EIA Energy Conferences & Presentations, April 7, 2009

Session 5: "Renewable Energy in the Transportation and Power Sectors"

Mr. Michael Schaal: Well, let's get started and we'll have people come in as we move along. Welcome to the session which addresses the topic of renewable energy and the transportation and power sectors, a topic that is very much on the minds of the public at large, policymakers who are pondering the cost benefits and preferred outcomes of a variety of current and potential future laws and regulations, and also researchers who are busily involved with pushing the state-of-the-art in a number of key technology areas and also technology developer who are weighing the risks and benefits of pursuing different business plans in this evolving market, and environmentalists who are concerned with the direct and indirect, both good and bad, impacts of pursuing these technologies versus a business as usual or other options.

Before we get started, however, there are a few housekeeping items. I know this is the last session of the day, but I would appreciate it if you would check your cell phones and ensure that they are off prior to our getting ready for our sessions and secondly, we'll be handling questions in format of writing out in cards. You should all have cards on your chairs and at the end of each of the presenter's presentations, a few of our fine staff will be going through the audience to collect your cards and at the conclusion of the final presentation we'll begin answering – asking our presenters some questions.

Now, just a few days ago, the Energy Information Administration released its long term assessment of energy markets and as reflected in that release, as represented at the bottom of this chart in both green and yellow, renewables, which in this chart includes hydroelectric power, comprised a small but growing share of the nation's energy supply portfolio. In 2007 the combination of biofuels and other renewables constituted almost 7% of total supply and is expected to grow to become 12% of supply by 2030, and it's about 3.2% per year annual average growth rate, easily growing faster than any other form of supply.

Indeed, the growth rates of non-hydro renewables and other components are growing at a faster rate. This is the growth rate that EIA projects will occur under currently enacted laws and regulations, and under a relatively high oil price scenario.

Now, we have with us today a diverse group of speakers who are working at the forefront of developing renewable technologies for both the transportation and power markets and are also instrumental in creating the environment in which these technologies can flourish, and I think what we'll be interested in, and what I've asked the presenters to focus on, is how much is possible and when, what are the technologies that will make this happen, and what progress needs to be achieved with those technologies? When will that progress result in commercial scale quantities coming into being, what will this all cost? Will we have enough feed stocks at reasonable prices? What are the other impediments to achieving these visions of the future and what are the effects of success in achieving the full realization of these futures?

Now, we'll be starting out with the transportation side of things and as can be seen in this chart, which focuses on liquid fuels within the U.S. energy markets, the way EIA currently sees the world is that the petroleum side of the world will be essentially flat between 2007 and 2030 and that a majority of the incremental growth and liquid fuel demand will be made up from biofuels. Between 2007 and 2030 biofuels consumption grows at an average annual rate of 7% per year, which will increase under this projection, the market share of biofuels from 2.3% to almost 15% by 2030.

Now, with us today are Dr. David Humbird of the National Renewable Energy Laboratory and Matthew Hartwig who is the Communications Director of the Renewable Fuels Association, to describe some of the issues associated with the development and use of bio fuels.

And we'll start with Dr. Humbird. Dr. Humbird is a Senior Engineer and is a member of the Bio Refinery Analysis Team. He specializes in the design, integration and technical – I'm not quite sure if this is a word or not – techno-ecnonomic modeling of bio fuel processes to predict the production costs of pre-commercial technologies and assess their competitiveness with petroleum based fuels.

Prior to joining the National Renewable Energy Lab, David worked in the petrochemicals and semiconductor processing industries. He received a bachelors degree in chemical engineering from Texas A&M University and a Ph.D. in chemical engineering from the University of California at Berkeley. So we'll get David's presentation cued up and –

Dr. Humbird: Good afternoon, thank you. So for – the word was techno-economic analysis. Technical plus economic, and specifically for bio refineries, so let me spend just one second about what is a bio refinery and what we're talking about is any facility that probably looks like a chemical plant but which is operating on a biomass feedstock such as trees and grasses and ag waste and municipal waste, anything that's organic in nature, plant-like in nature and through some conversion process which I plan to talk about in-depth today, is then converted into anything that we would normally make from petroleum or for fossil fuel, so including power, including fuels, and plastics and resins and anything else that makes life better, right?

So focusing on transportation fuels as NREL does, we have a national commitment to making biofuels as put forth by the EISA Bill that says by 2022 we will have 21 billion gallons of cellulosic plus advanced biofuels in production ready to use. What do cellulosic and advanced mean? Those are defined by the greenhouse gas reductions that each of those – that can be attributed to each of those, for example, cellulosic biofuels would necessarily have to have a 60% reduction so that can only come from a waste source or a grass, and not a food source.

So to that end, between now and 2022, this bill actually spells out by year what the volume is going to be, and in 2012 is when cellulosic biofuels starts to ramp, so what NREL's goal, and in fact, the goal of the DOE Office of the Biomass Program is to have the technology, conversion technology in place such that in 2012 we can start making cellulosic ethanol that's cost competitive with fuel, with petroleum, and cost competitive with corn.

Michael asked me to comment on whether or not we can actually meet that goal and I don't have anything else in here except that let me just say from NREL's perspective we look at the conversion technology and from where I sit, it's there. We've got good companies with good technology who are ready to put demo plants in the ground, and I think that we know - from human history we know about learning curves and we say that once that first one's in the ground, things are going to get better fast. What's going to hurt us and probably cause us to miss this goal is the credit crisis, that none of these plants can get the money they need to actually build this facility.

A little bit about NREL. We are in Golden, Colorado, and we pride ourselves on being a demo or pilot scale research facility, so we have two pilot plants, one for thermo chemical conversion of biomass and one for bio chemical conversion along with some basic lab support characterization laboratories.

I'll talk a little bit about feedstock, what we mean by biomass. It's not really in NREL's purview, this is handled for DOE by INL [Idaho National Laboratory] and Oak Ridge National Lab. But what we think of as biomass today would be corn stover and it would be forest scraps. Why? Because that's what we have, and why we can talk about switchgrass and sorghum and miscanthus and whatever, the fact is that there's just not any of that out there, that if we wanted to turn it into fuel it would be gone in a day. So until that kind of energy crop is seeded out, we're stuck with what's around.

But to summarize what INL and Oak Ridge are doing, they're trying to envision an industrial scale or industrial class distribution system like you would have with corn, so today, if you wanted some corn you'd pick up the phone and corn would be on its way. That's not the case with biomass. Ultimately we need to get there, and the challenges to that are similar to a grain or a commodity source like that, how do you collect it, how do you store it, essentially, and then deliver it out reliably with a consistent quality and quantity. And quantity is important because we'll start talking about these conversion technologies and a lot of them need some economy of scale, some minimum size to actually make you want to build it. Now, if we're talking about biomass as a feedstock, if that's what we choose to use, we have to go out and get it, so how far do you want to go? 1 mile, 5 miles, 10 miles, you know, the whole west coast, the whole corn belt? There has to be enough.

So if we're talking about a 5 mile radius, let's say, that ends up being a very small fuel plant to the point where you would have one for every three counties in Iowa or something like that, and you'd have a really small one. Having a small plant doesn't work well for chemical processes, because if they're capital intensive like Fischer-Tropsch they need to be huge, they need to be mega plants in order to even make sense. So those sort of advanced technologies which we all kind of want to see succeed don't really compete with petroleum until we can have biomass readily available.

So if you were to visit NREL today, we would take you on a tour of the plant or the pilot plant, to the bio chemical ethanol plant, in which we put in biomass--corn stover in this case, and it's pretreated chemically and then with an enzyme to turn that biomass into sugar. The sugar is then fermented by a bacteria into ethanol. Then we would take you in the next building to the thermo chemical pilot plant which takes a woody feedstock and gasifies that – basically gasification is like an incomplete burning of the material. It turns it into what's called synthesis gas or syngas, it's CO plus hydrogen. That syngas is washed over a catalyst to turn it into mixed alcohol, so it's ethanol plus methanol plus propanol and that could be separated.

And our core research is both improving each part of those flow charts and then reducing the economics, reducing the cost of it to improve. Today we would tell you that the state of technology which is where we think conversion technology would be today would put us at, for a gallon of ethanol, at about 2.60 or 2.40 for the chemical state which is upwards of $4 a gallon for an energy equivalent of gasoline, and that's too expensive obviously, but our goal, like I said in the beginning, is to get down to make it cost competitive with 2012 price of oil which, who knows what that'll be, we think it'll be somewhere in the 2.50 per gallon range for gasoline which would make it about 1.50 for ethanol.

This is what we would tell you if you came to NREL, but let's say you came to NREL and you didn't leave, and you got to know us and listen to our existentialist ramblings and stuff, what you would find is there's a growing attitude that says ethanol, really? Because ethanol just doesn't inspire as a fuel and if we're talking about blending into E-10 there's what's called the blend wall which is that every drop of gasoline out there has 10% ethanol and we can't put anymore in there and Matt could probably talk about that, but without the infrastructure in place for higher blends of ethanol we don't know what we're going to do with it.

But the reason that ethanol has been studied, they say, is because it only takes one miracle instead of several. The one miracle in the biochemical case was converting cellulose into sugar and actually, that's pretty well understood and I think that that technology is ready to go forward and converting that ethanol is easy.

In the case of thermo chemical ethanol, the miracle was the catalysis part, turning Syngas into mixed alcohols. Unfortunately right now, that's not really what Syngas is good for and we can kind of make it do that, but it would be better to make it for something else. Let's say the catalyst we have right now is like marginally acceptable, it makes about 85% ethanol, 15% of these other alcohols and if we have a small plant, it's hard to justify separating those.

So I want to talk about what's coming after ethanol in forms of sugars, the Syngas fuels and then fats and oils and then what's near and what's long term and for the case of sugar, what we have today is to turn starch and cellulosics into sugar and then ferment that into ethanol. Some of the things that are coming in the future are aqueous phase reforming which is a purely chemical process that can hydrogenate sugars into gasoline and jet equivalents. There's a company called Virent that you can check out that does this. There's the engineered microbial fermentation which Secretary Chu had alluded to, these companies like LS9 and [Amyris] can engineer a yeast that instead of secreting ethanol as its waste now secretes a hydrocarbon which can look a lot like gasoline. And the third would be what I'll call dark algae. So algae are normally grown in the sun, but in this case, they're grown in the dark on sugar and they produce an oil that can be converted then into bio diesel or diesel.

What's beneficial about the sugar fuels is that in each of these cases they can be designed for infrastructure compatibility. They can basically be gasoline if you want them to. So we have control over the fuel properties. They're also not that capital intensive like I said. That's trouble for these other technologies, so if we believe that cellulosic ethanol can scale to 21 billion gallons, then we have to believe that these (businesses) can too, because it's fermentation. The challenge is going to be feedstock availability, like I mentioned in the beginning.

In the case of syngas with gasification, the current technology is to make a mixture of alcohols and separate those. Fischer-Tropsch is talked about a lot, and this is a fairly old technology where syngas usually from coal or from natural gas is turned – run over a catalyst and then made into Fischer-Tropsch liquid which is a mixture of hydrocarbons that can be upgraded into a compatible fuel.

Methanol to gasoline is another one. There are – there's no real players in methanol to gasoline right now, but it was run successfully by Mobil in New Zealand back in, I'll say the '70s, I have it here somewhere, and there's this third possible use of syngas which is actually fermentation to make ethanol. This – while Fischer-Tropsch and methanol to gasoline have – they're very capital intensive, so until they can get the biomass that they need, they really don't make economic sense but the fermentative route may be a little closer, although it's very technically challenging. What you have to do is take this syngas which is a gas and then dissolve it in water somehow and then have these bugs go find it. That's very challenging.

What's beneficial for this technology is that you have the Fischer-Tropsch methanol to gasoline, those things have been around since World War

II, maybe earlier, so they're proven. We just would have to get them to run on biomass and then get biomass up to the scale that they need to be competitive.

For advanced oils, the current state of technology for bio fuel from a fat or an oil would be bio diesel through – you take seed oil or a waste oil and transesterify it into bio diesel which is chemically different from actual diesel, so they can be blended with diesel but then has a blend wall of its own so it has limited use in the infrastructure.

We would move, in the near future, probably, to hydrotreating, hydrotreating being an operation that's already found in most refineries to treat sour crude. That same oil can be just run right into the refinery and turned into a diesel equivalent and most of the oil companies are – have some sort of project to come up with this, although planting crops to grow oil, to grow a seed oil, is – has a land use issue and right now it's too expensive.

The next would be pyrolysis which is similar to gasification. You make a sort of a black crude like oil from biomass, then that can go directly into the hydrotreater and then algae comes in here with the – a cell of algae grows a drop of oil inside of it, which is basically similar to vegetable oil, so if you were to grow enough of it, squeeze it out, you could then turn that into diesel too, so that's – I know everyone's heard about algae but that's where this would fit in.

What's nice about the oils is now we get away from that economy of scale because the oil intermediates are portable. So sugar, it would get contaminated and syngas is a gas, but the oil we could collect locally and then truck it somewhere for upgrading, so we would get a better economy of scale that way. The technical challenges in this area are much higher, though, for pyrolysis and for algae and we're just not there yet.

So if I had to order these. Bio chemical ethanol and thermo ethanol, we're going to see those very soon. Green diesel is the hydrotreated oils and those are kind of ready right now once it makes economic sense for us to start manufacturing. Fischer-Tropsch and methanol to gasoline have a capital investment inhibitor so we won't see those until the feedstock is worked out, and renewable hydrocarbons and algae are a long ways off because of process technology.

And yeah, so for NREL's side we are working on the ethanol conversion primarily and then looking towards the future for these, at these advanced biofuels that have a better compatibility and that's really where we think this needs to go. So, thanks.

Mr. Schaal: Thank you, David, I really appreciated you sharing with us some of yours and NREL's existential ramblings about biofuels technologies. So next up we have Matthew Hartwig with the Renewable Fuels Association. The Renewable Fuels Association has been very active for a number of years in the biofuels policy development arena and Matt Hartwig, who will be speaking with us today, is the Communications Director for the Renewable Fuels Association, and he's had that position sine 2005. I imagine during his tenure with Renewable Fuels Association he's had the equivalent of 30 years experience in the development of a new industry and the growing pains associated with that. Previously he served as press secretary for the Senate Agriculture Committee under then-ranking member Senator Tom Harkin and prior to that, he spent several years working on political campaigns at a variety of state and federal levels, and I'm sure that experience has helped him in good stead. I've come to depend on receiving emails from Matt Hartwig on a regular basis on any issue that confronts the renewable fuels industry and I find that he's quite both quick and articulate in explaining RFA's position on any issue that you care to raise. So with that introduction, I'd like to – everyone to welcome Matt Hartwig.

Mr. Hartwig: Thanks, Michael, and thanks for having me here. First, let me apologize on behalf of Bob Dinneen, my boss. Bob had agreed to speak at this and very much looked forward to it. Unfortunately he was called away and couldn't be here today so again, I thank you for allowing me to fill in.

Just very quickly, about the Renewable Fuels Association, if you're unfamiliar with what we do, we're the trade association for the ethanol industry here in the United States. We started in 1981, we represent something like 70-75% of the nation's ethanol production as well as a number of the marketers and technology suppliers and folks who are important to what we do.

A quick overview of the ethanol industry as it stands today. No doubt you read the same stories I do. Last year we produced 9.2 billion gallons of ethanol. This year we expect to produce around 10 and a half. We imported a little over 550 million gallons of ethanol, largely straight from the coast of Brazil. Right now we have 12.4 billion gallons of capacity built, but as you well know, the economics are such that our industry has seen some idling and right now we're about 10.4 billion gallons of actual online annual capacity at about 170 locations across the country.

I apologize. That may be a little tough to see, but I wanted to graphically sort of represent where our facilities are across the country. Obviously we're located centrally in the corn belt but you're seeing increased production on the coast and in the southeast and it is these facilities that are providing the foundation that will make these facilities a reality sooner than most people understand.

Michael asked us to talk about next generation technologies. Here are a couple dozen examples of companies here in the United States, where they're located. They're looking at using everything from corn cobs and switchgrass to sugar cane waste to fast growing poplars, wood waste, municipal solid waste, and dedicated energy crops like in energy cane. They're looking at all the technologies that David put up there and what you don't see on here is the advances that happening at today's facilities. There's a plant in Benson, Minnesota, for example, that has installed a biomass gasification unit using corn cobs today that is displacing about 15 or so percent of the plant's natural gas use. It's a 3 stage project. When it's completed they'll replace about 90% of the natural gas use, but that's not the only reason to put it in. This technology could very well be a bolt-on type of facility to an existing corn based ethanol plant to produce ethanol from both starch as well as cellulosic ethanol. So there's a lot of focus put on these next generation technologies and companies and as well it should, but I think we would be remiss if we overlooked the advances that are happening today at plants that have been operating 5, 10 and 15 years.

Two, to make sure that these plants are successful and even to make sure that the plants that are operating today are allowed to succeed, public policy and consistent public policy is incredibly important to this industry and to the investment community on which we will rely to get the dollars to build these facilities. True, the credit market is very difficult for our plants, not only to find capital to operate, but to find capital to build what are incredibly capital intense projects. It would probably cost you three and a half or $4.00 a gallon go build a cellulosic ethanol plant today but as was mentioned one the first one's in the ground, the line to be that second and third and fourth location will be quite long.

There are a couple of policy and regulatory issues that have really captured Washington's attention and our industry's as well. The first has to do with the renewable fuel standard or RFS-2 as it was passed in the 2007 energy bill. Most of you are probably familiar with the requirements for specific biofuels. Under this provision and the total goal of 36 billion gallons of renewable fuel used by 2022, this is what it looks like graphically if you were to put all of the various feedstocks to produce ethanol. The big yellow chunk on the bottom is corn based production from ethanol. The lighter green or lighter blue color would be cellulosic in nature. The blue is what they call advanced biofuels and then the top part is biomass based diesel fuel.

One of the big issues that has yet to be resolved is implementation of the renewable fuel standard, in particular how EPA is going to measure the greenhouse gas reduction requirement. There's a 20% greenhouse gas reduction requirement for that big yellow chunk on the bottom, however most of that has already been met and grandfathered in as part of the clause with approximately 12½ billion gallons of capacity online and another 2 billion gallons being built. A lot of that has been grandfathered in, but when it comes to advanced biofuels, and biodiesels and cellulosic ethanol, and those other remaining plants that we may need to meet the 15 billion gallon requirement for starch based ethanol in 2015, those are the greenhouse gas reductions, emissions that they have to meet.

How is EPA calculating that? There are questions about their modeling, about some of the assumptions that they are looking at, and it's also important because many see this as really a precursor to what will be a low carbon fuel standard nationwide. The current ethanol greenhouse gas profile, when you're looking at direct emissions, ranges anywhere from 30 to 60% depending upon some of the assumptions you make, but also the technologies that you are using. A recent study from the International Energy Agency suggests that that greenhouse gas number for – and this is, we're talking starch based ethanol here, will continue to improve. By the time we get to 2015, you may have corn based ethanol production achieving some of the greenhouse gas emissions requirements that are called for under the advanced and cellulosic ethanol provisions in the renewable fuel standard.

But there's always indirect land use change, sort of the unproven and 800 pound gorilla in the room that really lacks any scientific consensus. You can probably take a poll of everyone in this room and we won't find a majority on how do you define it, how do you measure it, who should be penalized because of it. We've done a lot of work, the RFA and the industry as a whole on this issue, working with EPA to try to inform them. There are very important assumptions and data points that need to be included and need to be accounted for, such as improvements in yield, not only at ethanol facilities but in the products that farmers produce.

Are you properly crediting the livestock feed co-product, distiller's grain? If you look at corn exports, for example, last year we saw either record or near record exports in corn, corn fed to cattle, we saw the DDG, the livestock feed co-product was a record export, and so you have to take a look at these. If the United States and our farmers are not reducing the amount of corn that they are supplying to the world market then how is it that you can penalize an ethanol produced from corn for land use change if there's no change in supplies? And there are other questions about how is it being applied. Is it being applied fairly across all fuel technologies? is petroleum getting the scrutiny that it deserves?

So moving forward, together with the NRDC, the Natural Resources Defense Council, we want EPA to get this rule on the street. It's time to start talking about this, commenting upon the proposals that they have. We believe that an inclusion of direct impacts, direct greenhouse gas impacts as well as domestic indirect land use change impact probably make sense. If you planted an acre of corn for ethanol that might have been soy beans in Illinois, that we can deal with. What we want them to do when they issue this, though, is to break out the component that would be the international indirect land use effects. It's important, I think, for people to appreciate the size of the penalty that very well may be applied to corn based ethanol and other biofuels down the road, and then of course, we will comment and provide analyses on the co-products credit and improvements in innovation.

Kind of the second big issues, and it was alluded to a little bit earlier, is the blend wall. What do we do when we get 10% ethanol in every gallon of gasoline? How is it that we make sure that the renewable fuel standard that calls for 36 billion gallons of renewable fuel use in 2022 can be successful? Here, and again, the blue didn't show up quite as well as I had hoped, but the blue line represents the RFS demand requirements, the red line represents the 10%, the theoretical 10% blend wall.

We believe that you probably get saturation somewhere between 12½ and 14 billion gallons. As you can see, by 2012 or 2013 we may very well, without changes in current statute, may very well run up against that blend wall, so what do you need to happen? Well, you need to see the expansion of higher blend infrastructure continue, more flexible fueled vehicles capable of running on higher ethanol blends, the infrastructure, the fueling infrastructure to dispense it, as well as an increase in the amount of ethanol that - the legacy fleet, the traditional non-FFV vehicles on the road an utilize.

This is perhaps a better graphical representation of the blend wall. The top solid blue line would be the theoretical blend wall. If you had 100% penetration in the marketplace, that would probably be where you would cap out. Subsequent are 90 and 80% penetration assuming that not every single gallon in the United States is blended with ethanol.

If were to get the E-15, and let me step back and say, the industry has petitioned the EPA for – it's called a 211 F-Fuel Waiver – asking them to approve for blending up to 15% ethanol. It's not a mandate. It doesn't require refiners and gasoline marketers to supply 15% ethanol, but it does provide them the flexibility to blend up to that amount and have it be a certified fuel by the EPA. If that were to happen, all of a sudden that solid blue line moves up dramatically and you erase some of the problems that will occur if you don't get more ethanol into gasoline with respect to the success of the renewable fuel standard.

So I don't know what happened to that middle block of colors. I guess I used one that doesn't show up but here is just, illustrative only, it's not what we're predicting, but ways in which that you could make sure that the RFS is met through various requirements. The yellow part would be growth in E-85, 85% ethanol, the black box would be 20%. That middle area that apparently is coming out white would be E-15 and then the blue box would be E-12.

Backing up to our E-15 fuel waiver, we believe that EPA can walk and chew gum with respect to this issue. We think that the science supports a move in the near term to maybe a 12 or a 13%, that fuel being substantially similar enough to E-10, 10% ethanol, that you could allow refiners to blend that much ethanol into gasoline without causing problems with vehicle technologies and other technologies. Obviously, to become – for the RFS to be successful, we have to move beyond that, including approval of E-15 and maybe beyond. I know DOE and EPA are doing the testing. We support that testing. Let's find out where that number is and let's move to it as soon as we can.

I think going back to the point that Michael raised first in how much can we produce, how fast can we get there, what's the outlook, we've got the policy drivers in place. The renewable fuel standard is the first time that we've ever taken an aggressive look at backing out foreign oil imports. We can achieve President Obama's goal, we can achieve goals of members of Congress in terms of becoming more energy secure and more energy sustainable through the provisions we have here, we just have to continue to work on it. We can't back away from the progress that is made because if the industry that we know today, whether it's the grain based ethanol, whether it's the biodiesel, wind, solar, all of them, these emerging renewable technologies need a solid framework upon which to build and the renewable fuel standard provides that.

That's all I have – thanks for your time.

Mr. Schaal: Thank you, Matt. And now we'll be moving from the transportation side of things to the electric generation side of things. EIA projects with its annual energy outlook that total non-hydro electric renewable power generation will grow from about 3% of total generation to almost 9% of generation by 2030. As you can see in this chart, in the most recent history the largest growth area has been wind. Wind has been achieved a market share of just over 1% in the current era and is projected to continue to grow at a fairly healthy rate within this projection, however we have with us, our next speaker, Ms. Denise Bode who's the Chief Executive Officer of the American Wind Energy Association and she's well qualified to have perhaps a differing opinion about the future of wind energy within the United States. Ms. Bode has accomplished a great deal across a broad spectrum of the energy industry, beginning with a law degree from Georgetown University. She first served as an advisor to then U.S. Senator David Boren as his legal counsel focusing on energy and taxation issues.

After some time in private practice, she served as President of the Independent Petroleum Association of America and then next accepted an appointment as Commissioner for Oklahoma Corporation Commission. Following that situation she next served as CEO of the nonprofit American Clean Skies Foundation to educate the public about environmental and energy issues, and in that role Ms. Bode has also been instrumental in the formation and development of Clean Skies TV, which as I understand it, she's still involved with. So please join me in welcoming Denise Bode.

Ms. Bode: Thank you all. Okay, you all, wake up. It's the afternoon, I know this is the last session, but I don't want anybody asleep while we talk about wind because the wind industry is on the move, and I know that you're hearing all of this technical stuff. Well, I'm a tax lawyer, so you're not going to hear engineering stuff from me and if you ask an engineering question you will not get an answer. So you can ask me numbers because I'm pretty good at numbers, but it's more in the tax arena and the financial numbers than it is engineering numbers, so I've got all my brilliant staff here who can answer all the engineering and technical questions that I can't, so I just give you advance notice.

Finally, before I get started and before I get docked more time – I know he's over there watching his watch – this is my birthday and I'm the oldest one here, so Happy Birthday?

Audience: Happy Birthday.

Ms. Bode: Okay, and I'm doing this on my Birthday. I didn't take the day off or anything. I came here to talk to you all, so anyway, I want you to know how important it is.

Okay, first of all, wanted to tell you the story in the very first slide that the wind industry is on the move. You know, the business as usual projections that we saw earlier about where we think we're going to be in the wind industry and the renewable industry without any action do not really represent what we think, and frankly what the Department of Energy has projected in its 2008 study. We're going to be into the year 2030 with wind power and frankly it's a great story.

I want to start with first a market update because we've just come out with preliminary numbers and our final numbers will be coming out very shortly on April the 13th of this month, but the preliminary numbers show that with over 25,000 megawatts, the U.S. is now the number one wind energy producer in the world and that is great news for the United States.

If you look at wind power installations in megawatts, we have installed 8,353 megawatts in 2008, that is a fabulous number, it's a 50% growth in wind generating capacity, it's enough to serve over 2 million homes and frankly, you know, it is a huge new investment in the U.S. because we're talking about an investment of $17 billion in the United States economy.

Look at capacity. We're also one of the leaders in new electric capacity added last year. In 2002 when we first looked at this chart, wind was less than 2% of new capacity being added, now it is over 40% in the year 2008. It's actually 42% in 2008 of new U.S. power producing capacity, one of the key leaders in adding new diversity and generation for the United States.

Looking at the state-by-state, you can see what's really happened. It's really exciting. Iowa surged into second place, and I think it's really interesting following on the discussion of the renewable fuels where you saw the picture of Iowa and you saw the picture of all of the corn belt across the middle of the country, well, it's also the place where they're really leading in new electric generation capacity added and Iowa has not only added in generation, as you'll see and I'll show you in a chart later on, they're also adding a tremendous amount of new manufacturing jobs along with that generation capacity, and that's another fabulous story that I want to talk to you about.

There are now over 7 states in the over-1 club with actually 1 megawatt or 1 gigawatt club with Colorado, Oregon joining the top 5 states of Texas, Iowa, California, Minnesota and Washington. Indiana saw its first utility sale project installed in 2008, a 130.5 megawatt facility and it's really exciting because coming up in the second week of April, Indiana is going to basically break ground the same week to two new major wind facilities plus turn on another major wind facility, all in the same week, so we're really excited about Indiana playing a really growing role not only on the generation side but again, adding new manufacturing jobs in that state.

Other fast growing states include Michigan which added 127, Utah and New Hampshire, Wisconsin, West Virginia which saw its total capacity currently quadruple its – the end of year 2007. Okay, let's look at new manufacturing.

This is the cool thing that I did not know coming into this job. I was watching, as a former utility regulator, who added the first wind generation in my state of Oklahoma through the efforts that we had at the Oklahoma Corporation Commission, I knew about wind farms, I knew about what it took to get it financed and in the ground. What I didn't know was the cool news about bringing jobs to America, bringing billions of dollars of investment, creating a new industry from the ground up for the over 8,000 parts that go into these wind turbines. This is fabulous, fabulous news and it's all across the country, these manufacturing facilities. It's not just in the parts of the country that you would consider the windy part of the U.S. These new manufacturing facilities are all across the country. We're talking about last year during the time when everybody was closing their doors or laying off people, 55 new manufacturing facilities added, 35,000 wind energy jobs created in one year alone.

Now, that is great news for this economy and that is tremendous opportunity going forward, not just in adding new clean energy, but adding new jobs that will be there for the long haul because we're not going to run out of this energy source. So this is going to be jobs for the long haul, manufacturing parts that will continue to have to be made, refined, perfected.

Growing the wind industry. Now, this is really – again, another opportunity to what wind power can continue to contribute to electric supply. When you look at what the Department of Energy said in its wind energy report where it said that they do believe that you can obtain at least 20% of electricity from wind by the year 2030, what we believe is we're going to get there even more quickly than 2030. President Obama has called for the U.S. to double its production of renewable energy in 3 years, here he is giving the thumbs up to the wind energy leaders on his way to the inauguration.

At the Cardinal Fastener manufacturing plant in Ohio, now, this is a very cool story. This company made bolts for the Statue of Liberty and the Golden Gate Bridge and 3 years ago they converted their facility to making bolts for wind turbines. They've added new employees, they're growing their business, and let me tell you, the owner, John [Grabner] of Cardinal Fastener, is the best spokesman you can possibly talk about for the industry, because this is America, this is small business, this is hope for companies that no longer can find industries to supply components for. Well, they're finding it in the wind industry.

Okay, we are ahead of the curve on the DOE report. When you look at what was projected, we would need to be there by the year 2030 and you saw the business as usual as we began. We are already ahead of the curve in what we needed to add in order to reach that 2030 goal. Let's talk about what it's going to take to get there. That was one of the things that Mike wanted me talk about. What we need to do is obviously - short term, we need to restructure the production tax credit to work in an adverse economy. We had obviously, just like every other industry, terrible economic times, no money out there, no ability to finance projects. In the stimulus package, we were able to get a multi-year production tax extension, we got the option to in addition convert that to an investment tax credit and allow us for those tax credits that we were unable to use, to be able to apply to the Department of Treasury for a grant for the unused taxed credit, so it is an opportunity to keep this industry growing, to keep the momentum growing.

The next thing we have to work on, and we're already in the mix in the energy legislation about the House and Senate side is a national renewable electricity standard. We just talked about the impact and the import of the national renewable fuel standard. A national renewable electric standard is what is going to make the difference in providing a long term commitment to those people we're asking to come here and spend billions of dollars in manufacturing and to create the kind of incentive nationwide where we're talking about 28 states with all these different kinds of renewable electric standards so people are trying to run around and decide where they're investing and how they invest and what the rules are. Give some certainty, give some national certainty for this interstate commerce of electricity. The second piece of it is we need transmission legislation, certainty in transmission, provide greater national oversight and over-involvement in this interstate highway for transmission and then finally, effective carbon regulation.

The National Renewable Electric Standard, obviously what the President talked about was 25% by the year 2025. Generation from wind could increase tenfold compared to today and meet over 10% of the U.S. generation needs and that includes meeting those targets. Clearly, we're ahead of the curve on even doing that.

We need Federal level transmission policy and we're talking about planning, we're talking about the ability to pay for and the ability to have interconnection wide certainty on cost allocation. The interconnection wide transmission planning is critically important because it will allow us to move faster in building this national super highway. The transmission cost allocation and certainty for cost recovery, frankly FERC already has that authority, but the ability to give them the certainty to move forward, to do this quickly is going to be critically important, the ability to have that backup from the Federal Government to be able to move on this green super highway. All of these things are critically, all of these things are absolutely critically important to move forward.

In fact, there are almost 300,000 megawatts of wind projects and transmission cues in the U.S. today, more than enough to meet the 20% of our electricity needs, so need that kind of – that kind of transmission highway that will move wind and renewables from where it is being produced to where the demand is to provide for tremendous new reduced costs and long term certainty in electricity. This is just a conceptual transmission expansion plan that could accommodate 400 gigawatts of wind power. In this plan, this would look at really, in the neighborhood of $60 billion worth of investment. That is really small potatoes in terms of what your total energy bill is and to the ability to do this will over the long haul tremendously reduce cost, provide greater reliability of the system and certainty. And it certainly will allow us to achieve 20% or more in terms of renewables to get to the market.

Okay, and finally the national climate change legislation. That is the first and critical step is RES. The second part of it is the national climate policy which is really – get us even closer to targeting, really diversifying our energy portfolio.

Now, let's go through briefly just the benefits. I talked to you a little bit about the job projections and a 20% report. They say really a minimum of half a million total jobs would be supported directly by the wind industry. It currently employs over 85,000 Americans and remember, this is an industry that's really in its infancy.

$C0_2$ reductions. This is like a no brainer. This is really, when you look at some of the recent statistics and they show the impact of their renewable electric standards on reducing $C0_2$, this has been – the RES's and their similar provisions have been really critically important to moving $C0_2$ reductions. Significant water use – and as somebody that comes from the southwest, from really a state that is drought stricken often, in Oklahoma, the southwest, the western states, this water use issue is going to be the next major national issue. The fact that wind energy uses no water is going to be a fundamental issue in generation. It is a cost that is not properly evaluated today. It will continue to be an even increasing cost because - for others to look at because this is going to be an issue where states go to war with each other over water, and water issues are a tremendous part of the cost of generation, so I think that we underestimate how much this issue is going to mean going forward.

Managing winds variability. First of all, for those of you – let me just get it out of the way before anybody asks the obvious question – wind is an energy resource. It's not a capacity resource. Reliability concerns often are founded really on serious misunderstandings of how the grid operates, how wind projects fit into system operations. Wind output is variable, it is not intermittent. Wind forecasting plays a key role today and will play an increasingly important role in the future. You can predict how wind moves up and moves down and it can play a role in how you address this issue, as a system control operator.

There is a cost to managing winds variability. It depends on the system's characteristics, but it's generally very low and we have many wind integration studies that have been performed in the U.S. and the E.U. that demonstrate this. When you're talking about the total operating cost impact, here's a whole series of studies that basically have analyzed the total operating cost impact of integrating wind. If you're talking about at the maximum $5.00 a megawatt hour and you're talking about the total megawatt hour of being in the neighborhood of $50 or so, you're talking about this being less than 10%. This is critically important to understand that the cost of integrating wind makes it very reliable and affordable and it is opportunity to really move this forward.

Let me talk a little bit about the wind integration lessons learned. Wind forecasting can significantly reduce integration costs by reducing uncertainty, the wind resources spread over larger areas are less variable. That is something we've learned in the southwest in particular. Diverse wind has very little variability on the minute-to-minute time scale and there's been a tremendous amount of work done in this area that really demonstrates this. Wind is easier to integrate on a more flexible power system, and that's really what we're talking about moving to is an even more flexible power system that includes and involves much greater ability to control these kind of flexible and variable resources.

Finally, market system operation reforms such as control area consolidation, can significantly reduce wind integration costs as can coordinated regional operations, and as coming from first President of the Regional State Committee of the southwest power pool where we implemented regional state tariffs, we put in balance markets in place. I can speak to this from first hand knowledge of how this works and how I know first hand this can happen.

Let's look at variability on the power grid. You know, I always get questions about okay, what about storage, and I heard it in the previous panel, you know, before we were able to get up here. Let's look at the cost and the flexibility supply curve, and I think one of the things that people don't understand is really there's things that you can do that are very low cost that give higher flexibility, right now, that really have had an impact and why you don't see in Europe storage all over the place when they're basically looking at 20 and 30 and 40% integration of wind into their supply. You're looking at really markets which is real time day ahead demand response, that's one of the most inexpensive ways to really provide and accommodate variability. Flexible generation, simplified combined cycle gas turbines, wind and natural gas or natural partners, traditional storage, and you're talking about here hydro, pumped hydro, gas storage. Again, a little bit more expensive, but again, another very important element in accommodating it.

Obviously, wind curtailment is another way, again, more expensive again, but again, another way of accommodating, and finally the storage that people like to talk about because it's techie and that is the batteries, SMES, CAES, capacitors and fly wheels. That stuff is being looked at, it's being researched, there's now money available and there will be money available to do more of this, but that's the higher cost issues and frankly we don't need storage in order to accommodate wind right now.

I really appreciate the opportunity to talk to you all. First of May we're having our wind power conference in Chicago, we expect over 17,000 people to show up, we have over 1200 exhibitors at the convention. If you want to learn more about wind and talk to all the latest – see all the latest and greatest technologies and talk to leaders in terms of development and manufacturers, please join us there. Thank you so much for having me.

Mr. Schaal: Thank you, Denise, for sharing your views here on your Birthday. And now we will – our final speaker for our panel hails currently from Palo Alto. Brian Hannegan is Vice President of Environment and Generation for the Electric Power Research Institute and in his capacity he leads the teams responsible for EPRI's research institute's technologies and practices that maintain a safe and reliable power plant fleet, but in addition, develop cleaner and more efficient power generation options for the future and reduce the environmental footprint associated with electric power generation, delivery and use.

Prior to joining EPRI, Brian was not a stranger to the Washington, DC area. He held not one but two jobs within the prior Administration, first as Chief of Staff for the White House Council on Environment and Quality, and then also as Acting Special Assistant to the President of Economic Policy. During his tenure he worked on a number of energy environmental issues including the development of the Administration's advanced energy initiative and also played a role in the implementation of the Energy Policy Act of 2005.

Brian also has experience as a staff scientist for the U.S. Senate Committee on Energy and Natural Resources and also has a Doctorate in Earth System Science, a Masters of Science in engineering, both from the University of California at Irvine and a Bachelors of Science in Meteorology from the University of Oklahoma. Please join me in welcoming Brian Hannegan.

Dr. Hannegan: Well, thank you, Michael for that kind introduction. Denise asked me, you know, she said be nice to me, it's my birthday, and I think what you're going to hear actually is quite a complementary continuation of the story that she tells with regards to wind, now extended to a number of renewables, because if we're really seriously talking about bringing renewables into the marketplace at the levels that Denise and Matt and David hinted at as being possible, then we've really got to look at a very different electricity system than the one we've got today.

And from the standpoint of an existing provider of power or perhaps a new market entrant it really gets you thinking about, well, what are the challenges that we're going to face, and I want you to think of the word challenges not so much as a negative but actually as a positive. These are things which, with all due respect to my colleague, may sound a little techie but they're actually quite necessary to bringing forward some of the economic, the environmental and the public policy benefits that we're looking for.

For those of you that are not familiar with EPRI, we are a nonprofit collaborative research institution, we're based in California but we've offices all through the United States, we work on public interest issues related to energy and the environment, and what I want to do today is show you some relatively new work that we're doing looking at renewables and policy and technology and sort of how this all blends together into a pretty bright view of the future.

It goes without saying for those of you who know anything about renewables that while wind is at the relatively far end of the curve, particularly on-short wind technologies are moving to maturity now with over 8 gigawatts of deployment last year as Denise showed. Not the same thing can be said for all of the renewables that are out there and this chart shows our view as of about 6 to 8 months ago as to where we saw things on the curve of development. That being said, a lot of the items that are on the left-hand side and in the middle are moving rapidly to the right-hand side and we're seeing a very robust development of a range of renewable options for the electric sector going forward.

I also want to make a point. We've segmented this into power and electricity – sorry, power and fuels – but in fact the two are quite interchangeable. Fuels are becoming an increasingly important part, particularly biofuels for electric generation, and some day we hope that through the plug in hybrid electric vehicle, renewable electricity can be a fuel right alongside renewable bio diesel, ethanol, and the other exotics that David talked about. So be careful, don't fall into the either/or, it's actually all of it and then some as I'll show you in a moment.

This is a chart from a recent EPRI report that shows a comparative levelized cost of electricity for various large scale generation technologies and this is absent subsidies, so this is absent the production tax credit or any other market driver but what we have shown you here is how those comparative costs change as you move the carbon price from zero on the left-hand side to $50 per ton on the right-hand side, and you can see why wind deploys really well with the production tax credit of about $21.00 per megawatt hour. That light blue line comes down into the competitive area with pulverized coal, PC or IGCC that blue line, and given the public positioning on coal technologies, it's no surprise that a lot of states are looking at developing wind energy as the first choice of generation resource. You've also got nuclear, you've got natural gas, you've got a whole range of options there, but the point I want to keep, and this is something that Denise hinted at in her slide, is that right now renewables are still out of the money without incentives. In our view, without long term cost production and advancement in the technology, it'll be a lot harder to achieve the kinds of significant share that we'd all like to see.

Some work that we've done recently springboards off of EIA's NEMS model platform with a very detailed, almost a plant in a unit by unit representation of the United States' electric system in our NESSIE model, so we take fuel and emissions allowance prices for all of the different pollutants and greenhouse gases from the NEMS model, the macro economic work that NEMS does, we put it into our every fine scaled model of the electricity future, and that allows us to say something in very fine detail with a number of iterations, some capabilities that NEMS does not have, we can talk about capacity expansion, systems operations under a variety of scenarios, and this helps utility planners and decision makers figure out sort of what are the right things to do from an economic and from a policy perspective.

We looked at 3 different scenarios in a publication that just came out at the tail end of last month. It's available at EPRI.com, just type in that report number there and you'll be able to download a free copy and get the full details, but we looked at three scenarios – the BAU or business as usual scenario with the production tax credit extended as far as the eye can see, a Federal RPS modeled loosely after the Bingaman proposal as of the tail of the last Congress, so it's based on the RPS policy assumptions contained in there and then a carbon policy case that mirrored the carbon prices that we saw in some of our modeling work that would follow the Lieberman Warner Bill, and we've seen something very similar in recent work that we've done on some of the newer proposals in Congress and you can see as listed there on those bullet points you get a nominal price of $C0_2$ in 2015 in this $C0_2$ scenario of about $27 per ton, so if you go back to the chart of the colored lines or the pixie sticks as we call them, we're about midway in the middle where all the pixie sticks cross and intersect, and there's a really diverse deployment of electric technologies.

We also can't forget the role of natural gas. If you look at the price of natural gas it has a lot to do with generation. At low dollars natural gas is the first to deploy. At high dollars it makes way for some other options as well. So we've got three different energy scenarios here and what's interesting is that as you look at how our model deploys renewables over time, and these are non-hydro renewables, its clear we get a significantly greater deployment of renewables, 35% generation share by mid century in a case where you've got both a production tax credit, renewable portfolio standard and a $C0_2$ policy, and in fact, the $C0_2$ policy is the biggest driver of new deployments and it works across the entire spectrum.

In the green area you see the wind capabilities, the wind generation share, much greater, biomass for those places that don't have the wind resources, even solar in concentrated form in the desert southwest where there's PV on rooftops, geothermal landfill gas and even waste to energy, all contribute and so while it's tempting to get locked into a one or the other scenario, to get to the levels of real sustainability within our electric power sector, it's clear we're going to need a number of renewable options to get there.

What's interesting is that even in our case with just a production tax credit, expansion is forecast with wind energy about 7½% and total renewables about 15%, and then obviously in the RPS case we hit the targets in the near term and then flattened off shortly thereafter.

The one point I want to drive home about renewables, though, is while the resource is variable, it's variable both in time as well as in space, and if you look at by NERC region in our model, you're going to see different deployments of renewables, and this is a slice that we take in 2030 under the RPS scenario, and you can see looking at the left-hand side with ECAR or with the [Erkot] region there in Texas there's an awful lot of wind being deployed but in the Tennessee Valley area, that tall spike there about two-thirds of the way to the right, there's a tremendous amount of biomass being deployed as part of what that region does to meet its portfolio standard, and then to the far right, California and Nevada, a huge investment in geothermal compared to some of the other regions, so realistically as we think about renewables we need to think about a portfolio of approaches and not just a few technologies.

Some of the keys that pop out of this study which are worth thinking about when designing your policies or your economic incentives is the overlay between national and local policy. If you have a Federal standard but then you have a state standard that interplays with that, how will those two either constructively or destructively interfere with one another in terms of getting renewables to markets? Is this really a wind portfolio standard in the sense that most of the deployments that will occur will be wind. In many areas that may well be the case. Some states have made some carve outs for other technologies. Those technologies at present and for the foreseeable future, without rapid technology advancement, will remain at a much higher cost and so the customers in those areas will ultimately have to bear that cost in the form of their electricity prices.

For biomass the biggest limitation is on the resource, and the resource economics are interesting, they're not insurmountable, but particularly when we start thinking about biomass for power versus biomass for fuel, with all the great things that David and Matt were talking about, one wonders if there's enough biomass to go around in a sustainable way, in a way that makes good use of water and makes good use of land use. So we want to study that and we want to understand the capabilities there as well.

Denise spoke very eloquently, I think, about the notion of the integration of the variable resource into the overall power grid and the jury is still well out, I think, on whether it's storage, it's gas backup, it's integration on the grid, it's a very different environment when wind is a couple of percent of the total electricity supply versus 25, 30, 35 or even more and we're just beginning to get experience with what that's going to involve. And we need to understand that at a national level as well as at a regional.

Again, a point Denise made, what about new transmission? Most of the models, NEMS included, our model included, have a very rudimentary approach to siting new transmission, to open up regions for the transmission of renewables. We really need to understand and be able to simulate that policy much, much better and that approach much, much better to get more robust belief in some of our economic assumptions.

And then the point I want to leave you with here at the close of this section is the real tradeoff between the RPS and the climate policy. While RPS lifts the renewables and keeps everything else constant, the climate policy actually lifts renewables to competitiveness while depressing the competitiveness of fossil units. Our model deploys a lot of renewables precisely because we retire a lot of existing fossil generation. If those retirements aren't there and demand is moderated either by a slower growing economy or improvements in energy efficiency via the smart grid, one wonders is there space for new generation going forward?

We have to think about the electric system as a system with pushes and pulls, but the bottom line is regardless of whether you think they're here in a small amount or in a lot of sizeable generation, renewables are here and so one of the things that we can do is help make them more affordable and more reliable than they are today.

And that's what I want to talk about now. We've been working with the American Council on Renewable Energy over the last several month to identify a technology strategy going forward for all of the renewables, listing the gaps in our knowledge, the gaps in our capability, the techie stuff that's going to be required to bring these into the grid and actually make these the backbone of the grid going forward. The draft is available on both the ACORE and the EPRI websites and you can see the two leaders there who would welcome your comments after you download it and have a chance to review it with your colleagues.

The technology plan covers the entire gamut of renewable issues, all the way from things like self-erecting wind towers to speed the delivery process to new novel coatings on solar energy PV to reduce the water use in PV applications, even processes like gently roasting the way that you would with coffee, biomass to allow you to match the btu content and the moisture content of the biomass so that it's easier to co-fire it with coal without the wear and tear that current co-firing of biomass creates on existing facilities.

Even in the water power area, EPRI's one of the leaders in identifying the opportunity as well as the technology for wave and tidal resources, for river and stream resources, even for expanding hydro power at existing dams in ways which help preserve and actually extend fish habitat. So there's a lot of technology areas here, integration is certainly one of them, and we encourage you to take a look at it.

One of the things that is being knocked down, I think, a little bit, as a myth within the industry is that integration has to rely on gas turbines. We've done some simulations with real live wind generation from a unit that's in the field today, several units that are in the field today, and said what if we tried to match this entirely with a dedicated gas turbine? And what would that do to the gas turbine over the life of its existence?

Folks, these things were not manufactured to have ramp rates of 10s and 20 megawatts per minute, to be cycled on and on, and off, and on again and off again. If you drove your car like this, it would be done in a matter of weeks, and so it really speaks to the need to have a number of different approaches, to integrating the variable resources like wind, like solar who deals with clouds from time to time. The issue of ramp rates right now is something that the future electric system has to be rethought and redesigned in order to accommodate at widespread level.

And that's where we come in. We work with technology vendors, we work with utilities, we bring collaboratives together to solve vexing research problems by doing work at the front end in our technology innovation program which really looks at breakthrough research, we work hand-in-hand with the Department of Energy and other laboratories on that kind of thing. We then have research programs all across the electricity spectrum to bring those breakthroughs into the electric market and turn them into useful products, or useful knowledge, that can be used to improve the electric system going forward. Once we've demonstrated that it works in the lab, we create pilot projects and then larger scale demonstrations such as we're doing right now with compressed air energy storage and the smart grid as well as a diversity of integrative approaches to bringing variable resources onto the system, keeping in mind that wind's not the only thing or solar's not the only thing that's integrating on the electric grid of tomorrow, or that's varying from one set to another.

You've got people plugging in their hybrid vehicles, you've got people running their electric load, you've got smart houses managing their thermostats and their cooling and their energy use. The energy grid of the future is going to be much more variable than it is today and there's a whole host of technologies and practices that need to be developed in order to accommodate that.

So we're investing significantly in renewable energy research to carry out the ambitious goals and gaps that are laid out in the technology roadmap we've developed with ACORE. Again, we hope you'll take a look at it and give us some comment, but we're beginning to do work now in all of the areas there on the right-hand side and we welcome you to our website at EPRI.com to take a look at what we're doing.

The final point I want to leave you with is, when we start talking about 50, 60, 80% reductions in $C0_2$ emissions from today's level, not just in the United States but globally which is what the IPCC indicates we need in order to head off the worst potential impacts of climate change. We're not just talking about renewables. Denise showed a chart that said here's what the 20% DOE goal would get us and here's where the 80% goes and there's still this white space in between. That white space has got to be filled with energy efficiency, with smarter grid, with non-emitting base load generation from nuclear and coal with carbon capture and storage, it's got to include plug-in hybrid vehicles, even possibly the expanded use of electrification. In places where we're currently using petroleum or natural gas now, if we can substitute electricity from an increasingly clean portfolio for those sources, we're going to make greenhouse gas reductions in those sectors too and that's what's going to be important to making sure that we hit the goals whether they're from climate legislation or a new global agreement, wherever those climate goals come from, we're going to need a full portfolio of options to get there in a way that's both affordable and sustainable from an economic standpoint over the long term.

So not without challenges, but with a lot of promise as well, and certainly as we look to the horizon, smart policy design does help bring technology into the marketplace, conversely if we don't get the policy design right, we can do a lot of harm in the way of developing the technologies we're going to need to both address energy security as well as climate change going forward. Thank you.

Mr. Schaal: Thank you, Brian. We'll have a few minutes for questions and I am quite impressed by the interest our audience has in the presentations we have here. There's quite a number of questions here and I don't think we'll be able to get through all of them, and I will say that a couple of these questions involve EIA projections and I would ask that Chris Namovich come up to the front at the end of the session and those people that have questions about EIA's assumptions and projections, if you would come up, we can have that discussion offline.

But first of all, first question, and this is for everyone on the panel. Nearly half of Americans can't name a renewable form of energy based on a recent survey. Is broader understanding and support critical to developing more renewable energy, why or why not? Go ahead, please.

Ms. Bode: That's my favorite questions. That's one of the reasons why for the last two years before I took this job I wanted to work with others to create a foundation that would support education on energy and the environment and I think it's because we haven't had that learning moment. I think what really happened and that we all saw in terms of energy and environment, we began that whole taking a look at energy and the environment when those hurricanes it – when Rita, Katrina hit and people started looking at supply systems, drilling rigs in the Gulf of Mexico, pipelines, they looked at generation, they saw these energy sources being leveled. It was having a direct impact. They could see what happened in the weather, what happened to cause energy disruption and they were feeling it at either the pump or on, and so I think that began sort of a learning moment for the public and these high oil prices last year have continued that emphasis and even though prices have come down, I think where we are right now in terms of being in this economic crisis where every penny still matters, even at a lower energy price, I think people have not gotten complacent about energy. I think they have incorporated – now, how much do they know about what different sources of energy – I think yes, the numbers show you that they still believe that, you know, maybe all electricity just comes out of the wall plug, you know, or your gasoline comes out of the pump and still there's not that complete connection, but I do think the numbers show that the public is getting more educated about it. They are more aware of it, and frankly I think that they have - the most important issue – they have incorporated the concept that energy does matter and that the cost of energy does matter and that the environment matters too. I think that's become something that has become increasingly important as well, and so I guess I'm – I've got a very optimistic view after spending the last two years working on reaching out to the public and talking about these issues, is they're hungry for information and I think it's – that's part of why I think this is a wonderful time for all of us to be in the energy and the environment, you know, place, because we can all contribute to that education.

Mr. Schaal: Okay, any of the other speakers care to address that issue? Matt?

Mr. Hartwig: Well, Denise is absolutely right. I think one of the challenges that we face – Denise and I representing industries at the trade association level but government officials and everyone in this room is avoiding complacency. You know, when the economy recovers and if gas prices aren't too high and things are going along okay, will the public slip back into the previous state of mind where everything's okay? Denise is right. They've come a long way, they're paying a lot more attention today because of, unfortunately, events that require them to wake up – Katrina and $4.00 and $5.00 gasoline will grab their attention. I think our challenge now is to seize upon their interest level right now and keep them engaged so that they can then tell the people who made policy in this country what it is they would like to see.

Dr. Hannegan: Yeah, and I think that Matt's last point there is probably one to expound on a little bit just because there's still a great majority of Americans and frankly people around the world, those who have access to electricity tend not to really think about where it comes from. They assume that the lights will always be on, they wonder why their rates went up when they get the bill and they look at it and they usually call somebody and yell at them. It's not really more of a – you know, well, why did my rates go up? Tell me, I'm willing to learn, it's more of a how could you do that you so and so. And so I think the challenge with public education is it's a double edged sword. You want them to know everything about the system because you want them to ride along with you as you make changes. That is, as I think all of us will concede, a very difficult challenge because the energy system, both liquid fuels and for power, is so very complicated and yes, there are these signature events, but just as soon as these events appear they also disappear, and public attention waxes and wanes.

I think it's more important that we focus on even raising the awareness and the education level of those who are making decisions, because in my time in Washington I certainly experienced decision making and policy setting that didn't really have a full understanding of what was going on in the system and where the levers were to pull that would make things better versus those that might actually compound the problems you were trying to avoid, and when we layer in energy security and economic development and jobs and you know, we want on the one hand with the environmental issue, we want the price of energy to be higher so that people will use less and energy efficiency will deploy and new technologies will deploy. On the other hand, the higher cost of energy's the very thing that depresses economic growth, and new investment. So there's a give and a take here that we have to make sure that those who are making the decisions really understand in detail and it doesn't matter which side of the aisle you're on, I'm not convinced that we have that yet to the level that we'd all like to see it from a community standpoint.

Mr. Schaal: Okay, thank you. Well, a softball for Matt. Could the corn based ethanol industry exist on an economic basis without the Federal subsidy?

Mr. Hartwig: Yeah, a softball, a great one. The answer is yes if you assume that it's an entirely free energy market. Take away all of the supports for all the other energy sources, fossil fuel, petroleum, others, yeah, we'll compete on that playing field. But recognizing that that isn't the case, the question isn't can you survive but is the investment providing a return, are you creating a new industry that is going to develop the kind of green jobs that you're looking for? Are you seeing an investment in an industry that is reducing the amount of oil we have to import from other nations? I think when you look at the tax incentive for ethanol, which I should clarify because it's often still misunderstood, goes to the petroleum refiner, not the ethanol producer. It is on the demand side. When you look at it in its totality, it is a tremendous return on the investment.

Mr. Schaal: Okay. Next question's for David Humbird. What does gasoline, hydrocarbons derived from fermentation gain us in terms of a carbon output $C0_2$ emissions, and I'll extend that just a little further and ask is NREL involved in or considering any of the issues associated with carbon mitigation for renewable fuel technologies?

Dr. Humbird: Well, for the first part making gasoline out of corn or out of a starch or sugar cane is not necessarily any better than making ethanol out of that same crop, but what I'm referring to is in the future once that technology, fermentation is mature and then once the pre-treatment side of it is mature, i.e., turning lignocellulosic – just waste biomass or grass and whatever into sugar that can then be turned into gasoline, that crop is not irrigated, it's not even necessarily fertilized, it has – it's not food and doesn't grow on arable land. That's where you can get a bigger carbon benefit then, say, certainly than petroleum and even then corn ethanol.

Mr. Schaal: Okay. Next question's for Denise but I'm going to bring Brian into this. The national renewable energy standard indicates a one size fits all solution that ignores locational differences. This will adversely affect the renewable poor southeast the most. Why should I, living in the southeast, support the national renewable energy standard when my electric bills will likely increase?

Ms. Bode: Well, first of all, if you saw the maps that I showed without even going to the electricity question, if you saw the job maps that I put up there you'll notice that a number of those manufacturing facilities already being built are in the southeast. In fact, you know, in the pan handle of Florida, General Electric has one of its largest manufacturing facilities that are building components for these turbines so this is not something that does not have a tremendous benefit for every segment of the country, but I would say that the renewable electricity standard right now – it's critically important to provide that national commitment because right now what we have are 28 different states that are doing, you know, their own thing. It makes it very difficult for the development of renewable energy to really – renewable electricity to really grow because you've got billions of dollars of investment chasing, you know, these different standards that are uncertain when you've got an integrated national grid, you know, that we really would all like to get to, so it's critically important, I think, that this commitment be there to move it forward.

Now, in terms of the Southeast, every study that we've seen demonstrates that in fact the southwest power pool that I was just with their head of transmission on Friday at a conference in the Gulf Coast, every single study demonstrates that it will actually reduce costs by bringing this power that's developed in the windy parts of the country, particularly for wind and renewables to those states that need it.

The Tennessee Valley Authority just went out for 2000 megawatts, to purchase 2000 megawatts of renewable power right now. They obviously must believe that this is going to benefit their rate payers in the Tennessee Valley area which is in the deep south. This is a tremendous opportunity for us to diversify our portfolio. One of the things I think people don't understand about looking at the renewable portfolio standard, the renewable electric standard is that it will really create an opportunity to diversify all parts of the country, not only for wind, but for biomass development, for solar development, for geothermal development, for hydro, I mean, it diversifies our portfolio and provides us a tremendous amount of diversity and thus greater reliability and energy security.

Mr. Schaal: Okay, Brian?

Mr. Hannegan: Yeah, and I think that last point that Denise makes is the most important one. We've had a substantial interest from a number of southeast utilities about biomass and all the different approaches, whether it's new biomass gasification which is not unlike what David was describing for bio fuels, whether it was co-firing of biomass on an existing unit, there's even some novel approaches about taking solar energy, even the low heat content solar energy that you get in the southeast and being actually able to create steam and feed that right into the steam cycle of an existing fossil unit. That speaks to one of the things that I think we caution about when we look at the renewable standards. From an economic perspective, you really want these things to be as flexible as possible to accommodate as many renewable opportunities as possible, to allow for a full and efficiently working market. Obviously if it's a regional market in the southeast at 20%, those renewable costs are going to increase the cost of delivered power and frankly, our modeling work which you can see in the study that I referenced online, I mean, you don't get anything for free. This stuff will cost you something, but the way in which you keep those costs down is to (a) advance the technology; (b) create a flexible and efficient market for the renewable credits; and (c) allow a diversity of renewable options into the marketplace because the resource base isn't one size fits all, so the policy ought not to be either.

Mr. Schaal: Well, thank you very much. We are over time and unfortunately we won't be able to get to all the questions. I'd like to take this opportunity to thank all of our presenters for being here and addressing our questions with good humor, and I appreciate your patience for staying for the entire day and we'll see you bright and early tomorrow morning.

Speaker: And again, Happy Birthday to Denise.

Mr. Schaal: Yeah, Happy Birthday, Denise. And those people who had direct questions about EIA's forecast assumptions, we can talk over here.

[END]