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Chairman Whitfield, Ranking Member Rush, and Members of the Subcommittee, thank you for the opportunity to discuss the Department of Energy's (DOE's) transportation portfolio—specifically our vehicle technologies and alternative fuels programs. As part of the President's sustained, all-of-the-above approach to American energy, the Department is working to develop advanced vehicle technologies that can secure our energy future and provide consumers with greater choice while saving energy and reducing costs.

As Deputy Assistant Secretary for Energy Efficiency in the Office of Energy Efficiency and Renewable Energy (EERE), I am responsible for overseeing DOE's portfolio of energy efficiency research, development, demonstration, and deployment (RDD&D) activities, including those related to advanced vehicles technologies.

Today, with the help of the Department's vehicles and alternative fuels programs, the automotive industry is reinventing itself—expanding the number of new, more fuel-efficient and environmentally sustainable vehicles and helping to create jobs throughout the vehicle supply chain. By supporting manufacturers building everything from advanced combustion engines and turbochargers, to cutting-edge batteries and more efficient tires, the Department is strengthening the global competitiveness of America's automotive industry.

The transportation sector accounts for approximately two-thirds of the United States' oil consumption and contributes to one-third of the Nation's greenhouse gas (GHG) emissions.[1] Net expenditures for imports of crude and petroleum products have been hundreds of billions of dollars every year. After housing, transportation is the second biggest annual expense for most American families.[2] Improving fuel efficiency of vehicles and developing alternative fuels represents one of the best opportunities we have to reduce our dependence on oil and lower our transportation costs. The economic, national security and environmental costs of our existing vehicles and transportation infrastructure make developing advanced, more fuel-efficient vehicles and alternative fuels an imperative for the Nation.

The Department is investing in a broad portfolio of near- and long-term vehicle-related technologies that includes electric drive, advanced combustion, advanced fuels and lubricants, biofuels, and hydrogen fuel cells, as well as technologies such as advanced lightweight materials that benefit vehicles regardless of size or propulsion technology. We have set aggressive goals and targets. We have mapped out the strategies to achieve them. And we are making significant progress, demonstrating the real promise of all of these technologies and justifying our investment.

Today I will address the work and progress of three vehicles and alternative fuels programs in EERE:

1. The Vehicle Technologies Program, with a specific focus on electric drive vehicles,
2. The Biomass Program, and,
3. The Hydrogen and Fuel Cells Program

[1] http://www.eia.gov/totalenergy/data/annual/pecss_diagram.cfm and http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2012&subject=0-AEO2012&table=17-AEO2012&region=1-0&cases=ref2012-d020112c

[2] http://www.bls.gov/news.release/cesan.nr0.htm

1. The Vehicle Technologies Program

EERE's Vehicle Technologies Program (VTP) accelerates the development of advanced, energy-efficient, environmentally-friendly transportation technologies that reduce petroleum consumption and lower GHG emissions without sacrificing vehicle performance. The VTP portfolio reflects a mix of near- and long-term technologies including advanced combustion engines, advanced fuels and lubricants, lightweight materials and propulsion materials, advanced batteries, power electronics and electric motors, and vehicle systems and enabling technologies. Program activity covers technologies applicable to a broad range of vehicles from light-duty passenger cars to heavy-duty trucks. VTP's Clean Cities initiative, a community-based deployment activity, provides technical assistance to fleets and informational resources to help consumers save money on their personal transportation, whether they are looking for a new car or tips for increasing the fuel efficiency of their current car. In tandem with the Administration's historic new fuel economy standards, DOE's work in all of these areas will help enable the continued improvement of vehicle fuel economy, provide consumers with a variety of choices to save money at the pump (or avoid the pump altogether), and strengthen our national energy and economic security by reducing our dependence on oil.

While we embrace the portfolio approach, given the potential for significant benefit to our nation and individual consumers, the Department has placed increased emphasis on vehicle electrification. Electric vehicles (EVs) – both plug-in hybrid electric vehicles (PHEVs) and all-electric vehicles – make sense for a number of reasons:

- Electricity is cheaper than gasoline for powering a vehicle (at about $1 per gallon equivalent gasoline price),
- EVs allow for convenient charging at home at night, or potentially at work,
- EVs can potentially offer the same or better driving performance compared to today's gasoline powered vehicles, and
- EVs will reduce America's dependence on petroleum, protecting consumers from price spikes and keeping the money Americans spend on energy here at home.

Other countries recognize these benefits—and recognize the economic opportunities —and are making their own investments. We face tough competition in the global race for a clean energy economy, and we must do what it takes to position ourselves at the lead for transportation technologies.

To help focus our national effort, in his 2011 State of the Union address, President Obama set a goal of being the first country in the world to have one million electric vehicles on the road by 2015. This goal is not an end point but an ambitious milestone on the path to the many millions of plug-in and battery electric vehicles needed to move U.S. transportation away from dependence on oil, build a robust domestic supply base, create high-paying manufacturing jobs, and stimulate the American economy.

With support from the American Recovery and Reinvestment Act of 2009 (ARRA), we are establishing a U.S. supply chain and building our capacity to manufacture advanced batteries and electric drive components. Our industry partners, selected through an open and competitive process, are matching

federal funds dollar for dollar. Together we have already created a total capacity of more than 140,000 EV batteries per year, and we are on track to reach our goal of having the capacity to support 500,000 EV batteries per year by 2015. Similarly, facilities for manufacturing motors and other electric drive components are expanding and now filling orders for domestically produced all-electric vehicles.

To move electric drive technology beyond initial early adopters, we must continue to reduce the cost and improve the performance of key component technologies such as advanced batteries. Technology developed with DOE support is in nearly every hybrid vehicle on the road today, and we are building on that success with research and development (R&D) of next-generation technologies. Since 2008, DOE has demonstrated a 35 percent reduction in the production cost of lithium ion batteries.[3] With recent successes, such as the development of a cathode at Argonne National Laboratory (ANL) with double the energy density of previous cathode materials, we are on track to demonstrate an additional 50 percent cost reduction by the end of 2014, bringing the modeled cost to $300/kWh, which will make these vehicles cost-competitive in the market.. This, together with expected progress in power electronics and electric motor technology, would help enable electric vehicles to be sold for a low enough price compared to gasoline-powered vehicles that they would pay for themselves in fuel savings after just a few years, without subsidy.

On the infrastructure side, the Recovery Act's Transportation Electrification initiative has enabled the largest-ever demonstration of plug-in electric vehicles and charging infrastructure, with a final projected total of 13,000 vehicles and more than 20,000 chargers. Every vehicle and charger is instrumented to collect real-world usage data that not only provides important feedback to the R&D community but also yields a first-of-its-kind public data set on charging behavior, local effects on the grid, and other lessons learned about time-of-use rates, for example, that will help local communities, manufacturers, and electric utilities effectively plan future PEV charging infrastructure.

We have made notable progress, but there is still work to be done. Transitioning our Nation's transportation sector is a formidable challenge. That is why, building on his one million electric vehicle goal, President Obama announced a new clean energy grand challenge in March of this year. The EV Everywhere Grand Challenge seeks to enable U.S. companies to be the first in the world to produce EVs that are as affordable and convenient for the average American family as today's gasoline-powered vehicles, in the next ten years. EV Everywhere calls to action American innovators to rapidly develop and commercialize the next generation of vehicle, component, and charging technologies to achieve sufficient EV cost reductions, range improvements, and infrastructure enhancements to assure widespread EV deployment without subsidies.

Another key initiative is the proposed National Community Deployment Challenge (NCDC). Announced in March as part of the President's blueprint for a new era of American energy, the NCDC is designed to provide local communities with the support needed to significantly accelerate the deployment of clean, alternative fuel vehicles and infrastructure around the country. With a fuel-neutral approach, communities can choose the technology— or combination of technologies— that best fits their local

[3] Cost estimates are based on high volume manufacturing cost projections, using a peer reviewed cost model.

needs, whether that's electric drive, natural gas, biofuels, or another alternative fuel. As envisioned, the NCDC would highly leverage private sector investments and be awarded via an open and competitive grant program with an emphasis on deployment at scale and economically-sustainable market transformation following the expenditure of federal funds. Participating communities would be asked to meet competitive goals and serve as national leaders for the implementation of these technology deployment models. Data collection would be an essential component of the effort—allowing communities to continue to replicate successes across the United States.

2. The Biomass Program

The Department of Energy's Biomass Program aims to develop and transform our renewable biomass resources into commercially viable, high performance biofuels, bioproducts, and biopower through targeted research, development, and demonstration (RD&D) supported through public-private partnerships.

Because of its potential to reduce our oil dependence and protect the environment, biofuels technology development has historically received strong bipartisan support. This Administration has prioritized developing and commercializing innovative biofuels. The previous Administration, under President Bush's Advanced Energy Initiative and "Twenty-in-Ten" initiative, also set priorities for biofuels: to make cellulosic ethanol cost-competitive with corn-based ethanol by 2012 and to increase the supply of renewable and alternative fuels. Members of both parties in Congress supported the Energy Independence and Security Act (EISA) of 2007, which expanded goals for moving biofuels into the marketplace through an expansion of the original Renewable Fuels Standard (RFS). Specifically, EISA stipulated the supply of renewable transportation fuels should reach 36 billion gallons per year by 2022. Biofuels are playing a growing role in the U.S. transportation market and are projected to provide more than 13 percent of energy used by light and heavy duty vehicles by 2035, up from 9 percent in 2010 and driven primarily by the RFS mandate.

There are three main categories of biofuels that we can use to reduce our dependence on oil: starch based ethanol, cellulosic ethanol, and "drop-in" biofuels. Technologies in each of these categories are at a different stage of commercial readiness.

Starched-based ethanol is a well-established commodity fuel with wide market acceptance through low-level blends in conventional vehicles and at higher blends in flex-fuel vehicles. The average concentration of ethanol in the U.S. gasoline supply, including all blends, reached 10 percent in the summer of 2011. The vast majority of the ethanol in the U.S. fuel market today is starch based ethanol, as cellulosic ethanol technology is currently moving through the demonstration phase into commercialization.

Cellulosic ethanol, like starch based ethanol, can be used to displace gasoline for light duty vehicles. Through R&D efforts, the cost of converting cellulosic biomass to fuel ethanol is becoming competitive. Over the past ten years, breakthroughs in biomass pretreatment and enzymatic saccharification have

helped reduce the modeled costs of cellulosic ethanol produced via biochemical conversion from over $9.00 per gallon in 2001 to a modeled minimum ethanol selling price of $2.15 per gallon in 2012. One of the Biomass Program's short term objectives is to assist in demonstrating the commercial viability of cellulosic ethanol production.

DOE and the bioenergy community are leveraging cellulosic ethanol RD&D successes to accelerate cellulosic and algal "drop-in" biofuels technologies that can be used to displace gasoline, diesel and jet fuel. "Drop-in" hydrocarbon biofuels are advantageous because they are largely compatible with existing infrastructure to deliver, blend, and dispense fuels. Also, unlike ethanol, "drop-in" fuels can be used to displace diesel and jet fuel in addition to gasoline. Through RD&D, the Biomass Program seeks to contribute significantly to making cellulosic "drop-in" biofuels competitive with petroleum-based fuels, achieving a modeled mature-technology wholesale finished-fuel cost of renewable gasoline, diesel and jet fuel of less than $3.00 per gallon by 2017. The program also expects to help support meeting the RFS volumetric requirements by deploying first-of-a-kind integrated biorefineries that can produce advanced biofuels by the end of 2014.

In addition to the efforts by the Department and its private sector partners, DOE is working closely with other federal agencies to support commercialization of "drop-in" biofuel substitutes for diesel and jet fuel. On July 2, Navy, USDA and DOE jointly announced an opportunity for up to $30 million in Navy funding for an initiative that seeks to establish one or more complete domestic value chains capable of producing drop-in replacement biofuels. This includes feedstock production and logistics, conversion facilities (Integrated Biorefineries), and fuel blending, transportation, and logistics. The contemplated effort will include the design, construction and/or retrofit, validation, qualification and operation of a domestic commercial-scale biofuel supply chain that meets a target of at least 10 million gallons per year neat biofuel production capacity.

The RD&D activities sponsored by the Department of Energy's Biomass Program are addressing technical barriers, providing engineering solutions, and developing the scientific and engineering underpinnings of a bioenergy industry. Historically, the Program's focus has been on RD&D for cellulosic ethanol production. More recent national and DOE goals require the Program to expand its scope to include the development of other advanced biofuels that could contribute to the volumetric requirements of the Renewable Fuels Standard (RFS). This includes "drop-in" biofuels such as biobutanol, hydrocarbons from algae, and biomass-based hydrocarbon fuels (renewable gasoline, diesel, jet fuel). The Program specifically focuses on advancing bio- and thermo-chemical pathways, addressing feedstock logistics, and demonstrating integrated biorefineries.

The Program's bio- and thermo-chemical conversion R&D is focused on developing technologies to convert feedstocks into commercially viable liquid transportation fuels, as well as bioproducts and biopower. Biochemical conversion efforts focus on producing sugars from biomass and fermenting those sugars into fuels or chemicals. Thermochemical conversion work is focused on producing intermediates from biomass and organic biorefinery residues via gasification, pyrolysis, and other chemical means and converting these intermediates into fuels, chemicals or power.

The Program's feedstock supply R&D is focused on developing sustainable technologies to provide a reliable, affordable, and sustainable biomass supply. This R&D is conducted in partnership with the USDA and DOE's Office of Science. The Program's primary focus is on feedstock resource assessment, feedstock logistics (i.e., harvesting, storage and transportation) and algal feedstock supply R&D.

The Biomass Program's demonstration and deployment activities focus on the Integrated Biorefineries. DOE's 24 integrated biorefineries aim to validate first-of-a-kind technologies at pilot, demonstration, and commercial scales to reduce risk of further investment. These demonstrations help to overcome key technical and economic barriers for producing advanced biofuels and better enable future scale up and replication of biorefineries by the private sector. These efforts are industry-led, cost shared, competitively awarded projects. Twenty of the 24 projects are either in construction or operating.

Integrated Biorefineries are a critical component of the Federal government's efforts to advance the commercialization of biofuels. In 2010, President Obama set a goal of breaking ground on at least four commercial scale cellulosic or advanced biorefineries by 2013. That goal has been accomplished, one year ahead of schedule. Together, these projects and associated demonstration and pilot projects will have the capacity to produce a combined total of nearly 100 million gallons per year of advanced biofuels.

3. The Hydrogen and Fuel Cells Program

EERE's Hydrogen and Fuel Cells Technology Program (FCT) supports R&D to reduce the cost and improve the durability of fuel cells, to improve the performance of technologies for producing, delivering, and storing hydrogen, and to develop and demonstrate manufacturing technologies and processes that will reduce the cost of fuel cell and hydrogen systems. The Program seeks to enable fuel cells to achieve cost-parity with internal combustion engines for vehicles by 2017 and to enable renewable hydrogen to be competitive with conventional fuels by 2020, based on modeled costs projected from component technologies to systems in high-volume production.

FCT's R&D efforts have reduced the production cost of automotive fuel cells by more than 30 percent since 2008 and more than 80 percent since 2002 (from $275/kW in 2002 to $49/kW in 2011, based on projections to high-volume manufacturing). We have reduced the capital cost of water electrolyzer stacks by more than 80%—from over $2,500/kW in 2001 to less than $500/kW in 2011—and reduced hydrogen delivery cost by tube trailer by 40% since 2005.

In addition to this significant laboratory progress, we're demonstrating these technologies in real-world applications. Through our Technology Validation efforts, we've completed demonstrations of more than 180 fuel cell electric vehicles that made 500,000 trips and traveled 3.6 million miles as well as 25 hydrogen fueling stations that provided more than 33,000 refuelings. Demonstrated refueling time was less than 5 minutes and the driving range was over 250 miles—with one vehicle achieving a 430 mile range. The vehicles demonstrated more than 2,500-hour (about 75,000 miles) durability operating under

real-world conditions, with low degradation and efficiencies of nearly 60 percent—more than twice the efficiency of today's gasoline vehicle engines. We also demonstrated the world's first tri-generation station—co-producing heat, hydrogen, and power— which had a combined efficiency of more than 50 percent for co-producing hydrogen and power from a stationary fuel cell (100 kg/day of hydrogen).

EERE has had substantial impacts on the hydrogen and fuel cell industry. Nearly 700 DOE supported fuel cell lift trucks were followed by more than 3,500 additional fuel cell lift truck deployments by industry, purchased or on order—with no DOE funding. Additionally, approximately 700 fuel cell backup power units were deployed with support from DOE that were followed by more than 1,300 units purchased or on order by industry with no DOE funding. And DOE-funded R&D has also led to more than 300 patents and more than 30 commercially available technologies.

Major original equipment manufacturers (OEMs) have stated that they are on track to begin commercializing fuel cell electric vehicles in the 2015 timeframe and several states are developing stationary applications and hydrogen infrastructure. For example, combined industry statements indicate that approximately 53,000 fuel cell electric vehicles (FCEVs) are planned for California by 2017 in order to help meet the State's zero emissions vehicle mandate, and nearly 70 hydrogen fueling stations are estimated to be needed by 2017 to service these vehicles. Global shipments of fuel cell systems more than doubled from 2008 to 2011, with more than 20,000 units shipped in 2011. This industry's progress in the U.S. could continue to help build the nation's manufacturing base, support economic growth, and keep the U.S. competitive internationally.

Conclusion

With efforts like DOE's vehicles and alternative fuels programs, the Department believes the United States can position itself as a leader in the global clean energy sector. Working with industry and state and local partners from across the country, DOE's transportation portfolio will benefit consumers, improve national security through reducing our dependence on oil, and keep America on the cutting edge of clean transportation energy technologies. Thank you again for the opportunity to discuss these issues, and I welcome any questions.