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Mr. Chairman and Members of the Committee, thank you for the opportunity to testify today on behalf of General Motors. I am Denise Gray, director of Hybrid Energy Storage Systems. I direct Development of Hybrid Energy Storage Systems for GM with a focus on developing and qualifying new battery technology solutions. It's a daunting task for our team (and all of us as an industry) to develop and produce vehicles with these advanced battery systems in a robust and timely manner.

For 100 years, the global auto industry has run almost exclusively on oil. Tomorrow's industry will not. The solution: alternative sources of energy, along with new technology to allow automobiles to run on tomorrow's fuels. But what fuels? And what technology?

At GM, we believe that no one solution is right for every part of the world, or even every consumer in any given market. So our approach is simple: offer as many choices as possible, to as many consumers as possible, everywhere we do business. And regardless of the fuel, regardless of the technology, our goal remains the same – the best possible fuel economy for whatever type of vehicle our customers choose. That's why we offer more cars that get 30 mpg highway than any other automaker.

Our vision moving forward is to reduce petroleum dependency and greenhouse gas emissions by displacing oil with biofuels and electricity, as well as enhancing vehicle efficiencies. Over time, the goal is to reduce vehicle emissions to zero and make personal mobility truly sustainable, but it will take a variety of powertrain and fuel technologies to get there. And we have developed a comprehensive advanced propulsion strategy to meet these challenges.

First, we're continuing to make incremental improvements in the conventional vehicles that we produce (e.g., 6 speed transmissions, active fuel management). Currently, we have over 2 and one-half million flex fuel vehicles "FFVs" on the road today with 16 FFV offerings in the 2007 model year. We're continuing to expand the portfolio of FFVs, ramping up to over two million vehicles a year by 2012 – provided the fuel infrastructure and supplies are available.

Second, we're continuing to expand the portfolio of hybrid vehicles that we offer. For 2007, GM hybrids include: the Saturn VUE Green Line, and Saturn Aura Green Line and beginning next month, the Chevy Malibu, the Chevrolet Tahoe and GMC Yukon will offer hybrid models using our advanced 2-mode system. For 2008, the 2-mode hybrid system will be added to the Chevrolet Silverado and GMC Sierra pickup trucks and to the Cadillac Escalade. The Saturn Vue Green Line will also get the advanced 2-mode hybrid system.

And 3rd, beginning with the Los Angeles and Detroit auto shows, we created quite a stir with the announcement that we have started a plug-in program for the Saturn VUE Green Line 2-mode Hybrid, followed by the introduction of the Chevrolet Volt concept car.

We're also continuing to develop the fuel cell capabilities needed to produce hydrogen powered fuel cell vehicles and the infrastructure needed to support such vehicles. Later this month, we will roll out the first of a fleet of 100 Chevy Equinoxes for Project Driveway, the largest market test of fuel cell vehicles to date.

The E-Flex Architecture

The Volt is our first demonstration of an innovative new GM propulsion system called "E-Flex." The "E" stands for "electric," because all E-Flex vehicles will run on electricity. And E-Flex is "flexible" because the electricity can come from many different sources. The Volt is designed as a flex fuel vehicle capable of running on gasoline or E85 ethanol. In Shanghai, we showed the fuel cell variant of E-Flex in a fuel cell Volt. And most recently, in Frankfurt, we showed the bio-diesel variant of E-Flex in the new "Flextreme" concept car. By offering a system that drives vehicles with any of these fuels, E-Flex will provide our customers around the globe with a single elegant solution to tomorrow's energy future.

E-Flex consists of a common drivetrain that uses electricity created and stored on board the vehicle in a variety of ways. This includes creating electricity with a simple engine and generator, creating electricity from a hydrogen fuel cell, and storing electricity in an advanced battery by plugging the car into the electric utility grid. E-Flex enables energy diversity because electricity and hydrogen can be generated from a wide range of energy sources.

GM's E-Flex system is simpler than a hybrid because it is purely electrically driven. Electricity is stored in a battery pack and used with electric motors to drive the car, with the electricity for the battery obtained in two ways. First, you can plug the car into a common electrical outlet to recharge the battery. This allows the vehicle to operate as a battery-electric vehicle. Second, once the battery charge from the electric utility grid is depleted, the battery can also be recharged by a simple engine/generator set. This allows you to extend your vehicle's electric driving range to several hundred miles.

Battery Technology

There are really two types of batteries that we require. The one most people are familiar with is called "charge depletion." Think of this as a flashlight battery that depletes it energy with use, and then is either disposed of or recharged. It is the rechargeable version of this battery that we are interested in for plug-in hybrids. This is a new area of focus for USABC.

In addition to charge depletion, there is another type of battery known as "charge sustaining." These batteries are designed to accept and delivery power while maintaining a constant state of charge – they never deplete. These charge sustaining batteries are in use in hybrid vehicles on the road today, such as our Chevy Malibu and Saturn Aura hybrids. They store up the high power energy captured during braking and reapply that energy to help the vehicle accelerate. Although charge sustaining batteries have not yet met their cost and durability targets as defined by USABC, they have progressed to the point where many OEMs are able to offer a limited number of hybrid vehicles. We owe much of this success to the work of DoE and USABC with the supplier community.

For the future, what we really need are high energy "charge depletion" batteries necessary for plug-ins that also have the "power" of charge sustaining batteries to handle the re-generative braking and other high power situations of conventional hybrid vehicles.

To bring these new energy hybrid batteries to market GM is using a multi-phase process which starts at qualifying Lithium Ion cells, proving out key performance cycle life, power, calendar life, and then developing and testing battery packs to evaluate system performance attributes. Finally we work through important integration issues at the vehicle level such as thermal, interaction with hybrid controls, and durability.

All this work is necessary as a precursor to declaring a solution "implementation ready" and planning it into a production program. While this is a sequential process with some overlap it can take up to five years. Currently, our challenge is to parallel path key work streams to develop the battery solutions and vehicle in a faster timeframe.

In a traditional hybrid, the battery provides electric vehicle operation at low speeds, recharges only while driving, and is designed for very limited electric only drive. A plug in version of a traditional hybrid, such as our design for the Saturn VUE 2-mode hybrid would need to provide over 10 miles all electric drive, charges while driving and when plugged in. In our design for the Volt Range Extended Electric Vehicle, the battery would provide at least 40 miles in city driving. It would be charged through and onboard generator, regenerative braking and when plugged in. Each of these carries a very challenging goal of being "life of vehicle" solutions.

For example, the discharge power for 2-mode plug in hybrid is marginally higher than for a traditional hybrid. However, the Volt would require roughly three times more than traditional hybrids. In terms of energy, the difference is even more drastic. Range Extended Electric Vehicles like the Volt require significantly more energy than traditional hybrids.

Currently, NiMH batteries typically provide about 70 whrs/kg. Lithium-ion batteries represent a significant improvement over NiMH in terms of both power and energy. Energy formulations of Lith-Ion can provide higher specific energy, but lower power. Range Extended EVs, like the Volt, would need a more optimized balance of power and energy. Big challenges also remain in terms of thermal management & life.

GM has awarded advanced battery development contracts to two suppliers to design and test lithium-ion batteries for use in the VUE plug-in hybrid: the first to Johnson Controls and Saft Advanced Power Solutions, and a second to Cobasys and A123Systems. Both teams are being challenged to prove the durability, reliability and potential cost at mass volumes of their technology. The two test batteries will be evaluated in the prototype VUE plug-in hybrid beginning later this year.

In developing advanced batteries, OEMs and component suppliers have many similar objectives and needs. Auto OEMs need to determine which technologies and pack solutions are most promising. We need to develop strategies that maximize bill of materials reuse and move toward more plug and play solutions. As technology evolves, suppliers are looking for revenue stream quickly, reducing the amount of OEM specific work and not have to burden the entire risk of introducing new battery technology in the market. Both OEMs and suppliers should focus on the things they are good at and leverage others for things they are not.

Qualification of design solutions is the first big hurdle to enable both charge sustaining and charge depleting hybrids with Lithium Ion batteries. Once these solutions have met "design readiness" we need to quickly and in parallel, move toward high reliability and high volume battery "manufacturing readiness" as a parallel path that needs significant focus and funding support. Many of the leading battery suppliers have shared that it takes up to two years to ramp up high volume production once the high volume manufacturing process and equipment have been developed.

As an automotive industry, we are reliant on these rapid advancements in order to consider scaling to high volume the vehicle solutions that will use these batteries.

Legislation

As we assess pending legislation, we believe that as a general matter Congress should support initiatives that will accelerate the process and industrialization needed to ramp to high volume Lithium Ion battery manufacturing and subsequent access to these developed products that will help us together bring to life the sustainable mobility vision for our industry and for our nation. The additional funding for energy battery development that Congress has provided DOE and USABC is a good start. It will help our suppliers develop near term battery chemistries required if we are going to be commercially successful in the next few years. However, as an industry, we also recommend last November in response to a White House request that Congress provide funding

support for manufacturing and facilities development for potential US suppliers. This will be essential if these new battery chemistries are to be manufactured in the US at a cost and reliability level that will enable more than just niche market success sooner than would others be possible.

We also recommended that more funding be provide for long-term research into new, novel approaches to batteries. The potential of lithium-ion appears to be limited to plug-ins and other short all-battery operation mode vehicles. We will need all new batteries approaches if we want to extend the range of vehicles to the point where an internal combustion engine or fuel cell generator would not be required.

With these points in mind, we have the following comments on the Discussion Draft you provided us for review. First, we support the overall authorization levels for both basis and applied research into energy storage. If fully funded at these levels, the proposed research program could materially speed up the development of advanced batteries. Second, the direction to conduct demonstrations of advanced energy storage systems could make a valuable addition to the development of plug in vehicles, although funding is not specified in the bill.

One issue that is not clear from the draft is the relationship between this research program and ongoing DOE battery research programs, and the roles of USCAR and USABC in the new program. In general, we believe new legislation should build on the existing DOE structure and not seek to create a parallel research program.

Another issue is the scale of any demonstration programs. We believe that in the 2009-2014 timeframe, demonstration programs should be of limited size. As with fuel cells, we learn most of what we need to know with relatively few vehicles involved – placing thousands of vehicles in a demonstration program yields limited marginal returns. Within this time window, we look beyond demonstration programs to early purchase programs where federal procurement of early vehicles – realizing that they will be more expensive than today's vehicle technology.

We suggest that the Committee consider transitioning from demonstration programs to buy-down programs to reduce the cost of cutting edge technologies to federal and state agencies. Sections 782 and 783 of the Energy Policy Act of 2005, dealing with early federal and state purchases of fuel cells, may offer a model for plug-in vehicles.

Thank you.