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Green Racing Transcript

Shabnam Fardanesh: Picture is worth a thousand words, so we will turn it over to Forrest, and he can show you the car and walk you through the whole thing—the whole project. Forrest?

Forrest Jehlik: Thank you very much, Shabnam. Let me see here. I've got to click something here. I'm looking for it. Just give me a quick second here folks, let me get this sorted out. Screen, hang on. It's not waiting for it to show up on my—hang on. I have to show my screen, and I'm not seeing my presentation.

Shabnam Fardanesh: We have it as back up. Why don't we put it up for you?

Forrest Jehlik: Okay. I've got to show my screen. It's not bringing it up.

Shabnam Fardanesh: Sorry, folks. We are having a little bit of technical issues. We will be up and running in a second.

Forrest Jehlik: Hang tight, and I promise I will make it entertaining. I'll try my best.

Shabnam Fardanesh: Can you see the screen? Forrest, we'll bring it up and you just tell us when to…

Forrest Jehlik: Change? Sure. No problem. Yeah, no problem. That's fine. Just whenever I need it to click, just let you guys know. That's fine. Okay. Yea, I can see it now. Can everybody see it?

Shabnam Fardanesh: They can't—they are in listen only mode.

Forrest Jehlik: Sorry, folks. Okay, so I can see it now and hopefully you can. So real quick, I am going to talk about the program I got involved here a little over a year and a half ago. Actually, it has been over two years now, in Argonne National Labs. It is just one of my duties. My name is Forrest Jehlik; I am a research engineer at Argonne National Labs. Prior to Argonne, I worked in General Motors R&D, developing advanced engines—actually diesel engines. And then prior to that, I did my graduate work in Wisconsin doing engine research and my undergrad in Southern California, at Riverside, doing environmental chemical engineering. So, kind of a long background in automotive stuff, I have always had an interest in that since I was a kid. I watched my dad and his friend race small airplanes; I guess the fascination stuck, and that is where I came from. So I am going to talk to you today about a program we are involved in green racing at Argonne, over the last year. You might, the first question that might come to a lot of people's mind is, why would we be involved in racing at all? It might seem like a very natural question, but I hope I can convince you by the time that this is done that it is probably one of the more important things that we can do to actually really start a market and a revolution for competitive renewable fuels in a place that we normally wouldn't think, but could have a significant impact.

With that, titled the Grassroots Renewable Fuels Revolution, the car you will see I will talk about and the group of folks that are involved. It's a farmed group of people and then I really like a lively question and answer response at the end. Hopefully, this is entertaining enough where we don't all fall asleep and we will ask you questions at the end. So with that, we will go to the next slide.

Okay, so overall we are going to talk about the objectives right now. So next slide, please.

Okay, project objectives. So, within the green racing program we are working with the American Le Mans series to help push advanced technologies in racing so that that can hopefully transfer over into the general buying cars sector. The reason being is that racing has really tight development lines and actually in a lot of ways, every year, cars have to be developed for their series and then they have to go out so it is a pretty fast paced application to be able to push renewable technologies. The green racing program started with American Le Mans series leading to the green racing program in which we promote renewable fuels and advanced technologies and then branch out into the circle track project that I'm talking about. Circle track racing is racing anything from NASCAR to local dirt track cars, so cars that just go in circle left hand turns. I think most of us know what NASCAR is or many of us might even know local circle tracks or dirt tracks where cars race around the country. I will show you how big that is at the end it is very important.

What we wanted to do was demonstrate using renewable fuels and modern technology. Obviously, significant controlling displacement potential, a reduction in well-to-wheel greenhouse gas emissions, as well as being able to reduce criteria emissions while at the same time, increasing performance and greatly reducing operational costs. And the reason we think that would be important is that we believe that the circle track audience in the United States can really generate a significant outreach, not only to the racers themselves but also to the general public as well. Supply—and with the last two goals that I stated in the demonstration portion: increasing performance and greatly reduced operational cost. Racers, if they see that they can increase performance and they can decrease costs then they sure as heck going to go for whatever you are trying to sell them, that's just the nature of the business. If that happens, that will supply a market for sustainable renewable fuels. If it did happen would reduce apprehension for adopting use of the technologies in general cars that people buy. And as well kind of basically increase support for renewable fuels and at the end I think this will become more clear. So just keep that in mind as we go through. Next slide, please.

Okay, so the first part of the project what we needed to do, we needed to demonstrate, in a testing environment, whether or not renewable fuels gave an advantage to using the typical race fuel that racers use today. Race fuel today in race cars are typically either 100 to 110 octane race fuel. Costs anywhere from 10 to 11 and a half dollars per gallon at the race track. That doesn't have ethanol content, so most—some of it is even leaded today, but most of that has been removed. They use other things, very expensive. So we had to show, okay, we use race fuel in an engine application was it superior or inferior to renewable E85. So our team went down to a testing facility in Texas, called Mass Motor Sports, they are an aftermarket engine developer and they have their own dynanometer and test facility. We didn't do it here at Argonne because we actually don't have dynamometer powerful enough to absorb the energy that these engines put out. These engines put out anywhere from 500 to 750 horsepower, they make quite a bit. We just didn't have anything that would work. Next slide, please.

Okay, so we took the engine there is kind of a lot of acronyms—I'll walk you through it. It's an LS3, 6.2 liter, General Motors CT525—that's a mouth full. What that is is the 6.2 liter engine is basically the same aluminum fuel injected alloy engine that you can buy today in the Corvettes or the Camaro, the high performance cars. And the only thing the CT525 is it is just a variation of that engine in which General Motors puts in a different cam shaft for a little bit higher performance, they put in a different oil pan such that the oil flows in the engine will survive on circle track applications because they only turn left, oil tends to pool up on the outside of the engine and they need to make sure that it's durable for that. So they make some adjustments. But that is pretty much just about it. The 525 acronym means that it's dynomometered—it is tested on a dynamometer to

put out about 525 horsepower using a carburetor and yes, race cars today in many, many applications, especially in circle track rings, they are still using carbureted technology. This is basic, well this is 1920's technology, but that's still what they use. So our goal was to show and demonstrate that compare fuel injection versus carburetion, E85 versus 100-octane race fuel, which our E85 was 100 octane, so there was no benefit or detriment there. And actually using catalytic converters versus non catalytic converters and then benchmarking both the power, the emissions, and the benefits or detriments to using fuel. We recorded emissions using a Sensors, Incorporated Tech Unit that is an onboard emissions testing device that we also put in the car later that I will talk about and tested the vehicle on track as well. Below right there you just see some pictures at mass motor sports with the actual engine that we use.

Bare in mind, the engine that we used here was donated from General Motors. The engine that we tested on a dynamometer over a series of four days really flogging it pretty hard was the same engine we then put in the car and tested it at the track flogging it for another four days, was also the same engine we then went and raced to demonstrate the performance benefits later. I will talk a bit about durability later. So next question… Or, next slide please.

So what you see here is a—some testing results that have been boiled down to the Mass Motor Sports testing series that we did. You will see that the green lines are the electronic fuel injected E85 powered engine configuration with catalysts. You will see acronyms CPI that means cells per inch. One hundred cells per inch just means how much catalytic surface area exists in the catalyst. Catalysts are the same things we have in our normal every day cars now to clean up emissions and so forth, but we wanted to demonstrate not only could we make more power, but we could also be more environmentally friendly at the same time with regards to criteria emissions. What you see on the slide here as you have 100 octane fuel, carbureted, no catalyst with the gray lines versus E85 powered, electronic fuel injected with catalyst. What you see is from basically 2,500 RPM on X-axis all the way up to about 6,000 RPM we make significantly more power and torque than the carbureted race fuel version. Now, if you take a look at the peak hour values you will find that the peak hour value of the carbureted version versus the E85 version is higher. And if you go one more slide it is going to fill in the difference between this amount of information here, so go ahead and click.

There you go. So right there is the difference in torque and between the carbureted and E85 version. The red line for this engine was 6,500 RPM, so you will notice just at the very end of the red line you make a little more power in the carburetor but you make a ton more torque in the whole power band using fuel injection and everything else. The only reason for this being is that the carburetor manifold was tuned differently than the production plastic fuel injection manifold. So if somebody wanted to make more power with a manifold and fuel injection all you would have to do is change the tuning of the manifold and do that as well. This showed a significant increase in power potential for the E85 versus race fuel. Next slide, please.

So the race community is also a very skeptical community and they are going to want to see track data to support what they would see in a dynamometer, so we took the car that you see there in the background, we actually took and made our own data acquisition system, inverted the car, had two fuel systems both race fuel and E85 so that we wouldn't contaminate either of the two systems. Put on board emissions testing equipment and went and tested both performance and emissions during the race. So I am going to show you some results on the next slide here. So we took that same engine and dynamometer, put it in the car, went down to Florida at a track called New Smyrna, a little half mile track—a very common type of track that you would see here in the United States, thousands of these all over the place. And then the same matrix that we actually tested on the

dynamometer we actually tested with the race fuel in the same configurations, ran around the track, and collected the data and got the results. Next slide.

Okay, so there is a little bit of animation here. So what you are going to see here on the left is an RPM versus lower percent graph with a bunch of green dots and gray dots. And what that is, lower percent, think about the power it is basically a throttle position. And these are data points collected in every half second durable. And what it shows you around the track, basically, this is where that engine runs around typical half mile track. And you will see that like most racers they got pretty heavy feet. They are mostly 100% throttle and they occasionally lay off going into the turn, but for the most part their foot is down. Engine running anywhere from 4,000 all the way up to almost red lined about 6,250 RPM. You will notice in the little table that I have there RPM, percent load and drive cycle percent, that's a chart and you can go ahead and click another button. The next slide.

The data points are color coded between the electronic fuel injection and E85 carburetor set up. So what you see all the gray dots – I mean all the green dots or circles, if you will, those are points in which the engine with the fuel injection and the E85 and the catalytic converter so its making more power than that of the carbureted version. If you tally up the percent of the drive cycle that it is, it turns out—next slide, please.

It's 87% of the time. Only at the very end of the straight away did the tuning of the carbureted set up make slightly more power. Next slide.

And I've also color coded that on the next slide… on the dynamometer chart that I showed earlier.

So basically you have a very, very small portion of time at the very end of the straight away where it is making more power. But by that time the vehicle accelerated much quicker out of the turn all the way down straight to the very end and actually increases performance significantly. So next slide, please.

What we found is that the vehicle with that configuration made the E85, fuel injection, catalytic converter made two-tenths of a second faster per lap than the carbureted race fuel set up. Next slide.

In addition, the catalyst emission reduction potential, you will see the acronym EFO, that is electronic fuel injection, E85 the E85 and then the 100 cells per inch and 300 cells per inch and what we have is emission reduction using the catalysts, hydrocarbon is on the order of anywhere from 35 to 60%. Carbon monoxide was very low, not very high anywhere from 15 to nothing up to 30%. And knocks on order of 50%. The reason that we did have higher conversion efficiency is a typical catalytic converter will have well north of 90% emission reduction conversion efficiencies. That these engines in order to make peak power states durable, run very rich. They have a lot of extra fuel going in there. And so what that means is that in order for the catalytic converter to work correctly the chemistry requires more oxygen and these engines just don't suck in enough air to do that they use so much fuel. And so the way to fix that would be a secondary air system which would inject air into the exhaust stream after the combustion chamber straight into the exhaust runners. To do that we actually started working on a system to demonstrate that because we believe that we could probably get the same type of conversion efficiencies well north of 90%, basically reduce the tail pipe emissions out once it's warm to extreme numbers. We actually had a system at the track that we used, but unfortunately the air pump that we had couldn't get enough air flow to do what we wanted to. So we kind of put that on the back burner for further stages in the project. Next slide, please.

So finally, we wanted to take the track and demonstrate what it can do in front of an audience and see what they felt and so forth. So we took the track, next slide.

Or took the car up to the Wisconsin Oktoberfest, last October, just about a year ago up in the frost. Put in our own data acquisition system. We did not do real on board emission at this race because we already knew what that would do, but we wanted to measure fuel flow, hand parameters which are all the electronic parameters controlled by the engine controller. We ran the car exclusively on E85, the fuel injection configuration using catalytic converters. And then we wanted to analyze the data afterwards to figure out what the petroleum displaced green house gas reduction determination was. We had to get very, very accurate fuel flow measurements. We do test here in our lab we have really, really accurate fuel flow meters as well as carbon counting from our emission benches. And so in this car we used a real time, a very small kind of specialized fuel flow meter that does very accurate real time measurement and we wanted to be able to do that so that we can compare what this car would do with the greenhouse gas reduction potential, relative to kind of production based cars, which I'll get to at the end. It is actually pretty stunning. Next slide, please.

So what we did, what you are seeing here is the actual car, the top picture is the car at the track. For the races later in the day, the audience was totally packed; it was really nice. Down below are actual, the red lines are what you see right here—the driver of the car, that is the GPS recording his loops around the track for the race. Each race was 33 laps for a total of three laps for 100-lap total. It was three different reasons, we entered in every one of those. Next slide.

And so, the idea was that when I talked about earlier, you know, the racers might see that the performance is better and it's cheaper than they are likely to adopt it. And if it doesn't they probably won't. So what we wanted to do was kind of demonstrate what this would do at the track. So, go ahead and next slide.

At the race, the cost of and we actually took a picture of this, the race fuel that all the racers had to buy at the track it was 100 octane race fuel, $10.75 a gallon at the race. There were pumps locally there in the area. The cost of E85 was about $2.35 if you stopped to get E85 from a local pump. We actually had cellulosic ethanol that we ran in the car exclusively so we could do some tests on greenhouse gas reduction potential and petroleum displacement stuff. Next slide.

So we consumed just over 16 gallons of E85 at the race. Our fuel cost for the total weekend assuming we just bought E85 locally at the time would have been about $85. Next slide.

The race fuel using slightly less fuel race fuel simply because it has a higher combustion value you had to use just a little bit less, but I integrated that in the calculations. We would have spent $131 on gas. So basically we saved ourselves almost $100 just for we would have saved ourselves $100 just that one race just using E85 over the race fuel. In addition to that—next slide.

The engine that was donated from General Motors actually you can buy that engine. And actually it's a bit cheaper than that now. You can get that engine from General Motors for about $7500 today. Brand new. Crated up and just run it all season. Race engines that weekend that we raced against—go ahead, next slide.

Were on the order of $40,000. And those engines have to be rebuilt every two to three races. The sealed engine we have the LS3 through production development of General Motors you can actually run a whole season as long as you make sure you take care of your oil change intervals and air cleaner. Small things and you can run it the whole season. The other engines are pretty high spun and pretty fragile, you really need to keep up on it. So, next slide.

Had we shown up and raced the way that we did that just that weekend both in fuel savings and engine savings we would have actually saved ourselves almost $32,000, and we were competitive. I think out of the field of over 60 cars we came in at 14. I believe that was the number. So you can imagine what this would mean to that community if they are like holy cow, I can save that much money over my whole season. A lot more people can get into racing. The cost of them come down, integrates after market suppliers that can start working on these more advanced fuel injection engines. And, everybody kind of wins. Not only in addition to that there is a big educational opportunity for what the renewable fuels can do and we are going to get to that actually next. Go ahead, next slide.

So, the revolution part—a grassroots revolution. Again, we just talked about using this fuel versus petroleum based race fuel, but what is the real message and why is this so important. And this is the part of the presentation that I think gets interesting and is really, really important. So, next slide.

This is and I think most of you here that work in the Biomass group or renewable fuels you guys get this but this is something that I kind of liked to use sometimes just to get the average American an idea of what our true consumption of oil really means. So today we consume just over 20 million barrels of oil a day. I know we were at a peak of what about 21 million barrels of oil a day just before the recession came down to 19. I think it is about up to 20 again. And about four of the world's total. So how much is that? So I've always tried to get a feeling for what that really meant to me in some way that I can get a feeling for just how much 20 million barrels of oil a day is. So that's 365 days a year, so I went and measured a barrel of oil down at our shop and I did a calculation and so one day's consumption of oil in the United States, go ahead and click the slide. Next slide. Next slide. Next slide. Next slide.

Okay, one day's consumption of oil if we were to put a barrel on the beach in California and then put one barrel standing up next to it and just stretch them out in a line, one day's consumption would go from California to the East Coast, back to California, turn around and end up somewhere in the corn fields in Nebraska. And that is just one day. I mean that is pretty staggering number. I think we all realize the importance of energy diversity and being able to use renewable fuels and try to get into that market and be able to be competitive with what exists today. So go ahead, next slide. And that is just kind of the take away message of how much that really is. Next.

The upcoming oil gap, many of you I think are familiar with this. There is a lot of analysis that will suggest whether it is through IEA projected growth or through other projected growth that in the future that other world commodities come on and they start using these fuels that we are going to have a gap between either what is available in the ground and what can be processed, which are two different issues, but extremely important. So as we move forward I think we all understand the need for other sustainable resources to be able to power our transportation fuel. And you guys are welcome to look at this slide later for details and where it came from. Next slide, please.

So why is this so important? Well, racing in the United States, I think I get through at the end of this slide, has a significant volume of people that watch it. And why is that so important? So, next slide.

I'm going to show you what the petroleum displacement was with our configuration relative to what they do today. So for 33 laps of racing, about 21 miles, on the axis I am going to show you a few different configurations and then what that really means. The petroleum ethanol consumed per gallon was approximately—using street blades, which is the race fuel that is 100 octane race fuel—was 4.4 gallons. Next slide.

Using the cellulosic or corn ethanol the amount of petroleum that we would have consumed would have only been 8/10 of a gallon the rest of it, the green bar being ethanol. And you will notice we consume more and we all know that simply because the E85 has a lower combustion energy value than that of petroleum. We have to consume a little bit more, but that largely, obviously, offsets what petroleum content is there. Next slide.

So that's racing. Next slide.

Toyota Prius, not running around the race track but these are just numbers I get basically from mixed city/highway cycles through FTP testing. Driving around the city/highway would consume at that distance 21 miles would consume about 4/10 of a gallon. Next.

A Toyota Camry four cylinder car, I'm not picking on Toyota, I just chose those because the Prius is a pretty well known green vehicle. Camry is kind of a nice, mixed four cylinder sedan. So if anybody here is from Toyota, I'm not picking on Toyota, just picked these out of the blue. Next slide.

The 2010 Chevrolet Camaro SS unleaded going about that same distance mixed city/highway would consume about 1.1 gallons. So you will note that racing with a car using cellulosic ethanol going the same distance as these cars kind of driving around mixed city/highway, we would have only consumed about the same amount of petroleum using cellulosic ethanol as about a four cylinder Toyota sedan running mixed city/highway cycle. Gives you an idea of how much consumption would really happen using the E85. Obviously, if we just used petroleum it is much greater than that or four times greater than that. Next slide.

That is kind of a take away message. Next.

Okay, so using Argonne's green model we wanted to understand what the wells to wheels greenhouse gas impact was. And so on the left hand side you will see a wells to wheels CO_2 gram per mile value and on the X-axis you will see these different configurations comparing each other and what type of environmental impact they have. And so if you're not familiar with how many grams per CO_2 a typical car or how many grams per mile a CO_2 typical car would drive on these cycles, once I throw these up it would still be a relevant comparison and make a little more sense. Next slide.

So street blades, that's the race fuel. That's about how much the race car would have consumed racing around the track about 2200 grams per mile CO_2, just going full out, bore out, around the track. Next slide.

Using corn ethanol, using the Greek model the reduction would have been approximately 25% relative to that of street blades just over 20—I'm sorry just over 20%. Next slide.

Using cellulosic ethanol the fuel that we actually used, that was our green house gas wells to wheels impact that we have racing the car around the track on gram per mile basis. And then had we used neat ethanol, so let's say near neat on cellulosic ethanol that is what it would have been about a fourth of that. Although we ran the E85 and simply that reduction between those two is that much simply because you don't have anymore petroleum in the fuel. Next.

Toyota Prius, just to give you an idea, you can go ahead and click two more times.

You can get an idea with the Toyota Prius, taking its mixed city/highway numbers it is approximately 220 grams per mile. Again, the Toyota Camry same car I used earlier; little four

cylinder sedan gets about 440 grams per mile and Chevrolet Camaro SS gets 580 grams per mile. The take away part from this which we think is amazing just truly tremendous statement. Click one more time. That using cellulosic ethanol in a race car something that is supposed to be so environmentally friendly, you would actually have the same carbon footprint approximately racing that you would in a small four cylinder sedan running around mixed city/highway. And, additionally, if fuel were to be near neat ethanol, near 100% ethanol, the car would have half the greenhouse gas on a well's wheel basis that a Toyota Prius would today. As a matter of fact, that number, 107 grams per mile, I did some calculations; that's a car that has a greenhouse gas impact approximately of a car that gets 115 miles per gallon on a Co2 basis. And that's just an absolutely tremendous message. And that's not only were they making more power at a fraction of the cost of what they do now, but using these fuels and these technologies, the racing community could almost remove itself from the environmental debate and actually become a leader in that movement. It is just a tremendous take away statement. And that is something I would like to talk about later that is such an important thing. So next step.

Now this is where the revolution comes in; people don't realize it or maybe they do and maybe they don't. I didn't realize it until we really started working on projects. There is over 20 million people that have attended grassroots track races annually in the United States, its auto racing is the number two televised audience sport in the United States. Second only to the NFL, obviously with the NFL in right now it is going to be popular for a while. Auto racing is just huge. There is over 440,000 participants that is teams and drivers in the United States that do racing. And there is over 100 oval tracks in the United States. Every state has an oval track or a circle track if you will. Right here, I just have a couple of slides showing both the fan demographics of circle track racers as well as states that have 40 or more circle tracks. It is tremendous. It's huge. So what we see here is that there is this built in audience where not only is there a market where these fuels make perfect sense to both grow in an develop that market, but the audience the potential it could have is tremendous. This is something that we realize, that we didn't was leveraged within either the programs or within on the racing community itself it could have a tremendous impact to start building up support for this grassroots movement of using renewable fuels where it makes sense, supplying a market where it's a natural fit and really, really start growing both the fuel suppliers, the technologies and everything else. Just a great story. Next slide, please.

Great. So conclusions and then we will go ahead and get the questions, one of my favorite parts. Next slide.

Okay, kind of the tagline after we went through all of this testing faster, cheaper, cleaner and sustainable there are no compromises. I can tell you in all the work that I've done whether it was graduate work or General Motors or my work here at Argonne, these programs I have worked in, I have never been involved in a project where I didn't see any down sides to either the technology being used or the potential of it happening that I have here. We have increased performance at… We demonstrated an increased performance at approximately 75% cost reduction. We reduced petroleum consumption by over 80% with domestically generated renewable fuels. Greenhouse gas reduction by 75%, criteria emissions by 60% for certain ones other ones were less. We can do far better on that with small development. The circle track racing community offers tremendous audience potential for renewable fuels and sustainability. That's not only the 440,000 team drivers in the United States but the audience that sees that that might drive there from nice Midwest communities with a flex fuel vehicle and everything else—it's just amazing. We think there is, within that tremendously powerful method, the cellulosic E85 with advanced technology is used. In a 100 lap race it would consume roughly two gallons of petroleum less than a four cylinder small

sedan using petroleum driving the same distance in mixed city/highway driving. And we've also demonstrated with GREET analysis that we can have even less depending on whether it is 85 or 100% ethanol, lower greenhouse gas impact than that of even a Toyota Prius or even a car that got few times better fuel economy than that. So, it's just a really powerful message. A lot of people in that community are unaware of it. So we have been publishing articles as we go along with this project. Shoestring budget, we did this under the radar. Most of the stuff and the team that you saw here, they donated their time, their efforts. Same with me and a lot of the guys. We started this project, I did it kind of under the radar and with what support we got, we have been really happy with it; some smaller impact, there is a lot of people starting to talk about this in the publications in *Circle Track Magazine* and other places. This car was actually covered on Horsepower TV, which is going to air on Spike television. I think it's October 29 and 30 they did a whole episode on this car and both myself, the driver, and Rob Fisher from *Circle Track Magazine* were interviewed for that. The car was actually in the studio and that was kind of a nice fit too. Next slide.

I think when people think of environmentalism and who takes the charge, I think, you know, I showed this at the Biomass conference, I think a lot of people picture something like this, the Volkswagen van and peace and hippies and all that good stuff. But, really with using the technologies and really going after this, the truth be known, next slide.

The future environmentalist can look something like that. I think that looks a heck of a lot funner and has just an amazing potential to show the rest of the country and the world just what could be done with programs and DOE's developing, really get community support behind it and supply a market that it makes natural sense for. So I think with that… that only took about 35 minutes. My favorite part is the questions so I hope people are still awake or paying attention and ask some good questions. I think we can open up the floor for that, so.

Liz Penniman: Alright, Forrest, we have one question so far. And it is you mentioned a cross reduction when comparing E85 locally to race track fuel. But would you see the same cost reduction when purchasing cellulosic ethanol today?

Forrest Jehlik: No, and obviously no because there aren't all the technology, the DOE and the bio mass department has been helping develop these technologies and ramping up there really aren't that many people right now, at this moment, mass producing cellulosic ethanol. I know Poet, their Liberty Plant, is I think scheduled to come online and hopefully someone from the phone call here from the phone call here can correct me if I'm wrong, in the 2013 time frame, and there are a bunch of others that are. At this point, no, I think the way I would look at it I think a nice transition right now at this point was to go ahead and be using what is on the market now, the corn ethanol because obviously the corn ethanol and cellulosic aren't any different than the engine the only thing that could change that is the 15% fuel and the concentration of what's in that that could slightly change things, but, I think DOE has set some internal cost targets for what that would do on the market, and in the meantime, we could just use corn-based stuff.

That's a great question. I think people here that work in the biomass cellulosic part could probably have a better answer as to what the cost targets are, and when they think that could become available. In addition, I have to say that this project, we did ethanol today because we think that is one of the most readily available renewable fuel that exists in the United States. We are open to test all kinds of stuff in this car program, biobutanol, cellulosic ethanol, ethanol, catalytically tracked – catalytically cracked bio mass to fuel straight petroleum, algae based products as those come forward. We would be open to all of that. The way these engines are designed today, actually in their control systems can adapt pretty readily to the fuel that we give it whether it is an alcohol

based fuel or petroleum based. We just have to do some modifications to the fuel system and the fuel injectors. But the engine control system itself can readily adapt to the fuel.

Liz Penniman: Okay. Next question: are there fuel differences for Formula One racing and oval track racing?

Forrest Jehlik: Oval, absolutely. And as a matter of fact, depending on the fuel supplier for a track there are differences. Now the American Le Mans series, I know you talked about Formula racing, I don't know exactly what the FIA uses in Europe for their fuels and what they allow. They demonstrated some diesel stuff. The Europeans haven't been as favorable to the alcohol based fuels for certain reasons. Here at the Le Mans series which is kind of our version of Formula if you will at least in the L and P classes, they allow cellulosic 85, E10, diesel and a race fuel that is all ablaze that is all strictly controlled as to the concentration of the remainder of the fuel and so forth, but. I hope that answered the question. I don't exactly know what formula the Formula One uses but I do know the American Le Mans uses.

Liz Penniman: Alright. Next question, do you know how many cars in front of you are running the stock Chevy engine versus a race built engine?

Forrest Jehlik: None of the cars in front of us ran stock engines. Not one. They were all $30,000 highly tuned two barrel set ups that were screaming near 8500 RPM every single one of them. And like I mentioned earlier, I talked about durability; the engine that we have in our car was the CT525 engine we talked about earlier—we didn't modify this engine to take advantage of the properties of ethanol. It was a bone stock Corvette engine with a different cam shaft and a different oil pan and that was it. And we ran it the whole season. Actually, the race team did. We didn't support that. They donated their time to help us out. To let you guys know, we didn't ever pay for this car or anything; this team that has been working with us is just fantastic. They believe in the idea and it helps get them some notoriety, but we didn't pay a dollar to do any of this other than our own data testing systems and analysis and my efforts and my colleague, Danny Bocci's efforts. That is really about it. Next question. I love them.

Liz Penniman: What reactions did you see from the other racers at the track?

Forrest Jehlik: Oh, that's been my favorite question of the morning. People were so shocked, they loved it. It was unbelievable. Once we started talking about the cost savings to them and they saw the performance, not only that but some of you may not recognize, this car looks like a production Camaro. One of the most "stock" cars in NASCAR's today have nothing to do with production based cars. We purposely did that because we want to be able to bring the OEM products and the OEM cars back into racing so that people can see that tie between their product and the race. We got kept at the track until almost 1:00 in the morning by fans that were coming by asking us about the car. It was awesome. I mean they were just they had been reading about some of the articles following it in Circle Track Magazine, which is one of the most widely based race – one of the widest audience race magazines in the world and people had been reading about it. We didn't tell anybody we were going there we just showed up and people recognized the car. They kept us there really late and we had a great time. A lot of people were very interested in wanting to do something like this.

Kind of brings me up to another point, Rob Fisher from Circle Track and I we came up with a whole goal to want to be able to try to look for sponsors to start a series like this what would actually promote renewable fuel. It would be renewable fuel, production based engine only race

series that would bring back mustangs versus challengers, versus Camaro's using the coyote five liter, the 6.2 liter GM engine and the Hemi from the Chrysler product and renewable fuel only. As a springboard opportunity to really be able to educate the population about the potential we have in this country in the market that we have for something like that. Next question?

Liz Penniman: Okay, the next question is, 'what is next for this program?'

Forrest Jehlik: We are going to do two things—my colleague and I—Danni Bocci, also believes in helping promote advanced technology even in this series. Because production cars are now having hybridization come on board and so we are developing a two step hybrid system for this car. Don't tell anybody about this because we are keeping it under wraps until we start publishing it. But we started our first page where all of the – we called it the hybrid accessory system where all of the accessories on the car from the engine controller to the power steering pump to the fuel pump to the radiator pans, everything are going to be controlled and powered by a plug in if you will accessory list and ion pack. So the racer would go to the track and charge batteries up and run. So the engine is the only making power and accessories are going to be powered from a separate system to increase the performances, reduce the parasitic losses on the engine and I get the car on track.

The second stage of the project that we're going to do, and this is all using renewable fuel by the way, the next stage of the project we want to do a post transmission hybrid system with brake re-gen or a belt alternator starter plus system where it will be able to regenerate some of the kinetic energy during braking so a racer can use that for greater acceleration later on. So when stages are forming that and trying to get our team together on how we do that and then demonstrate that as well. So those are the next stages coming up.

Liz Penniman: Next question: is DOE considering involvement in racing series whether circle tracks on a local level or on a larger national or international scale?

Forrest Jehlik: I can't speak for DOE, the project that we have, the green racing program, is a very modest and it more comes from the angle of just promoting other rules to help promote the advanced DOE technologies or fuels and programs or demonstrations like this. I doubt it. Again, I don't want to speak for DOE. This is my own opinion. I just think with all the hoopla from DC and about budgets and the perception of the government involved in racing and so forth, I don't imagine so. Although, in my opinion, it seems to me that the natural fit for something like advanced technologies to really promote to the public the potential would be racing. And so I don't think so even though on my personal level it might be the right place to go. The U.S. Army spends a lot of money funding NASCAR teams to try to get people to sign up for the army. The Air Force does too, but I'm just not sure I see that. Maybe I'm wrong. I'd like it to see it a natural place for it.

Shabnam Fardanesh: And then, how can we get more involved, this is two parts; where can we learn more about this and/or contact you?

Forrest Jehlik: You can contact me at my email here at Argonne, I'll just give it out, my name is Forrest Jehlik and my email FJehlik@anl.gov, again that's FJehlik@anl.gov, and just to let you know where you can find this we actually, on our ANL site, we actually have a green racing page in the transportation division that you can look up. I'm going to see if I can get the URL right now. If you go to www.transportation.anl.gov and click on the left side you are going to see a green racing bullet and you can click on there and find out about that and some of the other programs we have been involved.

In my opinion, it has been a real shoestring budget for us to do the work with circle track stuff. We have actually kind of liked that because we can fly under the radar and get really creative with the groups that's involved. We definitely encourage good partners and good ideas in the program to help kind of spread this. We have just seen, and I approach this as a scientist, or a research engineer, I approach this really neutrally. I wanted to see if it benefitted or not. We just published the material as it came out, works and all. And it just turned out to be far better than we ever though. From that if there is a way that we can help educate the public and get them to want to do this I think we all win.

Shabnam Fardanesh: Forrest, is there any way that we could maybe involve the state energy folks or the clean city folks that are on the call as you go city to city to race this car?

Forrest Jehlik: Potentially. One thing that we talked about, so for any of the Clean Cities folks on board, I guess this is my sales schpiel. We drafted up a proposal to be able to start a race series I think off the top of my head I think it was a 13, 13 race series all across the United States that will involve a pack of cars, I think it was about 20, I think it's a pack of 20 cars or so. Our idea was that we would have an outreach center at each one of the races that would actually talk about the technologies, the greenhouse gas impact. We have mobile wifi outreach where people could upload to Facebook and other media. It's a whole package and we kind of came up with this idea where we saw the benefits and figured let's bring this racing into the 21st Century. One way and I don't know how the clean cities program totally works, but we had this proposal done and to get it done we need to look for sponsors and so the clean cities would be interested in doing something like this maybe they can get all of their different groups together to become I don't know if they could or would want to become a sponsor or with no contact, the industry that would want to do so. We can send out proposals. If you're interested. Email me. I can send you proposals and we can discuss and I think that would be a nice way. Aside from that, when the car goes out we do do demonstrations. Maybe there are some other methods where we can work on media and so forth. Go through clean cities, we are really open to that. The next event we are going to, we are going to Las Vegas at the SEMA show first week of November. That is S E M A, specialty equipment manufacturing association, and we are giving actually we are giving a keynote speech there on the green zone and about the after market parts that are used in it; as well as the potential it has to affect both the racing community and aftermarket community, as well. If anybody here is from the Clean Cities Nevada group or knows somebody who wants to contact us about that and see how they might, you know, get in touch, we're open.

Shabnam Fardanesh: Forrest, what do you think about putting the schedule on the Clean Cities website? There is a lot of state energy folks are also members of Clean Cities or are in contact with their Clean Cities coordinators, so that might be a great way to know, if they're not on the call like right now, they could at least learn about it from that.

Forrest Jehlik: Can you follow-up with an email on the site on that, and I will definitely take a look at that. That sounds fine. I mean, that's great.

Shabnam Fardanesh: You know, Lee could do that. If you could let Lee know.

Forrest Jehlik: Okay. That sounds great.

Shabnam Fardanesh: In the same office.

Forrest Jehlik: Okay, that sounds excellent. Any more questions?

Liz Penniman: That was all we had sent in. Do you have any closing thoughts?

Forrest Jehlik: Well, yeah. Absolutely. Thank you for your time. I really appreciate this opportunity. I know sitting on these calls, we all kind of sit on mute and go off in our worlds, but for anybody that was able to pay attention, hopefully you saw something kind of new and interesting and maybe something where we can move forward and make the world a little bit better place. I definitely appreciate your time, and if there are any questions, just contact me directly, and I'll be glad to talk with you. I guess that's about it.

Shabnam Fardanesh: Thank you so much.

Forrest Jehlik: Thank you guys. I really appreciate. Take care, you all.