-2009, Plug-In 2009

[2] N. Gioia, Ford, Key Issues and Solutions for Mass Electrification of Transportation, IEEE Vehicle Power and Propulsion Conference, Dearborn, MI, September 7-11, 2009, http://www.vppc09.org/ P. Nelson et al, ANL, Factors Determining the Manufacturing Costs of Lithium-Ion Batteries for PHEVs, 24th International Electric Vehicle Symposium (EVS-24), Norway, May 2009;

RESPONSES OF DAVID B. SANDALOW TO QUESTIONS FROM SENATOR MURKOWSKI

FEDERAL SUPPORT

Question 1. Please provide a summary of the types of federal support (including spending levels) that were available to electric vehicles in FY2009 and FY2010.

Answer. The table below shows the Department's fiscal year 2009 and 2010 funds focused specifically on electric vehicles.

	FY 2009	FY 2010
ARRA – Transportation Electrification	$400,000,000	N/A
ARRA – Battery and Electric Drive Component Manufacturing	$2,000,000,000	N/A
Relevant Annual Appropriations for the Vehicle Technologies Program • Energy Storage R&D key activity • Advanced Power Electronics & Electric Motors R&D key activity • Vehicle & Systems Simulation & Testing subprogram	$107,909,000	$142,894,000

In addition, the Advanced Technology Vehicles Manufacturing Loan Program (ATVM) provides loans to automobile and automobile part manufacturers for the cost of reequipping, expanding, or establishing manufacturing facilities in the United States to produce advanced technology vehicles or qualified components, and for associated engineering integration costs. This program received $7.5 billion in appropriations in FY 2009 to support up to $25 billion in ATVM loans. To date, $8.4 billion in direct loans have been made to four manufacturers, three of which have been exclusively focused on plug-in electric and hybrid electric vehicles.

ATVM

Question 2. To the greatest extent possible, please provide a summary of loans received to date by the Advanced Technology Manufacturing Program and the level of funding that remain available for additional loans.

Answer. The Advanced Technology Vehicle Manufacturing Loan program has made four loans to vehicle manufacturers so far totaling $8.4 billion. $4.2 billion of the credit subsidy remains for future loans awarded under the Advanced Technology Vehicle Manufacturing Loan Program.

DEPARTMENT STAFFING

Question 3. A significant amount of work could be required to implement and administer the programs and plans required by S. 3495. Please provide an estimate of the number of employees the Department of Energy would need to hire to fulfill the various sections of this legislation.

Answer. The Administration looks forward to working with Congress to consider the efficacy and efficiency of these and other measures in the context of comprehensive energy and climate legislation to protect our nation from the serious economic and strategic risks associated with our reliance on oil, to create jobs, and to cut down on the carbon pollution that contributes to the destabilizing effects of climate change.

The Department of Energy recognizes the wide range of activities and significant reporting requirements included in this bill and estimates that an additional 10 to 20 full time employees, including contract specialists, are needed to plan and implement these provisions by the deadlines specified in the legislation.

BUDGETING

Question 4. If enacted, would any of the programs within this bill (S. 3495) be priorities for the Administration and the Department of Energy?

Answer. The Administration looks forward to working with Congress to consider these and other measures in the context of comprehensive energy and climate legislation to protect our nation from the serious economic and strategic risks associated

with our reliance on oil, to create jobs, and to cut down on the carbon pollution that contributes to the destabilizing effects of climate change.

The Department believes that the programs outlined in this bill would accelerate the market introduction of electric drive vehicles, which can significantly reduce our nation's dependence on petroleum and reduce greenhouse gas emissions.

LOAN GUARANTEES

Question 5. Section 302 would authorize $50 million for loan guarantees for advanced battery purchases. As credit subsidy, what amount of loan guarantees would that funding cover, if appropriated?

Answer. The credit subsidy cost will depend on the terms and conditions and other project specific characteristics of these loans. This program has not yet been funded, nor are regulations in place outlining standard procedures.

R&D PROGRAM

Question 6. Section 201 would establish a robust research and design program for electric vehicles at the Department of Energy. Are there any new authorities in this section that the Department does not currently have?

Answer. The Administration looks forward to working with Congress to consider these and other measures in the context of comprehensive energy and climate legislation to protect our nation from the serious economic and strategic risks associated with our reliance on oil, to create jobs, and to cut down on the carbon pollution that contributes to the destabilizing effects of climate change.

Section 201 contains no new authorities for the Department of Energy (DOE). Nonetheless, although it includes a number of activities currently funded through DOE's Vehicle Technologies Program, there are several for which DOE has not previously prioritized resources. For example, R&D activities related to "the benchmarking and assessment of open software systems using nationally established evaluation criteria" (section 201(a)(2)(B)) and "identify[ing] possible uses of a vehicle battery after the useful life of the battery in a vehicle has been exhausted" (with demonstration projects and grants for the same) (section 201(b) and (c)) have not been emphasized previously.

TAX CREDITS VS. GRANTS

Question 7. S. 3495 contains a tremendous amount of grant funding, and it is my understanding that tax provisions could be added to it during floor debate. Do you believe that one of those forms of support is more appropriate or more relevant for the advancement of electric vehicles? Is it important to maintain a mix between tax credits and federal grants?

Answer. The Department of Energy supports incentives to support initial market introduction and subsequent market penetration of advanced technology vehicles. Tax credits haven proven effective in encouraging consumers and private-sector fleets to choose advanced vehicles, and they also can encourage additional private-sector investment in the technology. Federal grants to promote technology deployment have been effective for tax-exempt entities, such as State, local, and tribal governments. Federal grants also encourage private-sector entities—both those with minimal tax burdens as well as large and small companies that seek to offset the initial cost of vehicle and/or infrastructure purchases.

PACE OF DEPLOYMENT

Question 8. Hybrid vehicles debuted a decade ago, are popular with consumers, and currently account for about three percent of the light duty vehicle market. Is it reasonable to expect that this legislation—or any other legislation—will initiate a tipping point to allow electric vehicles to deploy at a much faster rate?

Answer. Legislation that facilitates electric vehicle (EV) deployment in significant volumes can increase production rates of components unique to EVs, such as batteries, power electronics, and specialized electric drive components. Relatively modest increases in production volumes can result in significant cost reductions and help overcome the current price disadvantage these vehicles have today.

Given the national priorities of ending dependence on petroleum and reducing greenhouse gas emissions, as well as fuel cost volatility, such legislation could be an important step in deploying electric drive vehicles at a much faster rate. The Administration looks forward to working with Congress to consider the efficacy and efficiency of these and other measures in the context of comprehensive energy and climate legislation to protect our nation from the serious economic and strategic risks

associated with our reliance on oil, to create jobs, and to cut down on the carbon pollution that contributes to the destabilizing effects of climate change.

COST SHARE

Question 9. S.3495 requires at least a 20 percent non-federal cost share.

a. Do you agree with this level of cost sharing?

b. Do you believe the Secretary should have authority to reduce the cost share below 20 percent, or eliminate it completely? If so, please provide an example of when that authority may prove necessary and appropriate.

c. Could a higher cost share (greater than 20 percent) help ensure that only the most financially sound communities are selected, and thereby lead to an even greater deployment of electric vehicles and infrastructure once federal funds have ended?

Answer. Cost-sharing is an important mechanism for leveraging federal funds and ensuring that the government's partners focus on topics relevant to the market. The costshare requirements set forth in Section 988 of the Energy Policy Act of 2005 (minimum of 20 percent cost share for R&D projects and minimum of 50 percent cost share for demonstration and commercialization projects) have proven effective in meeting these objectives. Providing the Secretary the authority to make decisions regarding cost share on a case-by-case basis allows the flexibility to ensure program objectives are met (for example, adequate participation among State, local, and tribal governments and geographic diversity of applicants). Section 988 of the Energy Policy Act of 2005 provides the Secretary this decision-making authority.

CHARGING UNITS

Question 10. The Administration recently announced it would use stimulus funds to pay for up to 4,400 charging units, worth up to $2,000 each, for the Chevy Volt. Why was just one vehicle chosen? Will any others receive similar support?

Answer. The provision of 4,400 residential charging units to support deployment of the Chevrolet Volt Extended Range Electric Vehicle (EREV) is part of Coulomb Technologies' "ChargePoint America" program, one of eight cost-shared projects competitively-selected for award under the Department's Transportation Electrification effort, funded by the Recovery Act.

In addition to the Chevy Volt, the Coulomb project will provide infrastructure to support electric drive vehicles from Ford and smart USA and cover nine major metropolitan areas. Another Transportation Electrification grant, awarded to ECOtality North America for "The EV Project," will provide free charging units to purchasers of the Nissan Leaf electric vehicle and the Chevy Volt extended range electric vehicle in seven metropolitan areas. In total, the eight Transportation Electrification awards will result in the coordinated deployment of nearly 7,000 electric-drive vehicles and over 16,000 Level 2 charging units in residential, commercial, and public locations.

CHARGING STATIONS

Question 11. How many charging stations do you believe will need to be installed for every electric vehicle put on the road?

Answer. A variety of factors will determine the optimal number of charging stations per electric vehicle, including the vehicle type (light-duty, medium-duty, or heavyduty), powertrain configuration (electric vehicle, plug-in hybrid electric vehicle, or extended-range electric vehicle), charger capability (standard Level 2 charging, or Level 3 "fast" charging), and charger location (residential, commercial, or public). The Department of Energy (DOE) believes that initially, Level 2 residential chargers (one per vehicle) will be the most important to the light-duty fleet, as the majority of these electric drive vehicles will likely charge during overnight hours where the vehicles are domiciled.

Through the electric drive vehicle demonstration and deployment projects funded through the Recovery Act's Transportation Electrification program, DOE will collect and analyze a comprehensive data set regarding electric drive vehicle usage patterns and charging infrastructure use for a variety of vehicle applications. This data will provide valuable information about the appropriate mix of charging infrastructure to support the large-scale deployment of all types of electric drive vehicle technologies.

Ultimately, the required number of publicly-available charging points will be a fraction of the number of electric drive vehicles on the road. It is anticipated that these public charging points will supplement residential charging.

CHARGING TIMES

Question 12. Right now, most gas-powered vehicles can be fueled in less than 10 minutes, and then drive for hundreds of miles. A drawback for electric vehicles is that they take hours to fully recharge. Even quick charging, which reduces battery life, takes at least 20 minutes. Can you discuss any changes to charging times that you see over the next several years?

Answer. Without a scientific breakthrough, significant reductions in electric vehicle charging times in the next several years are unlikely, given current operational constraints for both battery technologies and charger capabilities. However, the Department of Energy anticipates upcoming electric drive vehicles and charging infrastructure will be sufficient to meet the requirements of the majority of vehicle owners. According to the 2009 National Household Travel Survey, American drivers average 41.4 miles of daily driving. A quarter of drivers travel more than 50 miles per day (75th percentile = 48.8 miles driven per day). One in ten drivers exceed 85 miles travelling per day (90th percentile =85.3 miles driven per day)—less than the driving range of all upcoming highway-capable electric vehicles. Additionally, the market introduction of plug-in hybrid vehicles and extendedrange electric vehicles will not have a range limitation. For example, the Chevy Volt has a 40-mile all-electric range but also has a gasoline-powered rangeextender that provides a total vehicle range of up to 350 miles, allowing consumers to operate their vehicles in all-electric mode during the majority of their trips, while enabling much longer travel distances when required.

1990S VS. TODAY

Question 13. In your book "Freedom from Oil," you note that General Motors' EV-1 had a range of 80 to 140 miles and was popular with consumers. That's about what we expect of electric vehicles today, and yet, General Motors ultimately pulled the plug on the EV-1 program due to what you describe as "inadequate" overall buyer interest. I understand that the EV-1 was leased, and the Volt and Leaf will be commercially produced, but can you explain what else has changed to make the deployment of electric vehicles a sure thing today? How have the failures of the 1990s been resolved?

Answer. Better battery technology is the key difference between today's electric drive vehicles and the electric vehicles (EVs) of the 1990s. Initially, the EV-1 used lead-acid batteries with limited energy density, which resulted in a two-passenger vehicle, relatively short battery life, and a long recharging time. In contrast, today's lithium-ion battery technology allows the Leaf, Volt, and other EVs to accommodate 4-or 5-passengers with a warranty on battery life and much faster charging times.

BUILDING CODES

Question 14. The new International Green Construction Code from the International Code Council has provisions addressing vehicle charging, as does the National Electrical Code. Does Section 103(b) of S.3495 anticipate that the Secretary of Energy could adopt private sector model codes that provide for the efficient and safe charging of electric vehicles, rather than having DOE develop its own code?

Answer. The Department of Energy (DOE) does not author or adopt model code to address vehicle charging infrastructure; rather, it plays a supporting role in the development and adoption of model vehicle-and infrastructure-related codes and standards. DOE has extensive experience working with code development organizations and standards development organizations, including the International Code Council and others, to facilitate consensus around the development and adoption of these codes. DOE also has experience in training code officials and sharing best practices for the implementation of codes and standards for vehicles and infrastructure that have been adopted by local authorities having jurisdiction (AHJs). DOE supports the adoption of private sector model codes for safe electric vehicle charging and would work with code development organizations to modify existing codes if and where appropriate.

TECHNOLOGY NEUTRALITY

Question 15. As introduced, S. 3495 would authorize nearly $6 billion for electric vehicle technologies. How could this substantial increase in funding affect the development of other technologies, such as natural gas, hydrogen, or more efficient ICE vehicles, which receive far less funding each year?

Answer. The Administration looks forward to working with Congress to consider these and other measures in the context of comprehensive energy and climate legislation to protect our nation from the serious economic and strategic risks associated

with our reliance on oil, to create jobs, and to cut down on the carbon pollution that contributes to the destabilizing effects of climate change.

The Department of Energy continues to pursue a portfolio of advanced transportation technologies that can reduce petroleum consumption and mitigate greenhouse gas emissions, and electric drive technologies are a critical component of that portfolio. Several electric drive vehicle configurations, notably hybrids and plug-in hybrids, will still require highly-efficient, low-emissions internal combustion engine technology. Advanced combustion engines can significantly increase vehicle fuel economy and are an important part of a hybrid electric system. Continued development is essential to further increase the fuel efficiency of hybrid electric vehicles. Similarly, alternative fuel options such as biofuels will continue as important options for internal combustion engine operation and complement the emissions reductions possible through vehicle electrification.

Hydrogen fuel cell vehicles share electric drive component technologies, so advancements in electric drive systems also support and advance the development of fuel cell vehicles.

Question 16. By promoting one technology so greatly, could we inadvertently decentivizes the development of cheaper ways to reduce fuel consumption and greenhouse gas emissions, such as advanced internal combustion engines that achieve significant increases in fuel economy?

Answer. The Department of Energy continues to pursue a portfolio of advanced transportation technologies that can reduce petroleum consumption and mitigate greenhouse gas emissions, and electric drive technologies are a critical component of that portfolio. Electric drive vehicles include hybrids and plug-in hybrids that use biofuel and renewable electricity, full electric vehicles recharged with renewable electricity, and fuel cell vehicles that use renewable hydrogen. Other advanced technologies such as vehicle lightweighting and combustion engines can significantly increase vehicle fuel economy and are an important part of a hybrid electric system. Continued development is essential to further increasing the fuel efficiency of hybrid electric vehicles.

Question 17. By promoting one technology much more than others, do we risk freezing the industry's investments in fuel cell and other alternative technology vehicles?

Answer. No. Although the Department of Energy places some emphasis on electric drive technologies, we do not feel that we risk freezing industry investments in fuel cells or other advanced vehicle technologies. Working together with industry partners, the Department continues to pursue a portfolio of near-and long-term advanced transportation technologies that can reduce petroleum consumption and mitigate greenhouse gas emissions, and electric drive technologies are a critical component of that portfolio. Electric drive vehicles include hybrids and plug-in hybrids that use biofuel and renewable electricity, full electric vehicles recharged with renewable electricity, and fuel cell vehicles that use renewable hydrogen. These variations of electric drives share component technologies, so advancements in plug-in hybrid power electronics, for example, also support and advance the development of fuel cell vehicles. Similarly, advanced technologies such as vehicle lightweighting and advanced combustion engines can significantly increase vehicle fuel economy and are an important part of a hybrid electric system. Continued development is essential to further increasing the fuel efficiency of hybrid electric vehicles.

UTILITY PLANNING

Question 18. Section 301 requires each electric utility to prepare "a plan to support the use of plug-in electric vehicles" within two years.

- What sort of resource burden would that planning process impose on utilities that do not receive a waiver?
- How much would a typical planning process cost, and how could that affect rates if cost recovery is allowed?
- Would it make more sense to require only utilities in areas that are expected to have a significant near-term increase in PHEVs, such as the communities selected for the targeted deployment program, to undertake this planning?

Answer. The Administration looks forward to working with Congress to consider the efficacy and efficiency of these and other measures in the context of comprehensive energy and climate legislation to protect our nation from the serious economic and strategic risks associated with our reliance on oil, to create jobs, and to cut down on the carbon pollution that contributes to the destabilizing effects of climate change. The utility planning activity required in Section 301 is a useful mechanism for gauging the preparedness of the electrical grid to accommodate a national objec-

tive that amounts to a revolutionary movement in our transportation sector. It will enable utilities to make a rational assessment of how they, as critical partners in this transformation, will need to react in the coming years.

The resource burden for such a planning process as well as the cost will be highly variable, as will the effects on electricity rates. The cost of developing such plans will be dependent on the in-house resources of each utility, how each utility and its respective regulatory agency (Public Utility Commission, City Council, Co-op Board, etc.) perceives the requirement, their own impression of the state of their infrastructure, and the likelihood of PHEV penetration in their territory. In many cases, the bulk of the work required to develop the plan may be conducted by the respective engineering and business operations personnel at the utility, reducing the cost to produce the work. The effect of producing the plan on electricity rates will be determined primarily by the regulatory body.

It may be more cost efficient in the near-term to limit the applicability of the planning requirement initially to those utilities selected for the targeted deployment program. However, the greatest value of the planning requirement (i.e. the ability to assess preparedness for PHEVs on a national level) is preserved by not limiting the requirement to a few select areas.

TARGETED DEPLOYMENT PROGRAM

Question 19. A targeted deployment program could help deploy vehicles and infrastructure within communities, but it would do little to assist with long-distance driving. What do you think can and should be done to facilitate intercity road trips in electric vehicles?

Answer. The Department of Energy (DOE) anticipates the majority of trips in electric vehicles (EVs) over the next several years will be short, local trips well within the vehicle's range capability. Initial deployment of charging infrastructure will occur in cities and metropolitan areas with high concentrations of consumers whose needs will be met by such vehicles. DOE expects that to facilitate longer intercity trips, Level 3 "fast" charging infrastructure will be deployed along routes connecting cities, establishing a network of EV corridors between electric transportation hubs.

Several of the projects funded under the Transportation Electrification Recovery Act program target the deployment of charging infrastructure to demonstrate the viability of this hub/corridor system. These projects will place Level 3 "fast" chargers along corridors connecting Portland, Oregon and Seattle, Washington; Phoenix and Tucson, Arizona; and Chattanooga, Knoxville, and Nashville, Tennessee. Additionally, the availability of plug-in hybrid electric and extended range EVs will accommodate the needs of consumers who require longer travel distances prior to the full, nationwide deployment of EV charging infrastructure.

TARGETED DEPLOYMENT PROGRAM

Question 20. As drafted, I am concerned that communities in my home state of Alaska would have a difficult time being selected for participation in the targeted deployment program. This is driven in part by the current lack of electric vehicle manufacturing, retailing, and infrastructure development in Alaska, and also by the fact that some manufacturers have already selected initial retail markets for their electric vehicles.

- S.3495 requires communities to be selected for the targeted deployment program within one year of enactment of this Act. Let's assume this bill is enacted in September of 2010. In how many cities will electric vehicles be available for retail sale in one year after that date (hypothetically September 2011)?
- How many electric vehicles do you expect to be commercially produced and available for sale in the United States next year? Two years from now? Five years from now?
- Chevrolet has chosen Washington, D.C., Michigan, and California as its initial retail markets for the Volt. Nissan has reportedly chosen Seattle, Oregon, Tennessee, Phoenix, Tucson, and San Diego as part of the EV Project. Given that electric vehicles will be in limited commercial production for at least several more years, won't these cities and states have a significant advantage over others for selection to participate in the targeted deployment program?
- How could a state like Alaska overcome Section 106's requirements for community deployment plans to include "documentation" of 1) "plug-in electric drive vehicle manufacturers and retailers" and 2) "third-party providers of residential, private, and publicly available charging infrastructure or services"?

Answer. Most major auto manufacturers have publicly announced plans to sell vehicles with some type of electric-drive powertrain in the next several years. How-

ever, only a few manufacturers have named specific cities for their vehicle roll outs, and it is not clear which other cities will join those already named. Based on public announcements and according to the Department of Energy's (DOE) analysis of potential market introduction and penetration scenarios, we estimate that within a year, the U.S. market for electric and plug-in hybrid electric vehicles will be between 25,000 and 85,000 vehicles. Within two years, DOE anticipates the market for these vehicles will be between 60,000 and 300,000 vehicles.

Within five years, DOE expects between 200,000 and 1 million electric and plugin hybrid electric vehicle sales annually. These estimates represent the range of the most likely electric-drive vehicle market penetration scenarios, based on DOE analysis taking into account projected consumer demand as well as the ability of automobile manufacturers to scale up vehicle production.

Although cities that have been announced as part of manufacturers' existing vehicle introduction plans would seem to have an advantage, the targeted deployment program requires significant commitment from the cities in order to participate. A city committed to taking the necessary steps to facilitate electric drive vehicle introduction will attract vehicle manufacturer participation. In fact, even though specific rollout cities have been included in public announcements, we understand auto manufacturer intent is to sell vehicles nationwide. If states such as Alaska express interest in electric vehicle deployment, we expect that the manufacturers will want to meet that need and the market demand.

RAW MATERIALS

Question 21. I've often expressed concern that if we do not develop our own resources, we risk trading our dependence on foreign oil for a similarly devastating dependence on foreign materials. Do you share that concern? As the United States government looks at ways to promote electric vehicles, how would you recommend addressing it?

Answer. The Department of Energy (DOE) does not expect electric vehicle (EV) promotion and commercialization will lead to a devastating dependence on foreign materials. Currently, the United States consumes 378 million gallons of gasoline per day[3], equivalent to a weight of about 1 billion kilograms (kg) per day. Although some resources EVs use are considered valuable, they cannot be consumed at the same magnitude as petroleum.

Lithium is one material critical for energy-dense batteries used in EVs. One kg of lithium is required to make a battery that would propel a vehicle 25 miles. One gallon (or 2.8 kg) of gasoline can also be used to propel a vehicle 25 miles. However, the battery can be recharged another 3,000 to 5,000 more times to travel that same 25 miles, and once the battery has reached the end of its life, the lithium can be recovered to produce a new battery for use once again.

Today, the major sources of lithium are salt brines in South America (in Chile, Argentina, Bolivia), but there are also U.S. brine sources, and there are rock sources throughout the world, including in United States, Europe, China, and Australia. Current International Energy Agency estimates show no serious lithium supply problem until more than 50 percent of the world's vehicle fleet is electrified. (Per IEA Blue Scenario for Carbon Reduction).

Rare earth materials such as Neodymium, which is used in magnets for EV motors, also could be seen as limiting EV introduction. The Government Accountability Office has recognized that the future availability of some rare earth elements, including Neodymium, is largely controlled by Chinese suppliers[4]. DOE has also recognized this issue and is developing its first-ever strategic plan concerning rare earth metals[5]. Depending on production and market demands, it is possible that a market shortage of these materials could exist in the 2012-2015 timeframe. However, similar to batteries, each EV would require only a limited amount of these materials to be effective for the life of the vehicle, and there are potential U.S. resources for rare earth materials as well. Furthermore, induction motors can be made that do not use any permanent magnets or rare earth materials. Currently the Tesla Roadster and Nissan Leaf EV use this type of motor design.

---

[3] "Petroleum Basic Statistics", U.S. Energy Information Administration, http://www.eia.doe.gov/basics/quickoil.html

[4] "Rare Earth Materials in the Defense Supply Chain", U.S. Government Accountability Office, GAO-10-617R

[5] "DOE Announces RFI on Rare Earth Metals", May 6, 2010, http://www.energy.gov/news/8945.htm

LOCAL LEVEL GRID IMPROVEMENTS

Question 22. During the committee's electric vehicle hearing on the 22nd, a Senate-wide alert went out asking officers to conserve energy from noon to 7 pm. According to the alert, "Our local utility provider, PEPCO, is asking its customers to conserve electricity due to intense heat and humidity. This peak demand event may lead to possible power disruption in the DC area if electrical demand exceeds transmission capacity."

a. Can you describe the impact this sort of alert would have on consumers' ability to re-charge their vehicles during daytime hours?

Answer. Electric plug-in vehicles will increase the load on the grid whether they are charged on-peak or off-peak. However, power companies have a variety of tools at their disposal to reduce demand during peak periods. Tools include options such as (1) time-varying rates (e.g., critical peak pricing) which are designed to encourage consumers to switch their electricity use from on-to off-peak periods and (2) load management programs (e.g., air conditioner cycling) and devices (e.g., smart thermostats) which are designed to curtail power consumption during peak periods. Power companies will be interested in using these tools to manage re-charging schedules for plug-in vehicles. Options include: (1) offering special time varying rates for charging stations or owners of plug-in vehicles to encourage them to charge during off-peak periods and (2) offering load management devices to charging stations and owners of plug-in vehicles to reduce electricity charging during peak periods.

b. Can you describe the local level grid improvements that would need to be undertaken in order to ensure that sufficient transmission capacity exists to handle regular power demand and any additional demand from electric vehicles?

Answer. The type of grid improvements that will be needed in the future to accommodate plug-in vehicles depends on the number and concentration of vehicles and the charging patterns of consumers. For example, it is possible that little to no improvements will be needed until millions of vehicles are on the road, or until thousands of vehicles are concentrated in certain electric distribution service areas. Even in these cases, if owners charge their vehicles at night or during other off peak periods exclusively, analysis indicates that existing transmission and distribution facilities may be sufficient to handle the load if and until there are tens or hundreds of millions of vehicles.

However, integration with the grid would be enhanced, and the potential impacts on the electric system reduced, if grid infrastructure improvements were made alongside the development of the markets for plug-in vehicles. For example, vehicles can take many hours to charge at typical residential outlet voltages (e.g., 120v). Equipping charging stations with higher voltage plugs (e.g., 220v) can reduce charging times and make it easier for consumers to "refill their tanks." Other useful electric distribution upgrades include smart systems that enable grid operators to be aware of where and when vehicles are charging so that steps can be taken to reduce demand during peak periods. Also, deployment of advanced metering infrastructure can make it easier for power companies to apply time-varying rates that encourage owners of plug-in vehicles to charge during offpeak periods. In the longer term, smart distribution systems, equipped with real time controls and automated operations that can safely accommodate two-way flow of power, could make use of the storage capacity embodied in the battery packs on-board electric vehicles to use to meet electric system needs for local voltage and other requirements.

RESPONSE OF DAVID B. SANDALOW TO QUESTION FROM SENATOR DORGAN

Question 1. Will DOE please submit their analysis of the National Research Council's Plug-in Hybrid Electric Vehicles Study for the record?

Answer. The Department's analysis of the National Academy of Sciences' Plug-in Hybrid Electric Vehicles (PHEV) Study is provided below.

SUMMARY

The National Academy of Sciences' (NAS) report significantly overestimates both the current and future cost of battery technology. Unfortunately, this error results in a concurrent underestimation of market penetration and realized benefits cited in the report. There is referenced data (partial list below), as well as a wealth of anecdotal and intuitive examples, indicating that the NAS's assumed cost is inaccurate. The NAS was informed of this inaccuracy but chose to go to print without revision.

- The NAS overestimated the current cost of lithium-ion batteries, overstating the cost of PHEV-10 batteries, and significantly overstating the cost of PHEV-40 batteries for high volume production.
- Future cost reductions will be greater than those projected in the NAS study. Specifically, NAS assumes a 43 percent cost reduction by 2030 from a current estimated cost of $1750/kWh, whereas DOE estimates that a >60 percent cost reduction is likely from a current estimated cost of $800/kWh.

Current Battery Costs

The NAS estimates of the current cost of PHEV-10 batteries ($1650/kWh usable) and PHEV-40 batteries ($1750/kWh usable) are unreasonably high.

- Typically, $/kWh cost is lower for higher energy batteries, such as for the PHEV-40. As the report states, additional energy can be added with relatively small cost increment by making electrodes thicker. A PHEV-40 battery, with four times the energy of a PHEV-10 battery, is estimated to cost roughly twice as much as a PHEV-10 (Kalhammer, 2009). Thus, a PHEV-40 battery will have a much lower $/kWh cost than a PHEV-10 battery.
- Press reports describe the expected cost of the Chevy Volt PHEV-40 battery at approximately $8,000. This is equivalent to $1,000/kWh of useable energy, much lower than the NAS estimates of $1750/kWh of useable energy.
- Industrial developers of PHEV-10 batteries, under existing R&D contracts with U.S. Advanced Battery Consortium (USABC), are required to develop battery cost estimates, using standardized USABC cost models. These developers have estimated costs of $800-$1000 per usable kWh for PHEV-10 batteries at a production level of 100,000/year.
- A number of May 2010 media reports have indicated the Nissan Leaf battery as costing as little as $375/kWh. Although this cost is lower than current DOE estimates, the figure does correlate with announced Leaf pricing of $32,780 and an announced battery size of 24kWhr.

Future Cost Reduction Potential

Commercial 18650-size lithium-ion cells (used primarily in battery packs for laptop computers) currently cost $200-$250/kWh (Barnett, 2009). The cost of the battery pack ranges from $400/kWh to $700/kWh based on nameplate capacity.

- High volume production of these small lithium ion battery cells is a key enabler for achieving these low costs.
- These batteries use cobalt oxide cathode material, which is more expensive than the materials proposed for PHEV batteries. They also have small Ah capacity per cell, and thus are more expensive than larger-capacity PHEV cells would be at comparable production levels.
- Independent analysis conducted by TIAX, LLC (Barnett, 2009) indicated a future battery manufacturing cost of $364-$581/kWh useable energy for a PHEV-20 battery pack for the four leading battery chemistries being developed today.

Cost Reductions due to Manufacturing Efficiency Gains and Design Optimization

- The NAS report estimates that the cost of PHEV batteries can be reduced by 25 percent during 2010-2015 with "increased production and learning by doing".
  - —A major automotive OEM has estimated that PHEV battery costs could drop 20-40 percent immediately with volume manufacturing of 75,000-100,000/year (Gioia, 2009). Multiple projects are underway to establish this level of battery manufacturing (battery manufacturing awards funded under the American Recovery and Reinvestment Act).
  - —In addition, battery costs are estimated to reduce ?3 percent/year with technology improvements (Gioia, 2009).
  - —Using the OEM estimates given above (a 30 percent reduction due to volume manufacturing, and 3 percent/year technology improvement), costs would be expected to reduce by 40 percent during the same period.
- Lithium-ion battery costs are projected to be $600/kWh useable for PHEV-10, and $300-400/kWh for PHEV-40, based on battery manufacturing cost studies conducted by Argonne National Laboratory (Nelson, 2009; Santini, 2009)

REFERENCES

B. Barnett et al, TIAX, PHEV Batttery Cost Assessment, DOE Annual Merit Review, May 19, 2009, http://www1.eere.energy.gov/vehiclesandfuels/pdfs/merit__review__2009/energy__st orage/es__02__barnett.pdf

P. Nelson et al, ANL, Factors Determining the Manufacturing Costs of Lithium-Ion Batteries for PHEVs, 24th International Electric Vehicle Symposium (EVS-24), Stavanger, Norway, May 2009

Santini et al, ANL, Comparing Four Battery Cost Models, 2001-2009, Plug-In 2009

N. Gioia, Ford, Key Issues and Solutions for Mass Electrification of Transportation, IEEE Vehicle Power and Propulsion Conference, Dearborn, MI, September 7-11, 2009, http://www.vppc09.org/

F. Kalhammer, EPRI, 24th International Electric Vehicle Symposium (EVS-24), Stavanger, Norway, May 2009

Nissan media reports: http://www.thetruthaboutcars.com/nissan-leaf-batterypacks-break-the-400kwh-barrier/

RESPONSES OF DAVID B. SANDALOW TO QUESTIONS FROM SENATOR CANTWELL

Question 1. The Promoting Electric Vehicles Act (S. 3495) contains numerous provisions designed to provide grants to stakeholders, for purposes of scaling up electric vehicle and infrastructure deployment. I support this general effort. However, we are currently facing very tight fiscal times, and in addition to grants, there are other means of providing Federal financing to help deploy these technologies at scale, in a manner that may prove even more cost-effective to taxpayers. In particular, how does DOE intend to use programs already at its disposal—such as the loan guarantee program—to help scale-up EV infrastructure deployment? This seems like something DOE could start moving on today, rather than waiting for future appropriations and legislation.

Answer. The Advanced Technology Vehicles Manufacturing (ATVM) Loan Program provides direct loans to support the development of advanced technology vehicles and associated components. The ATVM Loan Program has closed loans totaling $8.4 billion with four advanced technology vehicle manufacturers. The program received a total of $7.5 billion in appropriated funds for the cost of ATVM loans. We expect to complete the investment of the funds by the end of FY 2010.

Section 1703 of Title XVII of the Energy Policy Act of 2005 (EPAct) identifies ten discrete categories of projects that are eligible for federal loan guarantees, including production facilities for fuel efficient vehicles, including hybrid and advanced diesel vehicles. The FY 2011 budget request includes $500 million to support between $3—5 billion in loans for renewable energy and end-use energy efficiency projects.

Question 2. Are there any barriers to doing so (perhaps barriers against projects that span multiple sites, as a result of OMB's existing rules)?

Answer. The Advance Technology Vehicle Manufacturing (ATVM) Loan Program and the Title XVII Loan Guarantee Program support development of advanced technology vehicles. The Advanced Technology Vehicles Manufacturing (ATVM) Loan Program provides direct loans to support the development of advanced technology vehicles and associated components. In addition, Section 1703 of Title XVII of the Energy Policy Act of 2005 (EPAct) identifies ten discrete categories of projects that are eligible for federal loan guarantees, including production facilities for fuel efficient vehicles, including hybrid and advanced diesel vehicles.

Question 3. If there are any bureaucratic barriers, or a perceived lack of existing statutory authority that prevents DOE from using either the loan guarantee program or advanced technology vehicles manufacturing program (ATVM, created under Section 136 of the Energy Independence & Security Act of 2007) to help finance EV infrastructure deployment, would you provide relevant legislative language to the Committee to provide this explicit authority?

Answer. The Advance Technology Vehicle Manufacturing (ATVM) Loan Program and the Title XVII Loan Guarantee Program support development of advanced technology vehicles. The Advanced Technology Vehicles Manufacturing (ATVM) Loan Program provides direct loans to support the development of advanced technology vehicles and associated components. In addition, Section 1703 of Title XVII of the Energy Policy Act of 2005 (EPAct) identifies ten discrete categories of projects that are eligible for federal loan guarantees, including production facilities for fuel efficient vehicles, including hybrid and advanced diesel vehicles.

Question 4. Accelerating the deployment of electric vehicles requires a number of moving pieces of policy to come together at once, and Sen. Dorgan's legislation is an admirable effort in this regard. One of the components of particular interest to me is our nation's evolving smart grid policy. As you are aware, members of this Committee and I had a critical role in crafting Title 13 of the Energy Independence and Security Act of 2007, which laid down the parameters for DOE's smart grid investment grant and regional demonstration programs, which are currently underway. Meanwhile, the standards-setting process is also currently unfolding at NIST,

with FERC expected to soon take them up. What is DOE doing to ensure standard and cybersecure communications protocols for EV's and the combination of public and private infrastructure expected to provide charging services for consumers?

Answer. Two DOE program offices, the Offices of Electricity Delivery and Energy Reliability (OE) and Energy Efficiency and Renewable Energy (EE), are concerned with EV charging infrastructure, and are coordinating in the effort managed by the National Institute of Standards and Technology (NIST) on the development of communication protocols for EVs. EE, through its Vehicle Technologies Program, focuses on the vehicle itself and the methods for provisioning it with energy, and OE focuses on the vehicle-to-grid interface and the attendant reliability, security and market aspects of EVs. Development of communications protocols for EVs is taking place within Priority Action Plan 11 (PAP 11), by a working group named "Interoperability Standards to Support Plugin Electric Vehicles". DOE and its national lab partners are participating directly in the working group, as are the critical standards organizations, namely SAE International (Society of Automotive Engineers) and IEC (International Electrotechnical Commission). Standards on the informational aspects of the vehicle-to-grid interface are expected to be ready for consideration under the 39 FERC rulemaking process established under EISA 2007 early in calendar year 2011.

Question 5. There are certain analogies that exist with respect to telecom and EV infrastructure deployment policies. That is, consumers can expect to drive their EV's outside their home utility's service territory, just as when "roaming" on a cell/wireless network. In your view, are utilities equipped to deal with the associated data-management and billing challenges, given the current state of the electric grid and its communications capabilities? What role should consumers have in choosing the kind of EV-related charging services they would like to purchase?

Answer. At existing capacities and current configurations, the electric grid and telecommunications infrastructures are not currently able to provide analogous services to EV owners as those that are currently available to users of cell/wireless networks. However, such services do not appear to require the invention of new technologies. What is needed is investment in existing technologies and equipment and the development of new designs and systems integration efforts that can detect charging and re-charging, and bill owners of plug in vehicles, enabling them to "recharge" while roaming among electric utility service territories. These new designs need to include smart grid technologies, tools, and techniques, including advanced sensors and controls, distribution automation systems, and advanced metering infrastructure.

With regard to data management and billing systems, electric vehicles do not resemble any other electric appliance so it is not surprising that existing data management and billing systems are not able to readily handle this type of application. However, it would not be a major technical hurdle to develop data management and billing systems to accommodate large number of electric vehicle roaming and recharging in multiple electric service territories. What is needed is a level of demand that encourages power companies or other entities to invest in the development and deployment of such systems.

Consumers will likely play a major role in the type of charging services they receive. Electric vehicle markets and consumer acceptance have never been tested on a large scale. Manufacturers have interest and incentive in conducting extensive market research to determine consumer likes and dislikes, not only about the vehicle themselves but about the other equipment involved in owning and operating vehicles. In addition, no one knows how this market will develop. It is possible for there to be a competitive market in the provision of charging services to consumers. If this turns out to be the case, then competitive advantage will require providers to involve and cater to the needs and desires of consumers for charging services.

Question 6. One of the potential advantages of EV deployment—depending on a number of other regulatory variables—is the ability to leverage them for distributed storage, in manner that could assist in evening out supply/demand on the grid, enhancing the economics of intermittent generation and load shifting. I am aware that DOE is currently working on an energy storage roadmap.

To what extent will the roadmap provide us with guidance on the economic and efficient integration of EVs with the existing power grid?

Answer. The Department is developing a comprehensive energy storage strategy by mapping system operational needs of stability control, frequency regulation, ramping control, and bulk energy management to the relevant and appropriate storage technology characteristics. In finalizing this strategy for energy storage, and in conjunction with other Departmental planning activities for grid storage, the Department is focused on providing an integrated perspective on both mobileplatform storage technologies and the stationary grid energy system.

The value of any energy storage technology derives from the operational needs of the system, and this value will be best realized when the functional characteristics of the storage technology are matched to the characteristics of these operational needs. This pairing of technology characteristics to system requirements becomes more complicated for instances such as EV batteries where the primary function is something other than grid storage. Dual use is a clear possibility, but the tradeoffs between primary vehicle requirements, secondary grid management requirements, and storage technology characteristics must be well understood and carefully considered from scientific, technical and economic perspectives so that the most effective and economically beneficial uses of the storage devices are enabled.

DOE is currently investing $110 million in RD&D specifically focused on mobile platform applications, which is complemented by additional funding for storage activities ranging from basic science to commercial scale demonstrations. This is coordinated through an on-going agency-wide energy storage working group, which ensures that challenges ranging from basic science to technology application are well understood across the Department.

Question 7. S.3495 provides loan guarantee support for the aggregate purchase of batteries, solely for stationary applications. In your view, is there a reason why this provision should be limited to stationary applications, rather than more inclusive of mobile applications that may emerge as the smart grid and vehicle technologies continue to evolve?

Answer. Battery purchases for mobile applications are currently incentivized indirectly through the tax credits offered for the purchase of electric vehicles and plug-in hybrid vehicles. While the provision in this legislation is limited to stationary applications, the batteries are nonetheless designed for vehicle applications. Thus, this provision provides a separate mechanism to help achieve economies of scale and therefore supports the overall objectives of the bill.

Question 8. Researchers at MIT have found that the acceptance of Alternative Fuel Vehicles (AFV) by the public is not a simple process, and takes time. Even the Prius, which is doing well today, had a relatively slow start—and that is powered by gasoline! Acceptance of new technologies isn't just about building awareness, but about building enough knowledge, familiarity, and comfort among the carbuying public that people put an AFV into their "consideration net"—the set of makes, models, etc. they actually consider when selecting their next vehicle.

One of the most robust findings in the literature on adoption of innovations is that most people are "imitators"—that is, they won't consider something novel until they see enough of their friends, colleagues, and others in their social networks doing it as well. Early adopters are helpful to get the ball rolling, but often not sufficient. Innovation adoption is enhanced when the innovation is highly visible, when its costs and benefits are easily evaluated, when it is easy to try the innovation at low cost, and when adoption is readily reversible (in case it turns out you don't like it after all).

Compared to, say, consumer electronics like the iPod, automobiles rank poorly on all these dimensions. They are quite visible—but only after there are some already deployed so that people can see them driving down the roads in their neighborhoods or on their commutes. The costs (purchase price, typically higher than for conventional vehicles) are readily available, but the benefits (lower cost of fuel, quiet, better acceleration) are experienced only over time and are much less salient; the environment benefits are diffused and not personally experienced by the owner. Trial is not easy—test drives take effort and provide only limited experience, and no experience at all about the long-term reliability of the vehicle. And adoption is not readily reversible—automobiles are the second most expensive purchase most people ever make, and once you drive it off the lot it loses a lot of value.

As DOE designs, recommends, and implements specific policies to encourage the deployment of electric vehicles, are you taking all of these hurdles into account? If so, how do the policies you propose address these hurdles? Please be specific.

Answer. The Department of Energy (DOE) agrees that the development and adoption of innovative technologies is extremely challenging. However, equally challenging is the imperative to reduce petroleum dependence and greenhouse gas emissions. DOE does not discount lessons to be learned regarding consumer acceptance of new technologies but believes consumers are also concerned about the high cost and volatility of fuel prices, the transfer of wealth caused by petroleum use, and the impact of vehicles on the environment.

DOE is working to address the challenges of electric drive vehicle deployment through a number of important education, training, and communications activities. The Transportation Electrification activity funded by the Recovery Act will result in the deployment of more than 7,000 electric vehicles and provide education to a broad array of audiences. Communities where vehicles are deployed will have a high

density of vehicles and charging stations, making them a fairly common sight to local citizens. In addition, related Transportation Electrification educational programs target undergraduate and secondary students, teachers, technicians, emergency responders, and the general public. Public and student workshops will raise familiarity and comfort levels with the new technology, technician training will ensure that early adopters have a positive experience with their electric vehicles, and emergency responder training will help assure the response community as well as the local public that not only are the vehicles safe, but they also can be handled safely in an accident response situation.

In addition to the Recovery Act-funded Transportation Electrification efforts, DOE's Clean Cities Program facilitates local partnerships and provides consumers with accurate, relevant technical information on advanced transportation. The 87 Clean Cities coalitions nationwide work with more than 6,500 stakeholders to deploy alternative fuel and advanced technology vehicles, including electric vehicles, and comprise a network for sharing best practices and lessons learned. DOE provides coalitions with a vast set of information resources and technical assistance, and the coalitions provide local early adopters—from fleets to consumers—with a set of trusted local experts to turn to for advice.

DOE offers other publicly available information resources, including the Alternative Fuel and Advanced Technology Vehicle Data Center (AFDC) and fueleconomy.gov. Each has information, including cost calculators, to help consumers learn and make decisions about choosing alternative and fuel efficient vehicles.

RESPONSES OF DAVID B. SANDALOW TO QUESTIONS FROM SENATOR LANDRIEU

Question 1. Can you please discuss the various technologies that exist to replace petroleumfueled vehicles? I know this hearing's focus is on electric vehicles, but I would like you to include natural gas vehicles and any other viable technologies in your answer.

Answer. The Department of Energy's (DOE) petroleum reduction efforts in the transportation sector include a broad portfolio of alternative fuels and advanced vehicle technologies. Efforts to improve vehicle efficiency and fuel economy include new technologies such as hybrids and plug-in hybrids, advanced engine combustion designs and clean diesel applications, as well as creating lighter weight vehicles through advanced materials design. In addition, outreach and education efforts focus on reducing unnecessary wasteful idling for trucks and buses and encourage smarter driving practices for consumers.

Technologies and efforts related to alternative fuels include a variety of nonpetroleum based fueling options. In addition to electricity, vehicles are available today that can be powered by natural gas, propane, ethanol, biodiesel, and hydrogen. DOE supports activities to accelerate the commercialization and deployment of these alternative fuel vehicles and related infrastructure.

Question 2. Can you please compare these technologies for their carbon intensity, average cost to consumer and timeline for commercial activity?

Answer. Vehicle carbon intensity is conveyed most usefully on a lifecycle basis, which considers both direct tailpipe emissions and indirect emissions for fuel production. In lifecycle terms, a mid-size conventional gasoline-fueled internal combustion vehicle emits about 475 grams of carbon dioxide-equivalent per mile traveled. In comparison, a diesel version emits about 5% less; a dedicated natural gas vehicle emits about 25% less; and a gasoline hybrid version emits about onethird less. A Plug-in hybrid electric vehicle emits between 33 and 80% fewer emissions depending on its all-electric range, how far it is driven and renewability of its fuel sources (renewable electricity and advanced biofuels). Fully electricdrive vehicles (battery-electric vehicles and fuel cell vehicles) reduce carbon intensity by about 40% on conventional electricity or hydrogen and 80% on renewable fuels (renewable electricity and renewable hydrogen).

Cost to the consumer is also usefully conveyed on a lifecycle basis, which combines upfront vehicle purchase cost with fuel costs incurred during vehicle use. A mid-size conventional gasoline-fueled internal combustion vehicle costs approximately 30 cents per mile to operate, as does a dedicated natural gas vehicle, a hybrid vehicle, and a plug-in hybrid with a ?10-mile all-electric range. A diesel version costs slightly more. Currently, the lifecycle costs of fuel cell and all-electric vehicles are high compared to other alternatives. Additionally, it is worth noting that fuel costs for fossil fueled vehicles are subject to great variability while electricity rates are more stable, so greater uncertainty is associated with the cost to operate fossil-fueled vehicles.

According to their public announcements, auto companies will begin to deploy plug-in hybrid electric and battery electric vehicles this year; fuel cell vehicle deployment is longer-term. In general, costs are expected to decrease as manufacturers increase production, thanks to increased familiarity with technologies and economies of scale. Additionally, laboratory research—which takes 3-5 years to be transferred to manufacturers and another 3-5 years for commercial availability—is expected to continue contributing to improved performance and lower cost of advanced technologies.

Question 3. What can state and local communities be doing now to prepare themselves for the transition to plug-in electric vehicles?

Answer. One important action for State and local communities is the formation of partnerships with relevant stakeholders, including electric utilities, local code officials and emergency responders, vehicle manufacturers and dealerships, infrastructure developers, and other local businesses. Forming partnerships is essential because electric vehicles affect so many different areas of a community, from the electric grid to parking garages. The Department of Energy's (DOE) Clean Cities Program provides a foundation, structure, and support for local stakeholder partnerships to advance the deployment of alternative fuel vehicles, including plug-in vehicles. Nearly ninety local coalitions now comprise the Clean Cities network, which enables communities to share best practices and communicate lessons learned. DOE supports Clean Cities coalitions with technical assistance and information resources.

DOE continues to engage stakeholders to better understand how it can support local community efforts to deploy electric vehicles and infrastructure. On July 22, we will host an Electric Vehicle Community Readiness Workshop to hear from experts on key issues, including permitting, as well as best practices for accelerated deployment.

Question 4. What are other countries doing to promote electric vehicles in their countries? What international markets, if any, are thriving?

Answer. Countries around the world are investing heavily in electric vehicle (EV) and battery technology. For example, as reported by the AFP, China committed $1.5 billion to EV and battery R&D in its national research plan.[6] According to reports, China has also taken the following steps to promote EVs:

- Through the 2008 Chinese stimulus package municipal governments and taxi fleets were offered subsidies of up to $8,800 per EV.[7]
- The State Council set an EV annual production capacity target of 500,000 units by 2011.[8]
- China's Ministry of Finance announced a pilot program in five cities to subsidize the purchase of electric and hybrid cars.[9] Consumers in those urban areas can receive about $8,785 off the price of a battery car and about $7,320 off plug-in hybrids.[10]

Bloomberg reports that Germany pledged to spend $705 million on EV development by 2011, with a goal of putting 1 million EVs on the road by 2020.[11] According to the International Energy Agency (IEA), Denmark set an EV sales target of 200,000 by 2020.[12] And, according to reports, the European Commission is focused on ensuring interoperability across the continent and is currently in the process of setting standards for charging electric vehicles.[13]

The IEA reports that Israel has committed to selling between 40,000 and 100,000 EVs by 2012.[14]

The IEA reports that many countries are working to implement strategic goals for deployment of EVs, and several have publicly announced targets for EV sales. Some examples include:

- Canada—500,000 EVs by 2018

---

[6] "China issues stimulus package for auto sector: state media," January 14, 2009, AFP.

[7] "China vies to be world leader in electric cars," April 1, 2009, New York Times. http://www.nytimes.com/2009/04/02/business/global/02electric.html

[8] Id.

[9] "China to subsidize electric, hybrid car purchases in five cities," June 1, 2010, Xinhua News Agency. http://news.xinhuanet.com/english2010/china/2010-06/01/c__13327814.htm

[10] Id.

[11] "Germany pledges $705 million to boost electric cars," August 19, 2009, Bloomberg. http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aoey..OnNzmY

[12] International Energy Agency, Technology Roadmap: Electric and Plug-in Hybrid Electric Vehicles. IEA: Paris. 2009. https://www.iea.org/Papers/2009/EV__PHEV__Roadmap.pdf

[13] European Commission Enterprise and Industry Directorate-General, Roadmap on Regulations and Standards for the Electrification of Cars. 2010. http://ec.europa.eu/enterprise/sectors/automotive/files/pagesbackground/competitiveness/roadmap-electriccars__en.pdf

[14] Supra note 7.

- China—540,000 EVs by 2015
- Denmark—200,000 EVs by 2020
- France—2,000,000 EVs by 2020
- Germany—1,000,000 EVs by 2020
- Israel—40,000 EVs by 2011
- Spain—1,000,000 EVs by 2014
- Sweden—600,000 EVs by 2020[15]

RESPONSES OF DAVID B. SANDALOW TO QUESTIONS FROM SENATOR SESSIONS

Question 1. If we are looking for the fastest pathway to energy security, doesn't it make sense to promote all near-term clean vehicle technology including fuel cells? Wouldn't it be a mistake to pick winners and losers this early?

Answer. Although the Department of Energy places some emphasis on electric drive technologies, we do not feel that we risk freezing industry investments in fuel cells or other advanced vehicle technologies. Working together with industry partners, the Department continues to pursue a portfolio of near-and long-term advanced transportation technologies that can reduce petroleum consumption and mitigate greenhouse gas emissions, and electric drive technologies are a critical component of that portfolio. Electric drive vehicles include hybrids and plug-in hybrids that use biofuel and renewable electricity, full electric vehicles recharged with renewable electricity, and fuel cell vehicles that use renewable hydrogen. These variations of electric drives share component technologies, so advancements in plug-in hybrid power electronics, for example, also support and advance the development of fuel cell vehicles. Similarly, advanced technologies such as vehicle lightweighting and advanced combustion engines can significantly increase vehicle fuel economy and are an important part of a hybrid electric system. Continued development is essential to further increasing the fuel efficiency of hybrid electric vehicles.

Question 2. What will be the impact of plugging in additional sources to our current electrical grid? Will there need to be additional power generation? If so, since most of our electricity is produced from coal, would the CO_2 reductions from plug in vehicles result in an actual reduction of greenhouse gas emissions?

Answer. The U.S. electric power infrastructure is designed to meet peak demand, plus an additional margin, and is thus underutilized during much of the 24 hour daily cycle. The idle capacity of the grid could supply a significant portion of the energy needs of today's light-duty vehicles without adding generation or transmission if these vehicles are re-charged during off-peak periods.

RESPONSES OF FREDERICK W. SMITH TO QUESTIONS FROM SENATOR MURKOWSKI

GRID CAPABILITIES

Question 1. In your written testimony, you mentioned an EPRI study that "found that plugging in just one PHEV to charge at 220 volts overloaded 36 of 53 transformers examined during peak hours and 5 of 53 transformers during off-peak hours." It would be wonderful if electric vehicle owners were able to charge their cars overnight—from, say, midnight to six a.m.—but it seems unrealistic to expect that to happen.

a. Can you describe the sort of local-level grid improvements that will be necessary to handle a significant number of electric vehicles, and how much those improvements might cost?

Answer. Generally speaking, the distribution system is capable of handling the load from the charging of electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs). The primary open question is the extent to which local neighborhood transformers can handle the additional load from these vehicles. One recent analysis from the Electric Power Research Institute (EPRI) did find that, in some communities, smaller transformers serving between five and seven homes could be easily overloaded by charging PHEVs at 240V (Level II charging). Specifically, plugging in one PHEV during peak times overloaded 25kVA transformers in 36 of 53 cases examined. During offpeak times, the number of 25kVA transformers that were overloaded by plugging in one PHEV fell to 5 of 53.

In the EPRI analysis, the distribution-system impact of plugging-in PHEVs varied significantly depending on time of day, size of transformer, and how many cars were charged simultaneously. In general, larger transformers were also affected, but not

[15] Id.

as frequently as smaller transformers. The 50kVA transformers examined by EPRI were overloaded by charging one PHEV during peak hours in just 5 of 103 cases examined—though the number increased to 36 instances if three PHEVs were charged simultaneously.

Routinely overloading transformers is a serious issue that will result in an acceleration of the rate at which they depreciate. Therefore, in instances where transformers are too small to support the load from EVs and PHEVs, they would need to be upgraded. Such upgrades are routine for utilities, and the costs of these improvements generally are recoverable by including them in their rate base. It is primarily a question of planning and organization. Because the need to upgrade transformers varies widely by system design and location, it is difficult to provide a national estimate for cost of replacement. Of course, the rate at which PHEVs and EVs penetrate the market, and the extent to which these vehicles are charged using smart grid technology, will also determine the rate at which transformers must be replaced in some cases.

b. During our committee's hearing, an alert went out asking Senate offices to conserve power (through dimming lights, shutting off computers, and otherwise reducing demand) due to the intense heat and humidity. Do you foresee eventual restrictions on charging during peak hours, much in the same way that communities with water shortages sometimes restrict daytime watering?

Answer. Neither the Electrification Coalition nor I personally would be comfortable "restricting" the ability of consumers to refuel their vehicles. That said, we clearly acknowledge the benefits of incentivizing consumers to charge their batteries during utilities' offpeak operating hours. As you know, demand for electricity is uniformly lower at night than during the day. Research from a variety of national laboratories and other institutions has demonstrated that the need to construct new electric power generation capacity can be minimized or eliminated for the foreseeable future depending on how closely vehicle charging patterns adhere to offpeak charging scenarios. (An additional and critical factor is the extent to which vehicles are charged using smart grid technology for load management.)

Therefore, while we recognize that vehicle charging may take place around the clock based on when consumers need to charge, we believe that it is appropriate to design the system so that drivers have a strong incentive to charge overnight. This will minimize the effect that EVs and PHEVs have on peak power demand, which in turn will minimize the need to construct new power generation capacity and/or to upgrade local transformers. The primary tool to incentivize offpeak charging is likely to be time of day pricing for electricity used to charge EVs and PHEVs. By offering rates for power to charge vehicles that are substantially lower during the overnight hours than at other times, we believe that consumers can be incentivized to charge their vehicles overnight in most cases. This, of course, is one of the strategies that should be tested in deployment communities.

COST SHARE

Question 2. S. 3495 requires at least a 20 percent non-federal cost-share, which can be lowered at the discretion of the Secretary of Energy. Do you believe a higher cost-share (greater than 20 percent) would help ensure that only the most financially-sound communities—communities that can continue to promote electric vehicles and infrastructure once temporary federal funding has ended—are selected?

Answer. We recognize the fiscal appeal of a cost-share, particularly from the perspective of the federal government. In general, the 20 percent cost-share contained in S. 3495 ensures that communities applying for selection as deployment communities have a stake in making the program successful. We believe that the bill also provides the Secretary of Energy with important flexibility to balance selecting fiscally sound communities with selecting the most appropriate communities.

We believe that the most important factors to consider in choosing deployment communities are:

1. Ability to demonstrate that the community can successfully deploy EVs and PHEVs in numbers that represent penetration of the mainstream automobile market;
2. Commitment from a broad range of stakeholders, including utilities, utility regulators, state government officials, local government officials, large local employers, universities, etc.;
3. Supportive regulatory environment that includes time-of-day pricing, ability for utilities to invest in necessary IT and infrastructure upgrades, and ease of permitting/ installation for consumers' home level 2 chargers; and

4. A plan for siting, installing, and networking Level II and Level III public charging infrastructure.

The U.S. effort to develop an electric vehicle industry is an undertaking of national importance and is deserving of national support. Ultimately, this is about the country's economic competitiveness and energy security. Particularly today—as state and local governments struggle to deal with the worst impacts of the most severe economic recession in a generation—it would be a mistake to over emphasize fiscal position in selecting deployment communities. The priority must be on those regions that can demonstrate the clearest path to success, while also ensuring geographic and demographic diversity.

SPENDING AND OIL PRODUCTION

Question 3. In your written testimony, you discuss the budgetary constraints we are facing and the increasing difficulty of producing oil. I certainly agree with your comments about the budget and how difficult it is to justify any additional deficit spending right now. But I also believe that we have placed short-sighted limits on where oil can be produced in America.

In Alaska, there are tens of billions of barrels of oil that can be produced in onshore and shallow water areas such as the Coastal Plain of ANWR, NPR-A, and the Beaufort and Chukchi Seas. The production of those reserves would also yield massive revenues for the federal government, which could in turn be used to pay for legislation such as S. 3495. Couldn't we solve both problems—our near-term need for oil and the ongoing shortfall in revenues—by increasing domestic production where it can be accomplished in the safest possible manner?

Answer. As you know, in addition to my participation in the Electrification Coalition, I am the co-Chair of the Energy Security Leadership Council (ESLC). The Council is a group of prominent business leaders and retired senior military officers dedicated to reducing U.S. oil dependence for economic and national security reasons. The Council has a well-established track record of support for a balanced national energy strategy—one that includes expanded production of domestic oil and natural gas.

Over the long-term, the Council believes that reducing the oil intensity of the U.S. economy is the only way to meaningfully improve our energy security. This reduction in oil intensity requires limiting the growth in total oil demand—or, in fact, reducing demand—as the economy grows. This metric is not based on differentiating between domestic oil and imported oil. Instead, it focuses simply on increasing the number of units of GDP that are produced for each barrel of oil consumed. The U.S. has had success improving our oil intensity in the past: between 1973 and 1985, it dropped by nearly 40 percent.

Our focus on oil intensity is based on a simple reality: the most damaging aspect of our reliance on oil is the extreme volatility of oil prices, particularly given that we use so much oil and that there are essentially no substitutes available to consumers today. Simply put, as oil prices rise and fall, consumers' ability to shift driving and consumption patterns is extremely limited, leaving them fully exposed to the uncertainty posed by rapidly changing prices. This makes it hard for businesses and households to save, plan, and invest, thereby disrupting economic activity. It is important to recognize that this is true regardless of whether the oil we consume is produced domestically or not. There is a fungible, global market for oil with a small set of benchmark prices.

However, an additional and significant component to the economic cost of U.S. oil dependence is the impact that oil importation is having on our trade deficit. In 2008, imports of crude oil and petroleum products accounted for 56 percent of the total U.S. trade deficit. At $388 billion, the petroleum deficit was larger than our deficit with any national or regional trade partner. In 2009, a year marked by reduced oil demand and a lower average global oil price, the U.S. still ran a deficit of roughly $200 billion in petroleum imports. In 2010, based on import levels and oil prices to date, our deficit in oil imports is expected to return to pre-crisis levels of nearly $300 billion. I view this as a substantial threat to the U.S. economy going forward. Of course, this says nothing of the national security impact of exporting several hundred billion dollars of national wealth abroad each year, some to unstable or hostile regimes.

Therefore, the domestic production of oil and gas is—and should remain—a critical component of any U.S. energy security strategy, including domestic production in Alaska. The transition to a transportation sector that is no longer heavily reliant on petroleum will take decades. While we focus on policies and investments necessary to facilitate this transition, we should also work to minimize the share of our oil demand that is met by imports. This will not only work to improve our trade

deficit and strengthen national security, but it can provide the state, federal, and local governments with much needed taxes and royalty fees.

TARGETED DEPLOYMENT PROGRAM

Question 4. A targeted deployment program could help deploy vehicles and infrastructure within communities, but it would do little to assist with long-distance driving. What do you think can and should be done to facilitate intercity road trips in electric vehicles?

Answer. First, I would simply point out that different electric-drive vehicles will face different challenges regarding longer trips. For example, PHEVs and extended range electric vehicles (E-REVs) like the Chevy Volt operate on a combination of electricity drawn from the grid and either electricity or mechanical energy generated onboard from a gasoline powered engine. These vehicle architectures allow for essentially unlimited vehicle range subject to the availability of gasoline, as with any gasoline powered vehicle on the road today.

Pure electric vehicles, however, will have a limited range between charges, which will impact their ability to travel longer distances in the absence of any charging infrastructure. The distance that electric vehicles can travel on a single charge will change over time, but today ranges from roughly 100 miles for the Nissan Leaf to more than 200 miles for the Tesla Roadster. Electric vehicles announced or on the road around the world and produced by OEMs like Mitsubishi, Renault, and BMW can travel distances roughly similar to the Nissan Leaf. Although vehicles with these ranges will meet most drivers' needs on most days, many drivers will also want the ability to driver farther than the vehicle's range on a single charge.

There are several approaches to facilitate long distance travel in electric vehicles. Fast chargers, which supply direct current at voltages up to 480 volts, will have the ability to charge a vehicle battery in several minutes as opposed to the several hours required for a 220 volt alternating current charge. Because of their expense and power requirements, the deployment of fast chargers will practically be limited to commercial facilities, such as fast charge stations akin to today's gas stations. Deployed in charging stations along intercity highways, they will facilitate intercity travel for electric vehicles.

Battery swapping also is an option to extend the range of electric vehicles. Better Place, a provider of electric vehicle networks and services, has developed a business model in which it will support electric vehicles designed to include swappable batteries. The technology is currently being demonstrated in a small fleet of taxis in Tokyo, Japan. Placing battery swap stations along intercity corridors would facilitate intercity travel by electric vehicles.

Because of the importance of facilitating intercity travel, and because of the questions about how to extend the range of electric vehicles, I believe that it is important that at least one—possibly more—of the deployment communities selected be a corridor that connects several mid-sized communities. Such an approach would facilitate a better understanding of the issues and solutions surrounding intercity travel for electric vehicles.

TAX CREDITS VS. GRANTS

Question 5. This bill contains a variety of grant funding, and it is my understanding that tax provisions could be added to it during floor debate. Do you believe that one of those forms of support is more appropriate and more relevant to the advancement of electric vehicles? Is it important to maintain a mix between tax credits and federal grants?

Answer. Perhaps the most important attributes of vehicle and infrastructure incentives is that they be transparent, usable, and immediate. If consumers can easily obtain the information they need about the applicability and duration of the incentive, they can make use of it without enduring an overly burdensome process, and they can capture it quickly, the incentive will have a positive effect. This kind of incentive provides much needed certainty for both producers and consumers.

One need only study the history of the wind power industry in the U.S. to see how and why incentives can fail. First, the wind production tax credit (PTC) was often in flux, expiring in one year only to return the next. In years when the PTC was allowed to expire, installation of new turbines plummeted, interrupting investment in the technology. Second, the credit was not always usable, because many of the companies willing to invest in wind turbines were relative young start-ups that had yet to realize a profit. As such, they had little use for a credit that could only be taken against taxes on income. In both cases, the industry developed workarounds, but it took several years and tremendous coordination among the various stakeholders.

That said, we would argue that both tax credits and grants have a role to play in supporting electrification in general and a deployment community approach in particular. However, it is important that each of these incentives be used where it can have the greatest impact. For those incentives that should be uniform across the program, such as incentives for vehicles and charging infrastructure, incentives should primarily be offered through the tax code, which offers uniformity and the greatest degree of certainty to the industry. One of the most important components of the bill is the inclusion of a vehicle incentive for consumers in the form of a transferable tax credit or point-of-sale rebate. These policies, or something like them, must be included in any final bill.

In addition to the incentives for vehicle and infrastructure, successful deployment communities will have to engage in a wide variety of other activities to support the rollout of EVs and PHEVs. For example, communities might want to survey the status of their electrical distribution system, offer non-monetary incentives to drivers of EVs and PHEVs, train first-responders how to interact with EVs and PHEVs safely, and initiate consumer education efforts and marketing campaigns. Such efforts would best be supported by grants, because their flexibility allows for each community to meet its own needs in its own way. We also believe that research regarding electric drive vehicles and their associated infrastructure and support systems is best supported by grants.

BATTERY TECHNOLOGY

Question 6. One of the biggest hurdles to the development of electric vehicles is the cost of their batteries, which adds greatly to the price of the vehicle itself. Can you share your views on how quickly batteries will advance over the next decade, and what that will mean for their cost?

Answer. Battery cost and performance issues are certainly among the most critical issues that must be addressed for electrification to succeed. I am, however, optimistic in the progress that can be made in relatively short order on both fronts.

First, a main contributor to battery cost is the current lack of production volume, or scale. The highest estimates of current battery costs are often based on small batch production volumes. Most OEMs and battery suppliers are currently utilizing a manufacturing process geared for small pilot programs. However, based on expected demand for the first EVs and PHEVs to hit markets in late 2010 and 2011, some OEMs are shifting to larger production volumes that will help drive costs down rapidly. Data from the Department of Energy suggests a plant that is capacitized to produce 100,000 battery packs per year will have battery costs that are 38 percent to 44 percent lower than a 10,000 unit plant.

I would also note that current supply chain structures also contain some cost inefficiencies. For example, the lithium ion cells for the Chevy Volt are currently produced by LG Chem in South Korea. They are then shipped to Michigan and installed into the final battery packs. The structure and distribution of the lithium ion cell industry necessitated GMs early approach. However, the company has announced plans to move cell production facilities to the U.S. in 2012, a step which will provide significant cost savings.

Based on these and other cost saving measures that are expected in the next several years, industry observers and analysts are forecasting meaningful reduction in lithium ion battery costs by 2020. For example, a recent analysis conducted by TIAX, LLC found future costs between $212-$568/kWh for a PHEV battery with 6.9 kWh of total energy (roughly a PHEV-25). The analysis incorporated a range of variables across four current battery chemistries produced at high volumes—500,000 units per year.

Another issue related to cost and performance is battery utilization. In particular, some current PHEV batteries utilize a 50 percent state-of-charge window. That is, a PHEV-40 battery today is designed to require only 8 kWh of its16 kWh capacity in order to travel 40 miles in pure electric mode. This practice comes at significant cost, driving current battery prices higher than technical requirements. In first-generation applications, PHEV manufacturers made the strategic decision to add extra capacity in order to ensure end-of-life performance metrics and meet battery warranty requirements. However, advancements already achieved have reduced the need to over-specify PHEV batteries and expanded the state-of-charge window, thereby reducing costs for the next generation of assembled battery packs. There also is the possibility of breakthrough technologies that will fundamentally change the cost equation for batteries. My recent meeting with the Director of ARPA-E was extremely encouraging in that regard.

RAW MATERIALS

Question 7. I've often expressed concern that if we do not develop our own resources, we risk trading our dependence on foreign oil for a similarly devastating dependence on foreign minerals. Do you share that concern? As the United States government looks at ways to promote electric vehicles, how would you recommend addressing it?

Answer. This is an important question, and it's one that we at the Coalition take very seriously. We agree that it is critical that the U.S. does not trade one national security risk for another. In our analysis, however, that is not going to be the case with electrification.

Concerns about lithium dependence tend to ignore a key feature of lithium—its recyclability. Research from Argonne National Laboratory shows that, when recycling is factored-in, global lithium reserves are adequate to support even the most bullish GEV deployment scenarios. The vast majority of material in lithium ion batteries is recyclable. Today, recycling rates for lithium are relatively low, but that has a lot to do with the small quantities of lithium found in most consumer electronics applications. There simply isn't a value proposition for recycling in such small quantities. But a lot of work is going into developing business models around recycling lithium from large format automotive batteries. In fact, battery recycling operations were among the recipients of ARRA stimulus funds.

Recyclability differentiates lithium from oil. Once an oil or natural gas molecule is combusted in a vehicle's engine, its energy potential is gone forever—hence the term, "non-renewable resource." Lithium is not a non-renewable resource. Instead, it is a storage device. Therefore, dependence on lithium is much different than dependence on oil. Vehicles do not deplete batteries as we drive; they deplete the energy stored within them. In other words, batteries are like the engines in conventional vehicles of today; though their life span is finite, they last for many years. Coupled with the fuel diversity of the electric power sector, grid-enabled vehicles insulate consumers from volatile commodity markets and related phenomena like oil shocks. So, there is a critically important structural difference.

The global market is also not as one-dimensional as some critics suggest. Annual production of lithium totaled about 30,000 tons in 2008. The top producers were Chile, Australia, China, Argentina and the U.S. Total identified world lithium resources stand at around 13.4 million tons, according to USGS. The two largest reserves holders are Bolivia and Chile, though Bolivia has yet to produce lithium in commercial quantities. Still, reserve estimates must be understood in the context of demand, which has thus far required only the cheapest and most accessible lithium to be developed. The U.S. Geological Survey identifies substantial lithium deposits in places as diverse as Austria, Afghanistan, India, Spain, Sweden, Ireland, and Zaire, but has not yet classified these deposits. Reserves also do not include the large quantities of lithium known to exist in oilfield brines in the western United States and in hectorite clays. Indeed, even the sea holds large quantities of dissolved lithium.

Finally, it's true that a number of rare earth metals are vital to GEV production. While China currently produces over 95 percent of rare earth oxides, it holds about 30 percent of known reserves. The United States actually holds substantial reserves, but has opted to import Chinese supplies since the 1990s due to cost. One company, Molycorp, plans to reopen a significant U.S. mine at Mountain Pass, California. Still, it's also true that global demand for rare earths is expected to grow rapidly in coming years—by around 15 percent annually for magnets and 20 percent for alloys—causing worry of a shortage and Chinese monopolistic manipulation. Beijing has recently enacted stringent export tariffs and quotas on unprocessed materials in an effort to ensure that all value-added processing, especially hard magnet production for batteries, occurs domestically.

This warrants close monitoring and an ongoing dialogue on trade with China. But I would argue that the threat of rare earth dependence pales compared to oil dependence. At the end of the day, manipulation or disruption of the rare earth market could make vehicle manufacturing more costly, but it wouldn't instantly disrupt the hundreds of millions of vehicles on the road at any given point in time the way an oil disruption can and has.

RESPONSES OF KATHRYN CLAY TO QUESTIONS FROM SENATOR MURKOWSKI

ELECTRIC VEHICLES

Question 1. Aside from the Chevy Volt, Nissan Leaf, Ford Focus Electric, Tesla Model S, the Fisker Karma, and the CODA, can you describe the types of electric

vehicles that may be commercially produced in the next five to ten years? Can you provide a general comparison of the range and cost of these vehicles, to the extent that those details have been made public?

Answer. Automakers have announced plans to launch a range of electric drive vehicles over the next five to ten years. Electric drive vehicles include a range of vehicle configurations that vary the relative amount of motive power derived from a battery or fuel cell and an electric motor, and a gasoline fuel tank and engine. Idle-stop configurations, for example, draw power from the battery when the vehicle is stopped to eliminate idling.

Plug-in hybrid and extended range electric vehicle configurations allow the vehicle to operate in charge depleting or charge sustaining mode. Under charge depleting mode, the vehicle runs in all-electric mode using the electric motor to drive the wheels until the battery is depleted, and then switches over to receive power from the gasoline tank and engine. Under charge sustaining mode, the vehicle switches back and forth between the electric motor and the gasoline engine in a way that is designed to maximize vehicle efficiency.

The all-electric range of any vehicle is dependent on many factors, including the battery technology used, the vehicle weight and design, environmental factors, and driving behavior.

BATTERY BUBBLE

Question 2. According to some recent news reports, the United States may already be on the verge of producing far more advanced batteries than electric vehicles. Do you see any evidence of this happening? What are the likely consequences if too many batteries are produced? What can we do to ensure there is no supply-demand gap for batteries?

Answer. It is unlikely that battery manufacturers will produce more advanced batteries than are required for the electric drive vehicle market. Contracts between battery manufacturers and automobile makers will allow battery producers to match their production to demand. It is possible that there may be excess capacity in battery manufacturing worldwide compared to the number of electric vehicles entering the market.

Excess manufacturing capacity could have the effect of depressing prices for advanced batteries and could affect the profitability of battery manufacturers. If suppliers of advanced automotive batteries also supply other end-use markets besides automobiles, this diversification could help mitigate the risks associated with attempting to predict future production numbers of electric drive vehicles.

TARGETED DEPLOYMENT PROGRAM

Question 3. A targeted deployment program could help deploy vehicles and infrastructure within communities, but it would do little to assist with long-distance driving. What do you think can and should be done to facilitate intercity road trips in electric vehicles?

Answer. Developing alternative fuel and charging corridors to link urban centers could facilitate intercity travel using plug-in electric vehicles. An example of this approach is underway in a cooperative effort by the states of California, Washington, and Oregon. In September 2008, these states signed a Memorandum of Understanding, agreeing to work together to foster the use of alternative fuel vehicles by developing the distribution network for alternative fuels along the I-5 corridor. The memorandum lays out common goals, a work plan and activities designed to further the development of this alternative fuels corridor. Similar efforts in other states, with federal and local government involvement, will be useful to enabling intercity travel using electric drive and other alternative fuel vehicles.

COLD WEATHER

Question 4. According to news reports, the BMW Mini-E loses quite a bit of battery capacity in cold temperatures. Can any of you provide an update on efforts to overcome the difficulties that some electric vehicles may encounter in cold climates, particularly in an Arctic state like Alaska?

Answer. Advanced batteries, such as lithium ion, provide somewhat shorter vehicle ranges at colder temperatures. The amount of this effect will vary depending on several factors, including vehicle design, the specific battery chemistry, and the vehicle systems that manage, heat, and cool the battery. Different lithium ion batteries will be affected differently by colder operating temperatures. "Lithium ion" does not refer to single battery chemistry but rather to a family of related chemistries, each with slightly different attributes including temperature tolerance.

For the current generation of lithium ion battery packs, and depending on the factors mentioned above, vehicle range may be diminished by 20 to 50 percent in cold weather driving conditions. Cold weather tolerance is an area of active research in battery technology development. Further work is also underway to improve vehicle systems that maintain battery temperatures to improve performance.

TAX CREDITS VS. GRANTS

Question 5. This bill contains a variety of grant funding, and it is my understanding that tax provisions could be added to it during floor debate. Do you believe that one of those forms of support is more appropriate than any other? Is it important to maintain a mix between tax credits and federal grants?

Answer. Tax credits and grants are each important to facilitating the production and consumer acceptance of new technologies. Ideally, these two policy approaches should be aligned to be mutually reinforcing. Both types of policy measures should be technology neutral to the extent possible. For example, tax credits could be provide to purchasers of any advanced technology vehicle meeting a set performance standard.

CHARGING STATIONS

Question 6. How many charging stations do you believe will need to be installed for every electric vehicle put on the road?

Answer. Because electric drive vehicles are only now emerging as a market, there is virtually no real world consumer data to allow us to predict with certainty what consumers demands will be in terms of access to charging infrastructure. Automakers believe that the majority of vehicle charging will take place in consumer's homes. After home charging, access to charging at the workplace will be the next most important factor in consumer acceptance, followed in importance by publicly available charging stations.

Accordingly, each electric drive vehicle will require, at a minimum, Level 2 (220/240 volt) charging equipment at the location where the vehicle is parked overnight. Home charging is the fundamental need for all plug-in electric drive vehicle owners and facilitating access to home-based charging should be the first priority in establishing an electric vehicle charging infrastructure that is best able to encourage early acceptance of the technology.

While home charging alone will be sufficient for some consumers, other consumers will also require access to charging at the workplace. These consumers will need two dedicated Level 2 chargers (one at home and one at work). Access to publicly available charging would be used for example, to facilitate inter-city trips, or for days when the consumer's driving exceeds their normal routine.

CHARGING TIMES

Question 7. Right now, most gas-powered vehicles can be fueled in less than 10 minutes, and then drive for hundreds of miles. A drawback for electric vehicles is that they take hours to fully recharge. Even quick charging, which reduces battery life, can take at least 20 minutes. Can any of you discuss any changes to charging time that you see over the next several years?

Answer. Automakers anticipate that "fast" charging (Level 3, or 480 volt charging) will be used by most electric drive vehicle owners only occasionally, on infrequent occasions when their driving needs for a particular day exceed their normal requirements. The lifetime of today's battery technologies is diminished slightly when charged at high rates; however, if fast charging is only used occasionally the overall effect on battery lifetime is unlikely to be significant. It will be important to educate consumers on the relationship between the use of high rates of charge and consequences for battery lifetime.

Over the next several years, battery development work will address the need to increase the amount of energy batteries can store per unit weight (i.e. energy density), battery lifetime, and the ability of batteries to receive higher levels of power safely.

PACE OF DEPLOYMENT

Question 8. Hybrid electric vehicles debuted a decade ago, are popular with consumers, and currently account for about three percent of the light duty vehicle market. Is it reasonable to expect that electric vehicles will deploy at a much faster rate?

Answer. Hybrid electric vehicles first entered the U.S. market over a decade ago, and currently account for about three percent of the light duty vehicle market.

These batteries onboard these "conventional" hybrid vehicles do not receive energy from the electrical grid, but are instead recharged using energy derived from onboard gasoline tanks. Consequently, these vehicles do not require consumers to have access to a new charging infrastructure.

Plug-in electric drive vehicles will require new infrastructure to make these vehicles acceptable to consumers. As discussed in our answer to question six above, each of these vehicles will require, at a minimum, access to charging equipment where the vehicle is parked overnight. The pace of deployment will depend on the strength of policies to support the establishment of a charging infrastructure.

The pace of deployment of electric drive vehicles will also depend on regulatory efforts that support our national goals of energy security and climate change mitigation, and encourage automakers to invest in these technologies. As noted in our testimony, the issue of how upstream emissions will be treated in future rulemakings is a crucial factor affecting automakers decisions about future production of electric drive vehicles. Until we significantly alter how we produce electricity, including upstream emissions in the vehicle greenhouse gas emissions standards means that electric vehicles will rate only marginally better than conventional internal combustion engines, and comparatively worse than conventional hybrids.

As a result, including upstream emissions creates a huge disincentive for producing electric vehicles versus other less costly—and less game-changing—technologies. This approach would also be unfair because it would treat plug-in vehicles differently than other end-uses of electricity, making vehicle manufacturers uniquely responsible for utility emissions—emissions over which automakers have no control.

BATTERY TECHNOLOGY

Question 9. One of the biggest hurdles to the development of electric vehicles is the cost of their batteries, which adds greatly to the price of the vehicle itself. Can you share your views on how quickly batteries will advance over the next decade, and what that will mean for their cost?

Answer. The Department of Energy (DOE) estimates that the typical cost for advanced automotive lithium ion batteries is $1000 per kilowatt-hour (kWh) and has set a goal of reducing this cost figure to $300 per kWh. This figure was developed in part through consultation with auto industry participants, and the industry believes that this degree of cost reduction would significantly increase consumer acceptance of the electric drive vehicles.

TARGETED DEPLOYMENT PROGRAM

Question 10. Section 106 of this legislation would create a targeted deployment program for five to 15 communities, to be chosen within one year of enactment. Many manufacturers have already selected initial retail markets for their electric vehicles; an example is Chevrolet, which selected Michigan, California, and Washington, DC for the Volt. Do you believe that the short timeframe of this bill and the select markets will advantage certain communities and disadvantage others during the selection process?

Answer. Individual automakers have identified early markets for their electric drive vehicle models. These companies have chosen regional markets or cities to focus their first efforts for launching these vehicles. As automakers learn more about the potential customer base for these vehicles, and as new markets emerge, each company will modify their marketing and deployment efforts to emerging circumstances.

At this early stage of electric vehicle deployment, automakers must remain highly flexible and responsive to the market. More real world learning is needed before any entity, public or private, will be able to identify which areas of the country will have the highest adoption rates of electric drive vehicles or the greatest needs for charging infrastructure investment.

TECHNOLOGY NEUTRALITY

Question 11a. As introduced, S. 3495 would authorize nearly $6 billion for electric vehicle technologies. How could this substantial increase in funding affect the development of other technologies, such as natural gas, hydrogen, or advanced internal combustion engines, which receive far less funding each year?

Answer. Our overall goal should be a national policy related to light duty vehicles that is, on balance, technology neutral. The auto industry is committed to developing a suite of advance vehicle technologies, including electric drive (e.g. plug-in hybrid, extended range electric, battery electric, and fuel cell technologies); clean

diesel; hydrogen internal combustion; flex fuel; and continued advancements in gasoline internal combustion engines.

It would be impractical to require each individual policy measure to address the entire suite of advanced vehicle technologies. For example, individual tax measures or infrastructure programs might appropriately focus on a specific category of advanced technology vehicles, depending on the goals the measure seeks to achieve.

The auto industry supports policies that encourage a portfolio approach to technology development. For example, setting performance standards rather than technology mandates allows automakers to explore numerous technology innovations and pathways, and to ultimately provide the public benefits sought at lower cost to consumers overall. Maintaining a balance in federal research dollar across all advanced vehicle technology options should also be a high priority.

Question 11b. By promoting one technology so greatly, could we inadvertently disincentivize cheaper ways to reduce fuel consumption and greenhouse gas emissions, as well as longer-term options like fuel cells?

Answer. Battery electric and fuel cell vehicles offer the most promise for helping to achieve the ambitious target of an 83 percent reduction of greenhouse gas emissions by 2050. For this reason, we believe the legislation should allow manufacturers, fuel providers, and communities the flexibility to invest in multiple electric drive pathways. Automakers support the inclusion of fuel cell vehicles and hydrogen infrastructure for eligibility in federal programs to accelerate the deployment of electric drive vehicles.

NATIONAL VS. TARGETED DEPLOYMENT PROGRAM

Question 12a. In your written testimony, you stated that, "Opening up the grant program to a larger number of communities, with wide regional representation, would avoid limiting automakers' potential customer base for these vehicles and maximize the chances of success for our public investments overall—even if this means that individual communities would receive lower levels of total funding." How many communities do you believe would be appropriate for a broader deployment program?

Answer. Rather than selecting an arbitrary number of communities to be targeted for electric vehicle deployment efforts, automakers believe that the objectives of the legislation would be best achieved by building on the success of the existing Department of Energy Clean Cities program as well as the transportation electrification efforts started through Recovery Act funding. These existing programs, like the provisions envisioned in the legislation, support greater electric vehicle deployment through cost-shared grants, technical support, and training to local communities.

Question 12b. Given the massive budgetary constraints that Congress is facing, can you discuss the impacts that could result if this legislation is enacted, and then just a few communities receive funding to participate in it?

Answer. As an industry, we have concerns about any approach that would overly limit investments to a small number of cities, particularly at such an early stage of electric vehicle deployment. Attempts to prejudge the market bring tremendous risks, and the problem is compounded if we are making just a few large bets. Selecting only a few communities as the focus of federally sponsored electric drive vehicle deployment efforts would risk limiting automakers' potential customer base for these vehicles.

RESPONSES OF KATHRYN CLAY TO QUESTIONS FROM SENATOR CANTWELL

Question 1. S. 3495 emphasizes the establishment of "deployment communities" that have a concentration of the necessary support infrastructure for electric vehicles. I understand you think this is not the best way to seed the market for these vehicles.

Answer. The Senator's statement is correct.

Question 2. The kinds of deployment communities supported in the bill are in many ways similar to—and building upon—the deployment plans of the automakers themselves. For example, Chevy Volt has announced they will deploy in Michigan, California, and Washington DC. Nissan has chosen Portland, Seattle, Phoenix, San Diego, and Nashville to roll out its all-electric vehicle the LEAF.

Answer. The Senator's statement is correct.

Question 3. Do you think the companies that are making these electric vehicles have it wrong? Should they not be taking this concentrated approach?

Answer. Individual automakers have identified early markets for their electric drive vehicle models. These companies have chosen regional markets or cities to focus their first efforts for launching these vehicles. As automakers learn more about the potential customer base for these vehicles, and as new markets emerge,

each company will modify their marketing and deployment efforts to emerging circumstances.

At this early stage of electric vehicle deployment, automakers must remain highly flexible and responsive to the market. More real world learning is needed before any entity, public or private, will be able to identify which areas of the country will have the highest adoption rates of electric drive vehicles or the greatest needs for charging infrastructure investment.

Question 4. If we do not adopt this plan based on establishing deployment communities, how can we support the deployment of electric vehicles in a way that is simultaneously fiscally responsible and moves them beyond early adopters?

Answer. Rather than selecting an arbitrary number of communities to be targeted for electric vehicle deployment efforts, automakers believe that the objectives of the legislation would be best achieved by building on the success of the existing Department of Energy Clean Cities program as well as the transportation electrification efforts started through Recovery Act funding. These existing programs, like the provisions envisioned in the legislation, support greater electric vehicle deployment through cost-shared grants, technical support, and training to local communities.

RESPONSES OF BRIAN P. WYNNE TO QUESTIONS FROM SENATOR MURKOWSKI

BATTERY BUBBLE

Question 1. According to some recent news reports, the United States may already be on the verge of producing far more advanced batteries than electric vehicles. Do you see any evidence of this happening? What are the likely consequences if too many batteries are produced? What can we do to ensure that there is no supply-demand gap for batteries?

Answer. While there have been projections along those lines, there is also a large body of analysis finding that demand will match, and potentially outpace supply in the 2017 time frame. For instance, Oliver Hazimeh, the director and head of Global E-Mobility Practice for PRTM, a global management consulting firm, is projecting that demand for lithium-ion batteries will be four times as many lithium-ion batteries in 2020 (200GWh) as the announced production capacity (50GWh) of the industry.

That announced supply of batteries (50 Gwh) for 2015 would serve 1.5 million vehicles—including hybrids, plug-in hybrids and battery electric vehicles in the light medium and heavy duty segment. They can also be used for non-automotive energy storage applications.

Federal policy is playing, and can continue to play, an important role in helping to build supply and encourage demand. Continuing support for research and development will speed reductions in cost and increases in performance of advanced batteries. Easing access to capital and establishing tax incentives has already resulted in increased investment in U. S. manufacturing of advanced batteries, components and vehicles and this success can be expanded with consistent federal policies. Federal deployment programs, such as Clean Cities and State Energy Program funds, as well as the Recovery Act's Transportation Electrification grants, are putting vehicles and infrastructure in place around the country. These programs and proposed regional deployment efforts will help to build markets and to build consumer acceptance of plug-in electric drive vehicles.

TARGETED DEPLOYMENT PROGRAM

Question 2. A targeted deployment program could help deploy vehicles and infrastructure within communities, but it would do little to assist with long-distance driving. What do you think can and should be done to facilitate intercity road trips in electric vehicles?

Answer. Electric drive vehicles come in multiple configurations—hybrid, pure battery electric, plug-in hybrid and fuel cell. Each of these is optimized for different uses. Hybrid trucks, for instance, are already operating on interstate routes, as the electricity generated on board does not require additional infrastructure.

With plug-in hybrids, the ability to use electricity and petroleum fueling infrastructure expands the range of the vehicle and provides flexibility in advance of ubiquitous local and interstate recharging locations.

Residential and workplace charging can serve the majority of charging needs for plug-in hybrids and battery electric vehicles. Publicly accessible charging stations and charging options in commercial facilities (garages, shopping malls, etc.) will expand the electric range of vehicles, as well as expanding the vehicle options of consumers with varying driving needs.

As the use and range of plug-in electric drive vehicles expands, infrastructure options will need to evolve as well. Collaborative efforts between infrastructure and power providers, city and regional governments and vehicle manufacturers are already underway. For instance, the EV Project, with the support of Recovery Act funds, is installing home and non-residential charging options in 13 cities and building charging corridors. Washington, Oregon, California, and British Columbia's public agencies and private entities are working together to build the Interstate 5 West Coast Green Highway, which will build a framework for electric vehicles and other alternative fuel vehicles along the entire 1,350 miles of the I-5 corridor.

Efforts such as these will help track and meet the needs of plug-in electric drivers, establish interstate business models and standardize technology and billing options for consumers.

Another key policy to facilitate longer intercity trips is to extend the expiring incentive for installation of alternative fuel vehicle refueling property and to ensure that it effectively recognizes the expenses associated with electricity recharging equipment and installation.

PACE OF DEPLOYMENT

Question 3. Hybrid electric vehicles debuted a decade ago, are popular with consumers, and currently account for about three percent of the light duty vehicle market. Is it reasonable to expect that electric vehicles will deploy at a much faster rate?

Answer. We and many industry analysts do expect plug-in electric drive to deploy at a faster rate based on the consumer interest in the vehicles and in oil alternatives, accelerated technology development, strong policy support and increasing emissions reduction requirements.

A 2009 National Research Council report provided a conservative forecast of 13 million plug-in hybrids on the roads by 2030 and an optimistic one of 40 million vehicles. While these estimates were based on unrealistically high battery costs and unrealistically static gasoline costs, the range provides a snapshot of the potential of the industry.

Long term projections are inherently uncertain, but it is clear that, with continued private sector advances and public support, the plug-in electric drive market can be accelerated. With growing consumer acceptance, and next-step policies that advance the technology and promote investment, the industry can achieve commercial scale penetration and mainstream acceptance in the near term. These steps are important to meet the President's goal of 1 million plug-in electric drive vehicles by 2015.

BATTERY TECHNOLOGY

Question 4. One of the biggest hurdles to the development of electric vehicles is the cost of their batteries, which adds greatly to the price of the vehicle itself. Can you share your views on how quickly batteries will advance over the next decade, and what that will mean for their cost?

Answer. Battery performance has been increasing rapidly while costs have been declining. Substantial private and public sector investment (including the Recovery and the Department of Energy's ongoing research and development programs) are accelerating both of these trends, while building domestic capacity in advanced batteries and components—which will also reinforce downward cost pressures. Two years ago, the benchmark for battery costs was generally quoted at $1,000kWh with the DOE benchmark goal set at $300/kWh. Substantial progress has already been made and that goal appears to be within reach for some manufacturers. Deutsche Bank estimates the benchmark price at $650 per kWh with indicators of $450 kWh cost in 2011-2012. A DOE report to be released this week is expected to project that stimulus funding could bring down battery costs from $33,000 for a battery with a 100+-mile range to $16,000 by the end of 2013 and $10,000 by the end of 2015.

COLD WEATHER

Question 5. According to news reports, the BMW Mini-E loses quite a bit of battery capacity in cold temperatures, which in turn reduces its range. Can you provide an update on efforts to overcome the difficulties that some electric vehicles with certain battery chemistries may encounter in cold climates, particularly in an Arctic state like Alaska?

Answer. The efficiency of all vehicles is affected by ambient temperatures. A gasoline engine will get fewer miles to the gallon with the air conditioner running.

Extreme cold can impact performance of battery electric vehicles, specifically at start up, but the impact depends on configurations (battery electric versus plug-in

hybrid), battery chemistries and cell-structures, overall system design and the different manufacturers' systems for maintaining the right internal temperature for optimal performance.

Essentially, at start up, cold batteries, which do not generate initial heat compared to traditional internal combustion engines, are in a lower state of capacity before ideal operating temperatures are reached during operation. Range can be affected if extreme temperatures prevent the system from reaching optimal temperature during operation.

Manufacturers are putting a number of vehicle-and chemistry-specific options in their cars to maintain optimal operating temperature. For example, the Nissan Leaf at launch will include an option for pre-warming the battery to an ideal operating temperature before the driver resumes operation. Other battery electric vehicle manufacturers are looking at other pre-warming strategies, such as small, fuel-burning heaters, to provide the battery with initial heat from a cold start.

In addition, battery manufacturers, with the National Renewable Energy Laboratory, are researching new battery chemistries and cell structures to limit the effects of cold temperatures on battery operation.

CHARGING STATIONS

Question 6. How many charging stations do you believe will need to be installed for every electric vehicle put on the road?

Answer. The infrastructure needs will vary by configurations (battery electric vehicles and plug-in hybrid electric), the size of the batteries (or electric range) and total range of the vehicles. For instance, for the Mitsubishi iMiEV, the company is planning for one home charging option for each vehicle, one workplace Electrical Vehicle Supply Equipment (EVSE) for every two vehicles and one DC Quickcharger for every 10 vehicles. For vehicles with a range extender or an alternative propulsion system, one home recharging option would be the primary need.

CHARGING TIMES

Question 7. Right now, most gas-powered vehicles can be fueled in less than 10 minutes, and then driven for hundreds of miles. A drawback for electric vehicles is that they can take hours to fully recharge. Even quick charging, which reduces battery life, can take at least 20 minutes. Can you discuss any changes to charging time that you see over the next several years?

Answer. Deployment of diverse charging stations options, including home, workplace and publicly accessible or commercial charging stations will advance the electrification of the transportation sector. Most consumer vehicles are parked for approximately 80 percent of the day. The vast majority of charging for plug-in electric drive vehicles initially will be at home, with workplace charging the second most frequent recharging opportunity. In both of these places, where the vehicle is commonly parked for several hours at a time, level 1 (120 volt, regular household outlet) or level 2 (240 volt, like a dryer outlet) will provide timely and convenient recharging for most drivers.

"Quick" or "Fast charging" (480 volts) is most likely to be employed in public or commercial recharging stations. A fast charge can take up to 15 minutes for a full charge—depending on the size of the battery or how "empty " it is. However, it is important to note that a full charge will not always be needed. If the battery is not fully depleted, or if the driver does not need full range to get to their home or other destination, then recharge time is even shorter.

Meanwhile, both battery and recharging technologies are advancing rapidly. Public and private research and investment are yielding results in reducing charge times while extending battery life. Recently, GE announced its WattStation public charging unit that will cut level 2 charging time in half. Last month, another company, JFE Engineering, announced a "super fast" charging system that can achieve a 50 percent charge in three minutes and 70 percent in 5 minutes.

In addition to technology advances that will reduce charging times, the industry is also developing diverse business models that will provide charging outside of dedicated service stations (parking garages, shopping malls, hotels) allowing consumers to recharge in the course of other activities.

The technology and the business models are maturing quickly but we are still at the beginning and expect substantial advances in reducing recharge time, as well as innovative options for meeting consumers' diverse recharging needs.

TAX CREDITS VS. GRANTS

Question 8. This bill contains a variety of grant funding, and it is my understanding that tax provisions could be added to it during floor debate. Do you believe

that one of those forms of support is more appropriate or more relevant to the advancement of electric vehicles? Is it important to maintain a mix between tax credits and federal grants?

Answer. Federal policy support, in both tax incentives and grants is important in helping electric drive achieve national penetration in the near and longer term. The technology has the potential to reduce dependence on oil, cut emissions of pollutants and increase our energy security. To achieve these large scale goals, we need a comprehensive plan to achieve a diverse national fleet of electric drive vehicles. Tax incentives promote investments in vehicles, infrastructure, manufacturing and research and development. Grant programs also support investment in the industry and in the collaborative efforts that will speed deployment of vehicles and infrastructure.

EDTA supports robust federal investment in the grant programs that advance electric drive research, manufacturing and deployment. We also support national tax incentives, including such as the plug-in electric drive vehicles credit and the advanced energy investment credit. We also support re-establishing incentives for medium and heavy duty electric drive vehicles and extending the recharging infrastructure tax credits to ensure that they fully recognize the costs associated with electric refueling property and installation.

TECHNOLOGY NEUTRALITY

Question 9. As introduced, S. 3495 would authorize nearly $6 billion for electric vehicle technologies.

a. How could this substantial increase in funding affect the development of other technologies, such as natural gas, hydrogen, or advanced internal combustion engines, which receive far less funding each year?

b. By promoting one technology so greatly, could we inadvertently disincent cheaper ways to reduce fuel consumption and greenhouse gas emissions, as well as longer-term options like fuel cells?

Answer. We agree with the findings of the recent National Research Council that federal policies must also advance longer term as well as immediate goals, including deployment of fuel cell vehicles and infrastructure and advances in emerging energy storage options that the private sector cannot support alone.

Recognizing that resources are finite and that a diverse portfolio of technologies will be needed in our transportation future, investing in electric drive today is an essential part of the solution to oil dependence. We need to build on our successes and take the next steps with a comprehensive effort to launch this transformational transportation technology on a national scale.

RESPONSES OF ALAN T. CRANE TO QUESTIONS FROM SENATOR MURKOWSKI

PACE OF DEPLOYMENT

Question 1. According a press release accompanying the National Research Council's report, "the maximum number of plug-in electric vehicles that could be on the road by 2030 is 40 million, assuming rapid technological progress in the field, increased government support, and consumer acceptance of these vehicles. However, factors such as high cost, limited availability of places to plug in, and market competition suggest that 13 million is a more realistic number." What do you think it would take to get 100 million PHEVs on the road by 2030? Is there any chance of that happening?

Answer. The committee that prepared the PHEV report believes that getting 100 million PHEVs on the road by 2030 (1/3 of the fleet) would require unprecedented rates of technology adoption and probably extraordinary Federal intervention in the market. The committee estimated the maximum practical penetration rate based on past experiences with new technologies, including hybrid electric vehicles (HEVs). Typically a new vehicle technology is introduced in just a few models, and as costs are reduced and performance improved, it spreads to other types of vehicles and manufacturers. HEVs were first introduced in the United States in 1999, and commercialization was accelerated by government support. After a decade, HEVs accounted for a few percent of new sales, and cumulative sales were about 1.6 million, less than 1 percent of the total fleet. HEV growth could have been faster, but most consumers didn't find the additional cost (even with government subsidies) justified by the fuel savings.

The NRC penetration rate for PHEVs was much more aggressive than experienced by HEVs, reaching 8 million in 12 years and 40 million in 20 despite the

much higher costs and modest fuel savings of PHEVs relative to HEVs, and the driver behavior modifications that will be required. More than half of U.S. car sales from 2020 to 2030 would have to be PHEVs to reach 100 million. Even if extremely ambitious technical goals are met, PHEVs are unlikely to be cost-competitive much before 2025. Many drivers will be unable or unwilling to plug their vehicles regularly or don't have driving patterns that make sense for PHEVs. The committee concluded that 40 million PHEVs is an upper bound for 2030.

FUEL CELL VEHICLES

Question 2. While the focus of this hearing is a bill to promote electric vehicles, can you provide the Committee with a general update on the status of fuel cell vehicles, barriers to their deployment, and when commercial production may begin in the United States?

Answer. Substantial progress has been made on fuel cell vehicle technology since the NRC report on the subject was completed in 2008. As noted in the NRC's recent review of the FreedomCar program, projected fuel cell system cost at 500,000 units/year has decreased from about $107/kiloWatt in 2008 to $60-70/kW now, a significant reduction in 2 years. Progress is on schedule to meet the target of $30/kW in 2015. In part this decrease is the result of continued decreases in platinum catalyst loading. Some companies now project that hydrogen fuel cell vehicles (HFCVs) will need less platinum than in the catalytic converters of conventional vehicles. On-road durability has increased significantly from 1250 hours in 2008 to about 2000 hours now. The 2015 target of 5000 hours appears achievable. In laboratory tests, some fuel cells have reached 7200 hours.

It is also significant that all major vehicle manufacturers have recently announced that they can achieve driving ranges of 300 to 400+ miles using compressed gas storage. Toyota and Kia have both demonstrated ranges in excess of 425 miles and system efficiencies well above 50%, for example.

Companies in the United States, Europe, and Asia are planning aggressive commercialization of HFCVs. As presented at the June 3, 2010 meeting of the Hydrogen Technical Advisory Committee (http://www.hydrogen.energy.gov/advisory__htac.html):

- GM plans to introduce HFCVs in 2015 with a very compact 124 kW fuel cell system that meets all commercial cost and performance objectives;
- The "H2-Mobility" consortium, a European initiative, plans to launch HFCVs and the accompanying infrastructure in Germany by 2015; and
- The Japanese government-corporate joint initiative plans to launch HFCVs in 2015. All the leading automakers and energy companies in Japan have committed to the Japan Hydrogen & Fuel Cell Demonstration Project (JHFC) goals.

Despite the impressive progress, fuel cell vehicles face several daunting barriers. Costs of the fuel cells and on-board storage of hydrogen must be brought down further through improvements in technology. The hydrogen infrastructure must be built simultaneously with the introduction of HFCVs. Meeting these goals will be difficult but not impossible; R&D is proceeding well, and the Department of Energy has developed a strategy to deploy hydrogen fueling stations in a pattern consistent with the growth of hydrogen demand. Initially, HFCVs will be much too expensive for most buyers, and hydrogen fuel will be hard to find. Mass production will bring costs down sharply, but significant, though declining, subsidies will be required to reach competitiveness and to build the hydrogen infrastructure before there is much market for it. The committee estimated these subsidies at about $50 billion total. While that is less than is being spent on other energy options, it will be critical for industry to have confidence that the funds will be available for the duration of the transition.

BATTERY TECHNOLOGY

Question 3. In your written testimony, you state that, "While the committee's estimates of future costs are higher than some (but not all) others, that may be because the committee assumed that durability and safety goals had to be met before cost goals." Can you expand on this statement?

Answer. The costs in the NRC report are based on the battery pack which includes the battery cells, the casing, and the electronic and cooling systems that are currently required to assure safety and durability. The committee was told by auto makers that safety had to be assured to very high standards in order for them to market PHEVs and that very high levels of durability were required to meet their warranty positions. Cheaper batteries undoubtedly can be made, but then they might have to be replaced several times over the lifetime of the vehicle, a cost that

wouldn't appear at first. The committee assumed that the electronic monitoring and cooling systems currently needed to assure safety and durability would be retained in the future. These contribute significantly to battery pack costs and are based on mature technology that is not expected to drop greatly in cost. Some projections assume that these systems will be deleted, but the committee was unconvinced that that could be done without jeopardizing durability. The committee did not attempt to predict breakthroughs in battery cell technology, which might lead to significant reductions in battery cost and in more marked reductions in the requirement for electronic monitoring and cooling requirements and thus, further reductions in cost. Although the report's assumptions in this area may seem to some to be conservative, the current flurry of automobile safety and recall issues suggest caution in making bolder technology projections that could affect safety.

BATTERY TECHNOLOGY

Question 4. One of the biggest hurdles to the development of electric vehicles is the cost of their batteries, which adds greatly to the price of the vehicle itself. Can you share your views on how quickly batteries will advance over the next decade, and what that will mean for their cost?

Answer. The cost of a battery pack for any specified range for a particular vehicle is a function of the cell cost and associated equipment as noted in the previous response. The committee estimated that a battery pack for a PHEV-40 (40 mile all-electric range) would cost $10,000 to $14,000 in 2010 and for a PHEV-10 would cost $2,500 to $3,300. These costs are for cells ordered several years ago for installation in vehicles manufactured in 2010 and 2011. They are unlikely to survive 10 years of operation. As noted in the previous response, the committee expects improving durability to take precedence over reducing costs. These battery packs are for small to mid-size cars. Many vehicles, such as mid-size or large SUVs, would require much larger and more expensive battery packs.

Cost reductions will come from several sources, the most important of which is the technology of the cell itself. In particular, as the technology improves, more energy may be usefully extracted from the cell without compromising durability. The next most important sources are likely to be improved manufacturing processes and yields. Cost reductions from increasing scale of manufacture will be small. Unlike fuel cells, lithium-ion batteries are manufactured by the billions per year in large and sophisticated facilities. The manufacturing processes for cells for automobile application are not very different from many cell lines already being produced.

Cost reductions of three -to four-fold over the next several years, as projected by some people, are not likely without inherently unpredictable major battery breakthroughs. The committee estimated that battery pack costs would decline by about 40 percent by 2020 based on discussions with representatives of cell manufacturers, automobile manufacturers, and battery pack assemblers. The committee also observed that the cost of Ni-metal hydride batteries has declined only slightly as production ramped up for use in HEVs over the last decade. It is important to note that the committee's estimates are for full, unsubsidized battery-pack costs. Companies may sell batteries and vehicles at or even below costs to gain market share, or governments may subsidize the costs of building and/or operating manufacturing facilities. Thus announced costs have to be examined carefully to determine if they are real or have simply shifted some of the costs to other payers.

CHARGING TIMES

Question 5. Right now, most gas-powered vehicles can be fueled in less than 10 minutes, and then drive for hundreds of miles. A drawback for electric vehicles is that they take hours to fully recharge. Even quick charging, which reduces battery life, can take at least 20 minutes. Can you discuss any changes to charging time that you see over the next several years?

Answer. Rapid charging will be important for all-electric vehicles but less so for plug-in hybrids. We assumed that most PHEVs would be plugged in at home overnight. Even a large SUV with a 40 mile battery pack can be charged in less than 4 hours on a 220 volt line. Therefore we did not study the effect of rapid charging rate on battery durability. However, I might note that, as you say, very rapid charging may well reduce battery life. It would generate a lot of heat inside the battery pack (possibly at a rate of over a kilowatt) which must be removed to maintain safe temperatures. Vehicle manufacturers may incorporate charging limiters in their battery packs until they are sure that any accelerated deterioration is minor. Rapid charging also might place heavy burdens on the infrastructure to supply the electricity if electric vehicles become common for long distance travel; a busy turnpike charging station could easily see demand at the multi-megawatt level. These and

other important issues will be answered only with considerable experience with battery vehicles on the road.

PORTFOLIO APPROACH

Question 6. In your written testimony, you conclude by noting that "A portfolio approach to research, development, demonstration, and perhaps, market transition support is essential." Can you expand on the types of technologies and policies that you believe should be included in a truly balanced portfolio?

Answer. The PHEV report and other recent NRC studies (America's Energy Future, FreedomCar) have shown the importance of a portfolio approach to meeting goals for reducing oil dependency and greenhouse gas emissions. We simply don't know at this point which options will be prove most satisfactory, especially in the long term. Focusing on one or two could easily produce suboptimum results. The portfolio should include options that will be available in the near and long term.

Important near term technologies include improved efficiency of internal combustion engine vehicles, hybrid drive trains, low carbon biofuels, and natural gas as a transition fuel. In the longer term, electric drive vehicles such as plug-in hybrids, all-electric vehicles, and fuel cells could yield large reductions in oil use and GHG emissions. Because of the longer time frames required to develop and commercialize electric drive train technologies (batteries and fuel cells), it is important to pursue near term strategies while developing electric vehicle technologies. The largest reductions are most likely to be achieved when these approaches are used together.

In the past 20 years, US alternative fuel policy has been characterized by a "fuel du jour" syndrome, which has led to "boom and bust" cycles of support for one technology after another. All long term options face challenges and uncertainties. Maintaining strong consistent support for a variety of options is crucial to nurturing their development.

TECHNOLOGY NEUTRALITY

Question 7a. As introduced, S. 3495 would authorize nearly $6 billion for electric vehicle technologies. How could this substantial increase in funding affect the development of other technologies, such as natural gas, hydrogen, or more efficient conventional vehicles, which receive far less funding each year?

Answer. The committee did not study how emphasis on one technology would affect development of others. However, I can make some general observations based on the NRC's recent review of the FreedomCar program and other reports.

Emphasizing any one technology is likely to starve others of funding. Even if R&D funding is maintained, money is not the only factor limiting development. Companies may not be able to hire all the engineers, designers, researchers, managers, and other skilled labor they would need to pursue all technologies at the maximum rate. Therefore, to some extent, picking winners also implies picking losers.

Question 7b. By promoting one technology so greatly, could we inadvertently disincentivize the development of cheaper ways to reduce fuel consumption and greenhouse gas emissions, such as advanced internal combustion engines that achieve significant increases in fuel economy?

Answer. In the near- and mid-term (i.e. before 2030), advanced fuel efficiency of conventional vehicles, biofuels, and natural gas are likely to be more effective in reducing oil consumption and carbon emissions than either batteries or fuel cells although their ultimate potential is less. None of these options will be cost-effective while gasoline prices are at current levels, but it seems logical to extract as much benefit as possible from the lower hanging fruits. However, the current CAFE standards are forcing manufacturers to rapidly increase fuel economy, and ethanol promotional policies are close to maximizing biofuel production until cellulosic ethanol and other advanced technologies are ready. Therefore I wouldn't say that the battery program disincentivizes the nearer-term technologies, but it may for fuel cells.

Question 7c. By promoting one technology much more than others, do we risk discouraging the development of fuel cell and other alternative technology vehicles?

Answer. As I noted in my oral testimony, it is by no means certain that batteries will become the technology of choice for a large fraction of the light duty vehicle fleet. A balanced program is vital at least until we find out whether the costs and other issues associated with batteries, fuel cells, cellulosic ethanol, and other technologies will prove acceptable. Furthermore, as discussed in the fuel cell report and in my response to question 2 above, commercializing HFCVs will require steadfast government support to assure industry that their investments won't get the rug pulled out from under them. Fuel cells need several more years of R&D before the much more costly commercialization phase could start, but companies may be concerned that government support for a second major initiative will not be there when

they need it. That could discourage private investment in the R&D that is still needed.

Thank you for this opportunity to expand on my testimony. I would be happy to supply copies of related NRC reports:

- Review of the Research Program of the FreedomCAR and Fuel Partnership: Third Report (2010);
- America's Energy Future: Technology and Transformation (2009);
- Assessment of Technologies for Improving Light-Duty Vehicle Fuel Economy.

RESPONSES OF ALAN T. CRANE TO QUESTIONS FROM SENATOR SESSIONS

Question 1. Since "cost reductions are not very likely without breakthrough in battery technology," how do you expect to get 40 million of these cars on the road by 2030 when the technology is not there to make it plausible?

Answer. The committee projects that battery costs will decline by over 40 percent by 2030. This is a significant improvement, but it is unlikely to be enough by itself that 40 million PHEVs will be on the road by 2030. Therefore, unless unpredictable breakthroughs dramatically lower the cost, substantial subsides will be necessary to achieve high penetration rates.

Question 2. If "policy intervention and/or financial assistance for buyers from government" is needed, how much will these processes cost the tax payers?

Answer. Subsidies could be from the government in the form of assistance to battery and vehicle manufacturers, or to buyers of the vehicles. In the early years, subsidies might also come from manufacturers selling at below normal markup or even below cost in order to promote sales and gain market share. The committee did not investigate how the subsidies might be supplied. It merely calculated the total that would be necessary. For PHEV-40s, over $400 billion would be required before break-even is reached under the committee's optimistic technology projection. However, if DOE's goals are reached by 2020, the total drops to $24 billion[1].

Question 3. Under current conditions, how much would it cost to produce a plug-in hybrid car that is practical for public use?

Answer. The Chevrolet Volt (PHEV-40), which will be introduced in a few months, will be practical for public use. The main problem is the cost. GM has announced that the Volt will list at $41,000. With all available options, the list price is $44,600. This is price, not cost, and may include some manufacturer subsidies for the batteries and vehicles, but not the tax credit for the buyer. Starting prices for the equivalent Chevrolet Cruze will range from $16,275 to $21,975, so the price increment for the Volt is on the order of $20,000. The committee estimated the current incremental cost, relative to an equivalent non-hybrid vehicle, at $14,000 to $18,000 for a PHEV-40, which is reasonably consistent with the price increment for the Volt. The committee's estimate for the PHEV-10 cost increment was $5,300 to $6,300.

Question 4. In your opinion, does the federal government need to provide subsidies in order to produce and market the 700,000 plug-in hybrid cars called for in the legislation? If so, what form of subsidy would be used? If it is financial assistance, what would the amount of the subsidy be?

Answer a. Yes. In order to reach beyond the early adopters and electric vehicle enthusiasts (and 700,000 is very likely well beyond these niche markets), PHEVs must offer a significant gasoline saving to offset their higher price. At current gasoline prices, unless subsidized few if any of the first generation of PHEVs will provide net benefits over their lifetimes to their owners. Manufacturers may provide some subsidies for early production vehicles, but are unlikely to be willing to continue as production rises. Most of the subsidization will have to be from the government, which has the additional incentives of reducing oil consumption and greenhouse gas emissions. Encouraging battery development and PHEV production is likely to drive down costs, and eventually the government's investment may prove worthwhile.

Answer b. As noted above, this study did not examine the policies necessary to ensure the penetration of PHEVs into the market, just the magnitude of the effort required.

Answer c. The committee's optimistic penetration projection reaches 700,000 PHEVs in 2017. If all are PHEV-40s, they would cost about $11 billion more than

[1] The committee did not expect that the DOE goals could be met without real breakthroughs in battery technology, which are inherently unpredictable. Even if they do occur, commercialization will require years of testing and refinement, and more years to set up mass manufacturing facilities and reach significant penetration into the fleet.

equivalent conventional vehicles[2]. Assuming the batteries last for 100,000 miles, a PHEV-40 might save about $4000 in fuel costs[3]. Therefore the net incremental cost of 700,000 PHEV-40s would be about $8 billion. At $7,500/vehicle, the Federal tax credit would amount to $5.25 billion. If the DOE goals for battery costs are met, the required subsidy would be much lower.

Question 5. Calculating total cost, including subsidy along with fuel savings, compare the life cycle cost of a plug-in vehicle to a conventional gas/diesel car.

Answer. The committee's analysis did not directly perform this analysis, but we do have some additional information that was not in the report and has not been subject to National Academy review. The results, of course, depend heavily on assumptions, but for the capital and fuel costs in the NRC PHEV report:

- Even with optimistic technology development, the PHEV-40 is more expensive than a conventional gasoline vehicle through 2030;
- With a subsidy of $7500, the PHEV-40 could become competitive by 2017;
- If DOE's goals are met by 2020, the PHEV-40 becomes competitive in 2020 without subsidy and 2013 with the $7500 tax credit;
- The PHEV-10 could become competitive in about 2025 without subsidies and in 2010 with the $7500 subsidy;
- Under the committee's probable technology development, the PHEV-40 never becomes competitive even with the subsidy. The PHEV-10 is competitive in 2010 with the subsidy, but does not reach competitiveness by 2030 without it.

These comparisons are shown in the attached figures. It should also be noted that subsidies do not alter the underlying costs. They just assign them to different payers.

[Responses to the following questions were not received at the time the hearing went to press:]

QUESTIONS FOR DAVID FRIEDMAN FROM SENATOR MURKOWSKI

BATTERY BUBBLE

Question 1. According to some recent news reports, the United States may already be on the verge of producing far more advanced batteries than electric vehicles. Do you see any evidence of this happening? What are the likely consequences if too many batteries are produced? What can we do to ensure that there is no supply-demand gap for batteries?

TARGETED DEPLOYMENT PROGRAM

Question 2. If $500 million is awarded to each community selected for the program established by Section 106 of this bill, what sort of impact will that funding have? How many electric vehicles and charging stations should we expect to be deployed?

TARGETED DEPLOYMENT PROGRAM

Question 3. A targeted deployment program could help deploy vehicles and infrastructure within communities, but it would do little to assist with long-distance driving. What do you think can and should be done to facilitate intercity road trips in electric vehicles?

---

[2] The committee's optimistic cost increment in 2015 is $11,200. Using that as an average for vehicles produced between 2010 and 2017, and including a markup of 40% for retail prices, the total additional cost for 700,000 PHEV-40s comes to $11 billion.

[3] EPA's mileage estimates for the Cruze are not yet available (it will be introduced with the Volt as a 2011 model), but GM says a high efficiency version will be available that gets 40 mpg on the highway. Assuming a city/highway average of 36 mpg, this vehicle would use about 2780 gallons in 100,000 miles. PHEV-40s are projected to drive 45% on gasoline and 55% on electricity, so in 100,000 miles it would use about 1250 gallons, saving 1530 gallons. At an average of $3.30/gallon, this saves $5050. At 200 Wh/mile, electricity consumption would be 11,000 kWh, which at 10.4 cents would cost $1140, so the net fuel savings would be $3910. The fleet of 700,000 would save $2.7 billion in fuel over their lifetimes. No discount rate has been applied to reflect the present value of future savings at the time the vehicle is purchased.

PACE OF DEPLOYMENT

Question 4. Hybrid electric vehicles debuted a decade ago, are popular with consumers, and currently account for about three percent of the light duty vehicle market. Is it reasonable to expect that electric vehicles will deploy at a much faster rate?

BATTERY TECHNOLOGY

Question 5. One of the biggest hurdles to the development of electric vehicles is the cost of their batteries, which adds greatly to the price of the vehicle itself. Can you share your views on how quickly batteries will advance over the next decade, and what that will mean for their cost?

COLD WEATHER

Question 6. According to news reports, the BMW Mini-E loses quite a bit of battery capacity in cold temperatures, which in turn reduces its range. Can you provide an update on efforts to overcome the difficulties that some electric vehicles with certain battery chemistries may encounter in cold climates, particularly in an Arctic state like Alaska?

TAX CREDITS VS. GRANTS

Question 7. This bill contains a variety of grant funding, and it is my understanding that tax provisions could be added to it during floor debate. Do you believe that one of those forms of support is more appropriate and more relevant to the advancement of electric vehicles? Is it important to maintain a mix between tax credits and federal grants?

CHARGING STATIONS

Question 8. How many charging stations do you believe will need to be installed for every electric vehicle put on the road?

CHARGING TIMES

Question 9. Right now, most gas-powered vehicles can be fueled in less than 10 minutes, and then drive for hundreds of miles. A drawback for electric vehicles is that they take hours to fully recharge. Even quick charging, which can reduce battery life, can take 20 minutes. Can you discuss any changes to charging time that you see over the next several years?

○