

Welcome to Southern CA Edison's Electric vehicle technical center. This, this facility has been around for about twenty years and it's unique in the utility industry there's no other facility like this in the United States today that is run and managed by utilities. We're doing basically industry leading work on evaluating emerging propulsion systems, electric propulsion systems for our cars and the energy storage technologies, the advanced batteries that are going to be so critical in the future as transportation and electricity industries converge.

It's an exciting time for us. It really is. What we're standing in here is our battery lab. So we're doing a lot of work now on understanding lithium batteries. As you know there's lots of different lithium chemistry. So we're fortunate enough to have cells or modules from the leading battery suppliers, automotive battery suppliers, that we are aware of today internationally. We're doing this in partnership, it's all about collaboration. We partner with the Federal government, Department of Energy, State government, the CA Energy Commission, the South Coast Air Quality Management Districts, the Public Utilities Commission, other utilities, like through Electric Power Research Institute, "EPRI". So we couldn't afford to do this all on our own. It's about building these collaborations where we are investing a little bit of our rate payer money but we're getting a lot of value that can be returned to our rate payers. So we've got environmental changes here running 24/7, 365 days a year, in fact our longest test that we've been doing on lithium batteries now is over three years. Going through, everyday basically cycling full charge, then discharge, charge, discharge, and we can do the equivalents with a plug-in hybrid battery, we can do equivalents of about 300 miles a day. Charging and discharging in the lab here bench testing. So we've got one test that's been going about three and a half years. We've done about thirty five hundred cycles. So that's the equivalent of about one hundred fifty thousand vehicle miles and that's a plug-in hybrid duty cycle, for a van and we're seeing really good performance. So we think that the battery technology is maturing rapidly, and there's still some questions outstanding, you know there's issues around calendar life, but we think that for the most part, these batteries are going to definitely meet the needs to drive the wheels.

So it's quite exciting, the work that we're doing here, we're actually expanding this area, as I said we got eight chambers running today with eight different batteries. We're going to put in probably four or five more in this area and keep this test running.

These batteries are confidential?: Yeah, yeah, can't really talk much about the batteries, but you would certainly know the companies. You - certainly would know the companies. You'd recognize the batteries so we're not going to do too much walking around here because knowing you, you'll go "I know that one". All of the battery testing that we're doing are here from these control panels.

As you know we have the largest fleet of electric vehicles in the United States. We have about 300 Ev's. We do about one hundred thousand Ev miles a month, and we've done a little over sixteen and a half million Ev miles since we started the fleet. That is the most amount of data of any electric vehicle probably pretty much any where in the world.

So we know an awful lot about how electric vehicles will connect to the grid and how we'll control them and how they perform and operate. I'm fortunate enough to have the best job in the world so I get to drive an electric car, in fact I've driven an electric car now for pretty close to thirteen, fourteen years and I do 180 miles a day, I have a charger at home, I have a charger at the office and I drive all over Los Angeles. I have never run out of juice ever, in those thirteen, fourteen years. So the technology absolutely works in specific applications as in urban car commuting around the cities it is absolutely ideal. Now Andy's been working on a lot of technology that is past the battery electric car, the plug-in hybrid and the beauty of the plug-in hybrid is you don't have a range issue. You've got kind of a by-fueling capability, so I

can go to a gas station, I can go to the grid, you know, five days a week in an urban setting, in an electric car. If I need to go to Vegas, or San Diego, or San Francisco on Saturday or Sunday not a problem, those first forty miles on an electric car, the other 260 miles on a gasoline hybrid that gets good gas mileage. So the plug-in hybrid architecture is kind of the mass market of volume architecture, the battery electric is more of a niche, more of an urban type setting. So what we are really seeing, the vehicles that we have in our fleet, they're basically from the 1990's. So it's old technology with all due respect, because it's absolutely fantastic technology. But what we're starting to see now with prototypes, battery electric Ev prototypes from companies like Mitsubishi, who are coming out with the IMiV next year they'll be producing it in Japan and they're working with Edison to access the market in the U.S. I've driven that prototype now twice, fantastic car, absolutely fantastic. Nissan are coming out with battery electric Ev's and then we have obviously the Chevy Volt from General Motors which is an extended range electric vehicle. What we'll be showing you here in our Ev technical center is we have several prototypes from Ford Motor Company, the plug-in hybrid Escape, so what we are starting to see is, these prototypes which are really good. I mean this not early generation technology; one of the little realized facts is that the battery electric car was never killed. You know we just didn't see it on the road, but the point is that the auto industry continued to develop all of the components in electric drive so the motors, controllers, inverters, some of the leading electric vehicle manufacturers major auto makers are on their sixth, seventh, eighth, generation of power electronics. You know the Toyota Prius, fantastic product, now coming out with the next generation and we believe it will have a plug eventually too. You know the fundamental power electrics in that car are fantastic. So what you're starting to see with these prototypes that we're fortunate to get at this technical center is the quality of the prototypes is fantastic and this is pre-production. So really this technology is maturing very, very rapidly, it's amazing what \$140.00 a barrel oil will do to the market place. Because literally thirty six months ago very few people were talking about plug-in vehicles, there was lots of talk about hybrids, but very few people were talking about plug-in vehicles and now today everybody is talking about them.

What we're doing is we partner with the auto industry, ok so it's all about collaborations and partnerships, we can't do it on our own, we don't make electric cars, we don't ever want to make electric cars. I think the auto industry is complex enough as it is with out utilities trying to build a car. But what we do, do is we work with the auto industry to build collaborations with federal and state government and we work with other utilities to evaluate and demonstrate these emerging technologies and what's really key is to understand the impacts of transportation on the energy system. Because ultimately we have a lot of excess capacity, you know all of the alternative fuels that are popular today in the United States, ethanol, methanol, biodiesel, natural gas, hydrogen, electricity. There's only one that has an ubiquitous infrastructure with a lot of excess capacity and that's electricity and the electric grid. So now the notion is that the grid is an energy security asset and we've got to get our heads around that as a nation. I mean if this is about energy security, if this is about getting off foreign oil and if this is about addressing climate change and emissions, the electricity is there, electricity is ready and electricity will make the difference for this nation. So utilities have to work with the auto industry, you know the irony of all of this, is that, as the auto industry puts plugs on the vehicles their customer and the utilities customer are one in the same. So these two titan industries have to come-together, have to collaborate because the autos can't do it on their own. You know the reality is not one single auto maker today has a sustainable business case for a plug-in vehicle. But technology is disruptive and it's inherently expensive. So it's going to take collaboration, it's going to take understanding where the value strings are, same customer, the customer is the nexus, customer is the one that's going to win here. But it's up to the utility industry and the auto industry to collaborate to return value to that customer and frankly we need federal and state support, major federal and state support. If we are going to make a difference here, we are going to get one shot, we've got a perfect storm. Alright, this nation is struggling with energy security, it's struggling with climate change, and it's struggling with the ever present crisis around tail pipe emissions from transportation. So if we're going to

make a difference here, what we've got to do is, we've got to get all the stake holders together, pulling together with a unified vision in a unified direction. That's what this facility is all about bringing those collaborations together, bringing the industries together, generating data, everybody has a theory about how all this is going to work. Everyday somebody comes out with a paper or a study, the problem is there are no data. So what this is about is generate data, use the data to help encourage good public policy and with good public policy and everybody contributing then this technology can emerge in a sustainable way. Because one of the things that we're dealing with that I think is really what we should all be concerned about is, there's a paradox. The paradox is on the one side is that the auto industry is being driven to bring this technology to market. Ok regulation, public policy, political emphasis, media emphasis, customer emphasis, I don't want to buy SUV's and trucks no more. I don't want to go to a gas pump every week and be constantly reminded about the wealth transfer from the United States to the Middle East or to countries that don't particularly care for us. So the customer is demanding alternatives and what's the auto industry doing, they're doing what they've done for the last one hundred twenty years, they're responding to the market place. So they're coming out with this technology, the paradox is, it's expensive and they will lose money on every single car that they sell and they can't make it up in volume. So what will happen is they are going to limit their risk as much as they possibly can so we see low volume. So the question is how do we bridge from low volume to mass market high volume and today that path is not clear. So it is going to take collaborations, it's going to take the data, it's going to take understanding the value strings and then working together to bridge from that low volume launch which is inevitable. But to bridge from that to mass market which is not necessarily inevitable today, that's the paradox.

So the vehicles that we have in our fleet are predominately a Toyota Rav4 Ev now this was a car that was designed and built back in the late 1990's. It has nickel metal high drive battery technology for it's time it was state of art. For it's time it is by far the best electric car that was built. It's certainly the only one that's still on the road for all intensive purposes in volume. So that's the good news. The bad news is Toyota's not making that car today. Ok not a problem because what we have is we have other auto makers now coming to market with their versions of the 21<sup>st</sup> century battery electric car. Its lithium battery chemistry, so what we're talking about is a battery that is double the performance of nickel metal, also double the cost and half the weight. So we've got performance and we've got weight which is good so we're giving the auto maker is getting more flexibility from a packaging perspective. But it comes back to that point about the cost of the technology I mean lithium battery technology is expensive today. So what we're working on in these collaborations is how do we get from \$1000.00 a kilowatt hour with no volume to \$500.00 a kilowatt hour with volume? So that's the goal how do cut 50% of the cost out of the batteries and get to a sustainable commercial business case for the auto industry.

The good news about electricity not only is the infrastructure ubiquitous, not only do we have a lot of excess capacity, but electricity as a fuel is about 25-50% a cost of a gallon of gasoline equivalent. So what you're talking about is fuel savings. Now when you talk about a battery electric car or a plug-in, particularly a plug-in hybrid the fuel savings is not necessarily the reason why people will buy the cars. At the end of the day they'll go to a gas station fewer times, they will fuel up at home with their domestic fuel a 100% domestic fuel. They won't be shipping so much money overseas and a plug-in hybrid is a pathway to ultimate energy sustainability or energy independence and that's the goal. So it's more than just the cost or the cost savings it's about doing the right thing it's about patriotism in this country. It's about doing the right thing so we are not doing this massive wealth transfer and what we're starting to do is invest in this country as investing in overseas nations.

A battery electric car from the battery to the wheels is about 85% efficient. An internal combustion engine from a gas tank to wheels is about 15% efficient. So life's a math problem and there it is. Alright so that's why the auto industry is putting more and more electrification

onboard of the vehicle is because it helps them to get to energy efficiency. A plug-in hybrid because it has both an internal combustion engine and an electric motor, isn't as efficient as the battery electric car. I mean a battery electric car is the best, but it's certainly on the path and again it goes back to a plug-in hybrid is a mass market car, the battery electric car is a niche market car.

It's not so much "I can't afford it", because at the end of the day, the MSRP, the manufacturers suggested retail price of this technology will be what the auto industry thinks the market can bear. It will not necessarily reflect the true cost of development of the technology. In fact it absolutely won't reflect that so it's a lost leader. So you can only do that for a certain period of time. So what this is about is how do we get to sustainable business cases with the auto industry and a function of that is volume with the batteries, maturing of the batteries. I mean we need domestic manufacturing and supplier capacity in the U.S. for batteries. I mean one of the concerns we have is this is all about energy security are we swapping the reliance on imported petroleum for the reliance on advanced imported batteries? I don't think we want to be in that area, you know that, that, that situation. So what we've got to do is we've got to encourage domestic supplier and manufacturing capacity that requires government intervention. We need the incentives to do that we need to help to create those favorable business environments for the manufacturers. We need five nines production quality, automotive grade production quality of batteries. These are not cell phone batteries, they're not laptop batteries. These are very, very sophisticated technology that has to be manufactured to the highest of standards because they've got to operate in the harshest of environments underneath the car. So the issue is how do we get from where we are today at around \$1000.00 a kilowatt an hour to that \$500.00 a kilowatt an hour? Ironically we're not talking about hundreds of thousands of cars, in some instances depending on the battery company it may only be tens of thousands or less to get to a more reasonable dollar per kilowatt hour. One of the areas that we think the utility industry can help is that these batteries that are being developed for the auto industry are being developed for the harshest of environment. They have to last ten years or one hundred fifty thousand miles. Well what about taking that same battery and reconfiguring it and putting it in a box and bolting it on the side of a house as a home energy storage devise? So perhaps the utility industry can come in and say look we understand energy, we understand the energy system, perhaps we will go to the same manufacturer that the auto industry goes to and we will order batteries for other applications, stationary applications. So that those batteries are integrated into the energy system, they're in essence distributed energy resources, mini power plants. So we are in batteries in those kinds of applications or even third party type aggregation, perhaps a GE capital might be interested in getting into that business. Perhaps you could have community aggregation where local communities band together and say we want to own a battery that we can all benefit from filling the battery from that excess capacity at night and then drawing down from the battery during the day when energy prices get very high. So we avoid the high cost of energy. That's good for customers and it is good for the energy provider because we are balancing the system. We're improving the efficiency of the system, it's all about energy efficiency. So this ability to move energy backwards and forwards, there's a fundamental game changer for the utility industry. Energy storage is a fundamental game changer for the energy industry, for the utility industry. So that's what we're working on it, so if we can find other applications for these batteries then the combined volumes of the utility industry and the auto industry then the battery company can start to forward price at a much lower rate.

We were all heavily involved back in the 1990's, some of us more than others, there's no question that Edison has always had a very, very consistent vision of how transportation will connect to the grid and why it makes sense for transportation to connect the grid. Back in the 1990's we actually set up a separate company called Edison Ev as you remember and we built the infrastructure for electric vehicles in California and Arizona. Other utilities had similar kind of businesses around the country but when the ZEV mandate changed the business kind of changed, the auto industry kind of abandoned the electric car and went to the hydrogen and

fuel cell vehicle, other utilities basically said we're done. Edison said you know what, this is a marathon not a race. We believe strongly enough in this technology that this facility was basically set up because of the emergence of transportation connecting to the grid. We just kept the programs going, it may not have been the battery electric car, it was cord electrification and truck stop electrification and electric truck refrigeration. You know to be fair, the other utilities are engaged through organizations like EPRI there are about thirty seven utilities now participating in EPRI transportation programs. So it's not all about Southern California Edison although as I say nobody has a facility like this.

**You're still the leader:** There's no question, and that is it is a part of the DNA of Edison. I mean we feel so strongly about it and we have such strong management support for this that and interestingly enough it has even transcended the change of management at Edison from our previous chairman John Bryson, who is a huge supporter of this to our new chairman, Ted Craver, who is equally supporting electric transportation. So that really speaks to this is part of the DNA, its part of the culture of the company.

**That's excellent, without that of course you can't move forward:** No, and again it's not about fair weather friends. It's about a long term partnership, it is a journey, it is a marathon not a race and that's why we have continued to build and establish our credibility and our spirit of partnership with the auto industry. It's going to take these two industries to really make this a success.

**I think most important thing that I see here is that you had the insight to continue while the rest of the industry fell back when CA backed off on its ZEV mandate:** Yeah from our perspective it really it was the ZEV mandate only a small piece. You know that was not the reason why we did this and why we maintained it fortunately. Otherwise this would have gone. So it was so much more about look, it those days it was about emissions, ever increasing regulation addressing tail pipe emissions would drive transportation to connect. Now we've got two other legs to the stool, it's about climate change, and it's absolutely about energy security.

It's frightening, what's going on at the moment is just terrifying. Interestingly enough these vehicles you know vehicles that connect to the grid, is a bipartisan issue. You know both the presidential candidates have talked and in very articulate manner about their support and their belief that this country has to address this crisis that we have in terms of the reliance on imported oil and electrification is absolutely going to be key to it.

What we've got here is the gas station of the future, alright an electrical plug. Now it may not look like this, let's not get caught up in that, but the point is, that the infrastructure is ubiquitous and what we've got here is really the child if you like, of Dr Andy Frank and all his efforts on plug-in hybrids. This is an auto maker designed and built plug-in hybrid prototype it's built on the Ford Escape platform, the gasoline hybrid platform. This is a heck of a car from Ford Motor Company. This will get around 120 miles in urban driving, 120 miles per gallon in urban driving. Then 40-50 miles per gallon on the highway, but it's a fantastic product. It absolutely drives just like a regular car and we come home at night and we connect it and we walk away. That's it, it fuels at night off peak using that excess capacity from the grid and we have full tank of gas in the morning and we go out on the road and we drive it. So these are really the first examples of an auto maker designed plug-in hybrid not a conversion from after market supplier and after this car we will have prototypes battery electric prototypes from Mitsubishi, in fact we should have prototypes towards the end of the year on their IMiV battery Ev and we'll have other prototypes yet to be announced that will come into this tech center that we will be evaluating with the auto industry and other industry partners.

Thank you...