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## Session 7: "Natural Gas: U.S. Markets in a Global Context"

Speakers:

Glen Sweetnam, EIA

Michelle Michot Foss, Chief Energy Economist and Head, Center for Energy Economics, Bureau of Economic Geology, Jackson School of Geosciences, University of Texas

Benjamin Schlesinger, Benjamin Schlesinger and Associates, Inc.

Andrew Slaughter, Shell

*[Note: Recorders did not pick up introduction of panel (see biographies for details on the panelists) or introduction of session.]*

**Glenn:** Let me welcome you to the Natural Gas Session. This is the only session in this conference that's devoted exclusively to natural gas *[laughs]*. I'm Glenn Sweetnam and I'm with the Energy Information Administration, and we're very fortunate this morning to have 3 very astute and long-time observers of the natural gas market to talk with us this morning about their views on recent developments both in the United States, Europe, China, and around the world. So we should have a good session and a good discussion. Let me introduce each of the panelists. The first panelist is Michelle Foss and she is the Chief Energy Economist and head of the Center for Energy Economics at the Jackson School of Geosciences at the University of Texas in Austin. And then, Ben Slazenger is the Founding President of Ben Slazenger and Associates, an Energy Consulting Firm, and Andrew Slaughter is the Business Environment Manager for Sheel's Upstream Americas Exploration and Production. So we really are going to have several very good perspectives. Obviously they're much more accomplished than just the titles I gave you there and as others have mentioned the full

bios are in the agenda, in the program. So here's the game plan. What I'd like to do is start talking about just a couple of slides, putting the global gas market in context, just so we're all starting at the same place. And then I'll turn over to the panelists and we'll focus on the 3 major regions one at a time, first the United States, then Western Europe, and then China. And then we'll end by pulling back and thinking about the global gas market in general and how we see that evolving and how the specific changes that we discussed in each of those 3 major regions play out in the global stage. We're going to all work from the same slides and there'll also be a lot of interaction. As you have questions, if could write them on the cards. The volunteers will pick up the cards and bring them to me and I'll try and work them into the discussion, or, if I'm not able to work them into the discussion, I'll cover them at the end.

So with that then, let me go to the next slide here. And to the right, good and so there's just the game plan I just spoke with you about talking about setting the context then the demands...supply and demand outlook for each of the 3 regions. And then the expectations for trade flows internationally, pricing and contract issues, and then finally other key uncertainties.

So let me start then by just putting natural gas in the context of total energy demand. And what we have here are the numbers from the International Energy Outlook 2009, and it's showing total energy demand worldwide. And the main point I want to leave you with here is that natural gas provides about 23% of total energy consumption in the world. And under our reference case we that holding right at 23%, but I think there's others at the conference that I've mentioned that I'm thinking of — Christof Rühl — here mentioned there is an opportunity, a lot of uncertainty about whether or not gas will compete will against coals. So the numbers could be very different and I'm hoping we'll get into that today.

Now when we look at it globally, it's sort of the supplies and demands are distributed around the globe unevenly, and so what I've shown here are the reserves in

each of the regions. And also 25 years, our estimate of 25 years of consumption. So you can see that in the North American region for example, we have reserves of 319 trillion cubic feet but our estimated consumption over the next 25 years is 752. So you would expect normally that we'd have flows coming into North America and in fact that has been the sense of things until just the last couple of years. We see the very large reserve bars in the Middle East and in Russia. Really the predominance of the conventional gas reserves in the world is in those 2 areas. And then you have areas where the consumption is much higher than production such OECD-Europe and Asia and Oceania.

So with that then as being the context is there anything else you want to add in terms of the context, the global context?

**Michelle:** Well I would start for Andrew and Ben's reactions as well if...and I think the question of the day for us is whether this is how North America looks really. And with our new discoveries, our resource potential, our frontier resources, is this really what we should expect? Should we real...are we really a load center as opposed to a more richly endowed location, geographic location and then what does that mean? I think that's you know really what everybody is wrestling with right now in terms of our own natural gas future and then how that affects what we do and where we sit in international trade flows. And what that means for everyone else. You know what is that price signal that is going to flow out of the United States as we figure this out going forward? What is that going to do to all of the projections of LNG cargoes and other things coming our way?

**Glenn:** So maybe that's a good jumping off point to sort of give into the North American gas picture but introduce-

**Andrew:** I just have a couple of points. One on this global reserves picture, it's quite difficult to compare North America with the regions.

**Michelle:** Hmm mm.

**Andrew:** And this compares one year's reserves with 15 years of consumption. In North America we tended to have a very efficient development process.

**Michelle:** Hmm mm.

**Andrew:** And maintain an hour of the P/E ratio about 11 years. Constantly we've done that for the last 20 or 25 years or so. So clearly, even absent new discoveries, reserve growth and efficient development would actually probably keep reserves and consumption more in line over time than would be implied by this picture. Where there's other parts of the world they have stranded gas, they have much more need for big infrastructure projects. So the whole development process is much more lumpy and inefficient.

**Michelle:** Hmm mm.

**Andrew:** So I would make that *[inaudible]* to the significance of this slide. On the...can I have back-up to the first slide?

**Glenn:** Yes.

**Andrew:** The one–

**Glenn:** I'll see if I can make the machine work here.

**Andrew:** -comment on that.

**Glenn:** Yes.

**Andrew:** 20-30 looks like a long time and you could argue that these percentage shares would change that we've missed something in the full cost business as usual it never happens. But however 23rd is only 20 years ago...away and the inertia or the energy system which people talk about yesterday...the capital stock that's already embedded in the system-

**Michelle:** Hmm mm.

**Andrew:** Means actually it's quite unlikely that you'll have radical changes in this fuel mix globally over such a short period as 20 years. We typically think of a 35- to 40-year cycle in the energy system for more significant changes to happen.

**Glenn:** Ben?

**Ben:** Thanks, Glenn. I hate to make you back and forth *[laughs]*.

**Glenn:** Yeah, but no, that's fine.

**Ben:** These...

**Glenn:** Is that what you want to do?

**Ben:** For years, thank you, and I apologize that, you know, we're all jumping on your slide here.

**Glenn:** No.

**Ben:** It's good...its...I think the concern that I've had you know for years is seeing this huge disparity in proved reserves. The closer we look to how different countries define proved reserves especially in Eurasia, we see some huge differences between their definition and our definition. In fact, Stockmen, Yamaha are included and booked as proved where as we debooked in North slip of Alaska when the pipeline was cancelled the...you know in 1986. I think in our study that we're *[inaudible]* in UN on global LNG markets. What we've done is dropped the discussion of proved reserves and we go to P50. We compare P50 volumes across the center. It really looks different.

**Glenn:** Okay.

**Ben:** I mean the, you know, major difference is that the US, height of the US bar is about where the Eurasian bar is comparable where it's two-thirds or 75%.

**Glenn:** I agree with that too.

**Ben:** Oh yes. Okay. Well I think that tends to portray a picture of where things may go, you know, looking forward. I think if we look at proved reserves in any event, we're looking at a snapshot.

**Glenn:** So but what I'm hearing from all of you is that North America is much more balanced then rather than what the slide.

**Ben:** Yeah, and the way to show it is kind of to take a P50.

**Andrew:** Right, okay.

**Ben:** Looking in just on the previous one, Andrew, you know I don't want to pick out, but if you take a look at the very beginning part of the slide on the left-hand side — it's my left — you can see some pretty radical changes in the period of only a couple of years. I think you can see some very major changes. We've seen a huge decrease in, you know, with the economy in energy use.

**Glenn:** Right, it's too bad I don't have that percentage broken out for 1980, isn't it? I just don't know what that is.

**Ben:** It's a pretty large change.

**Glenn:** Right. Okay, well let's move along then. So the major story in North America as, Michelle, you alluded is the shale gas stories. So, Andrew, maybe you could start off and give us your view on the sort of state of play for shale gas production in the United States.

**Andrew:** Well the astonishing thing about shale gas production is that, you know, it's recently — it's three years ago very few people saw this coming and we were talking about, you know, potential stability at best in North American supply, therefore growing import needs. Now, shale gas has been in development and for a lot longer period than that, but there's this momentum effect from the early success of the Bonnet Shale in the Dallas Fort Worth area. That momentum effect turned out to be very, very rapid over 2008 and 2009 as new plays started to come in the systems. So shale gas has taken off very quickly, much more quickly than anybody could have seen as recently as 3 years ago, until there's an awful lot of scope not just in the US on this map but in Canada as well. So in the North American region there's a lot of scope for development. Now the pace of that development will depend on various things. My take on it is not that production will grow at some periodic ordained rate because the mark...because the resources are there. Production will grow in line with market needs. So, the beauty of Shale gas production is that you can...unlike more conventional gas production, you can ramp up activity and ramp down activity in a shorter time scale. You're drilling lots of

wells, so you can reduce the pace of the wells; you can reduce the number of fracks you put in a well and then go back and refrack later. You got a lot more levers to change the pace of activity according to the market needs. So I would say there's a plentiful resource to support the market but don't analyze supply just on the basis of supply potential. It really depends from the other end on how the market develops on the power side and some of the other sectors.

**Glenn:** Yeah, well get into that in a few minutes. And yes, it's Ben.

**Ben:** Yeah, this is...this is an amazing story. I sometimes wonder whether it would have constructed 14 BC *[inaudible]* receiving capacity on the Gulf Coast if we knew that this was going to happen at the time we were planning this. We...I just want to take, you know, 30 seconds and speak about a conference that we held a month ago here in DC. We were meeting the National Capital Area Chapter of the US Association for Energy and Economics in conjunction with CSIS. There were a number of panels. One of them focused on just the numbers. How much is there and I guess the things that struck me about that I tell you I had a hand in putting this conference...in putting that conference together and I just made it a point not to put wild people on the first panel which is the one about supply. I still have some people angry with me for not having, you know, kind of promoted them to on that *[laughs]* first panel. But I wanted to have an...you know, it was tired of hearing giant, you know, wild-like forecast. I wanted to hear something very level-headed and sane. We put [Bella Cross Pera?] on the first panel and, you know, and somebody from Wood MacK[enzie], John Schneider. And still it was a jaw dropper. I hadn't planned it that way. I had planned it the other way around. We're hearing numbers in 7 fields alone, 2 in Canada, *[inaudible]* river, and the 5 big ones in the US. Several thousand trillion cubic feet of the total potential, 2 to 3, you know, I...that's just the counting I didn't like *[laughs]* unless it was coming from somebody very conservative. The numbers are very high. And the other surprise, I think, was how we've seen studies in the recent past that put the numbers like $6-7 on

this kind of gas. That's not what we're seeing today. Only within the past 9 to 12 months. Less than a year, we've seen this fall to the 4.50 and below range, even below $4 in some areas. And that's why production, you know, continues or at least holds when prices, you know, that are long since...as long as they're gone below.

**Glenn:** So good, so very large numbers but...with there are also some challenges associated with shale.

**Ben:** A lot of technology.

**Glenn:** I mean, Michelle, would...what's your view on this?

**Michelle:** I think it's astonishing what a $12 price signal does to drilling *[laughs]*. That's what I think is really astonishing. I agree with Andrew. I think this is going to be...the pattern of development is going to be very responsive to the market for a whole variety of reasons. I actually think that ultimately the resource space could be even bigger than what people think they can imagine now if we really do have a technology revolution and we can get...we can produce methane from the *[inaudible]* scale fractures and poor networks that exist in these rocks. And that's when...that's the interesting thing about this. You look at a sample of Shale from any of these locations and you can imagine something that looks like shale like a black chalkboard or something. What we're doing now in terms of drilling and treatment with hydraulic fracturing and extraction and exploitation of the resource is a deployment of technology and unconventional reservoir, but it's conventional technology. It's stuff that we know how to do. Where there have been some major strides in terms of improving that. And combining lateral drilling with fracking strategies that really optimize production from the resource but try to imagine a universe in which you're in...what a lot of folks referred to as nannodarcies. The poor spaces are so small but you can only see them through electron microscopy. Thin sections under electron microscope which is what all of our guys do at the Bureau of Economic Geology when they really want to understand this. New drilling materials, new materials for fracking would open up that universe. And I've

started thinking about a thousand years of shale gas supply. If we really do this and you can figure out how to do it safely which comes to, you know, some of the challenges that you raise. Water requirements for shale production, produce water as-as you produce the natural gas, the kinds of things that you need to be able to do to control the down hall environment during fracking. I mean all of those things that are in conversation now that are in discussion, what are the best practices? What is the industry doing? How is this done? All of these bases are different. All of the poor networks across all of these bases are different. The geological environments for the shales are all different. So there's a lot still in this stage of development that people are learning how to do and learning how to deal with.

**Glenn:** Yeah.

**Michelle:** But ultimately, if we're successful in managing all of that and we can sustain the development of the resource through all of the normal business cycles that we're going to have in the industry and everything that everyone has to deal with to be able to mobilize capital and come into these place, it's really an amazing endowment to have for this country.

**Glenn:** And what I hear you saying are partly it's going to depend on the market and the price.

**Michele:** Hugely depends on the market.

**Glenn:** And then...but there's big opportunities for technological, for this continuous technological improvements.

**Andrew:** And I would add one further point, Glenn, which is, if you look at the map and you include Canada, the geographical spread of the resources is very different from the conventional resources. It's much more diverse.

**Michelle:** Very diverse.

**Andrew:** And diversity of supply sources adds to reliability and security of supply. So the more places you can get gas if, you know, hurricanes in the Gulf take

down pipelines and offshore platforms, if, you know, tornados in the Midwest shot down drilling operations, there are lots of other places to draw a gas from in the short term.

**Ben:** *[inaudible]* actually during the hurricanes, you know, several years ago in Louisiana when we saw that some onshore pulling points were running fine.

**Glenn:** Yup.

**Ben:** Wait a minute, all these guys coming from the offshore. The offshore is blown away. How's that happen? Well this is how it happens.

**Andrew:** Right, so let's -

**Ben:** Major end.

**Glenn:** Good. So let's turn our attention to the market then now. And, Ben, do you want to talk about where...if we do have this large increase in gas production, the potential for large increase in gas production...where do you see that being used?

**Ben:** Well I could say natural gas vehicles. You know I have driven these for 7 years. The only house in Maryland where you can fill it on, you know, and all that. And unfortunately, I don't see it in that sector as much as I had wish, although it's not from the lack of trying. I know it's got to...increase has had to come in power generation and I think as prices have signaled in the last few years, we're going to see coal displacement. I don't think we've got enough gas right now in production to displace, you know, *[inaudible]* coal, but we're going to see some coal displacement. And gas, you know, is picking up the future from coal.

**Glenn:** When you think about coal displacement, what price do you think of as a sort of well hitter? Henry, half price, you got to be down that?

**Henry:** It's hard to say because a lot of the displacement takes place away from the Gulf where prices maybe a little bit higher. I think in the, you know, in the price range of 3.50 to $4.

**Glenn:** Right, so when the market's down, get's under $4, we start to see some of that switching.

**Ben:** Sure, in fact many of the plants are, you know; of course, it all depends on how the pools are dispatching. Who owns the plants and how they're bidding them. I won't get in to that, but just look at the long range. I also see good growth. *[inaudible]* as well in commercial buildings, markets, residential and commercial buildings markets, even while energy efficiency gains, you know, are being made, as they've got to. You know I think distributed generation is going to increase in other innovative ways to use gas. I'm seeing a lot of interest in commercial buildings.

**Glenn:** Okay.

**Ben:** Especially when prices were down.

**Glenn:** Andrew, you see this any differently?

**Andrew:** No, I think the power sector is really the key to the-the gas market. Other things like vehicles will be much slower to take off. Ben talked about the short-term switching. If you look at the long-term capacity editions, gas competes with coal on an investment basis taking into account the investment cost of coal plant versus gas plant. It competes to price well known as $6, if you take into account the different efficiency rates, heat rate factors, and the different environmental profiles of the-the plants. So it's very competitive and within any possible fees, possible price range that we could be talking about in my view.

**Glenn:** Okay, good. Well with that we eventually move on to sort of the supply-demand balance.

**Michelle:** One little plug for the industrial customers because there is a lot of discussion about whether or not this endowment could lead to and then...revitalization of manufacturing industrial activity in the United States. And there are some varying opinions about that and, certainly within the gas industry, some interesting politics that are emerging. But I think it's worth thinking about. What drives industrial customers away or feed stock prices that they can't manage? What will attract back and cost them to make a new commitment to capacity here in the country or feed stock prices they

think they understand. And I think this helps, you know this, certainly this...having this resource and understanding it better and being able to productively bring it in into the marketplace is very alluring to the industrial customers. There's lots of stuff to sort out but I think there's a possible turnaround there that we could achieve.

**Glenn:** And it sounds like when you're talking about the ability to sort of ramp up and ramp down production, you might have less volatility then in gas price as you think or how do you think that will shake out?

**Andrew:** Well, it's nature. There's volatility embedded in this market because of the supply and demand swings, the weather impacts. So it's probably structurally going to be a bit more volatile than other markets. I think the year-on-year variations in annual averages that we've seen in the last 10 years or so, those ranges will probably narrow but the seasonal volatility will remain just as wide.

**Michelle:** I think the important thing to understand is that these are what we called resource place. We know that the gas molecules are in place, the challenges of extracting them from the rock. When producers prove up production on lease-holds, they are living gas in place. So they have proved undeveloped production behind pipe from drilling and testing, and so that market responsiveness that Andrew had talked about, that's really how it happens. You're not starting from scratch exploring rank well, cut wells. You're going in with progressive development of lease-holds based on what you know is in place. And I think that's an important variable, a new variable actually that is going to impact price movements going forward in contrast to, you know, how cycles in the end have developed.

**Ben:** Before volatility. I have some disagreements with my friend here. I think we're in for some very significant volatility in the next several years as a result of huge amounts of LNG entering the market. Shale continuing to enter the market, you know, changes in national policies that are going to throttle, you know, gas or whatever they're

using down for renewable...I think that there's so many pushes and pulls in the marketplace that I see we're in for a period of significant volatility.

**Andrew:** This point about sort of annual averages becoming less volatile, is that…

**Ben:** Two to five years, and I can see a lot of changes.

**Glenn:** And for the industrial perspective that is probably fine 'cause they could contract –

**Michelle:** Well, I...no. Well, you know, industrial customers are sensitive to volatility, but they have options and right now what they should be doing is negotiating bilateral contracts *[laughs]* and taking advantage of the price environment that they're in and they're actually starting to do that. And it's really...a lot of volatility is associated with market structure. Electric power exacerbates that. That's something that we are really learning in Texas. We have a very interesting laboratory in Texas right now for all of these. And as different markets structures evolve and different contracting approaches evolve, I'm not sure that I agree that, you know, that volatility will as big an issue there. There will be other things but –

**Glenn:** Good, okay. And I guess before we leave this, we've already gotten a couple of good questions on this. One is, what is the probability that fracking is contaminating drinking water? And if it's not fracking, what is causing the contamination?

**Michelle:** People have done a lot of work on this over the years. We've done work at U.T.; other universities have done work. Other research labs have done work. A well that is properly drilled and cased, contamination is almost impossible because your drinking water supplies are above the reservoirs and there shouldn't be any communication between drilling fluids and aquifers. Now having said that, nobody wants a situation in which best practices are violated. Now I think that's always a challenge in every business, I think overall for the industry. The record on that is very, very clear.

Most of the problems are associated with surface accidents. And the surface accidents have to stop and they have to be dealt with the right way. There's a lot of concern about regulatory oversight and states that haven't had to oversee a lot of drilling operations in recent years and they're beefing up stabs and beefing up practices and it's a process.

**Glenn:** Do you see the Federal Government stepping in then?

**Michelle:** Well I don't know whether I want to go, you know, out on a limb with the projection on that. I mean I think there is, you know, oversight. Everyone has to figure out the right approach for that. And I mean the most important thing is to build confidence, public confidence, and have public confidence in the industry and

**Glenn:** I think the answer of the question…

**Michelle:** The question is the best way, you know, what is the best way to do that?

**Andrew:** To answer your question directly, I think the Federal Government is doing absolutely the right thing by instigating a study, a national study.

**Michelle:** Yeah. A study will help a lot.

**Andrew:** Potential water contamination. I think the issue isn't so much that they are on different plains. The ground water is at 2000, 1000, 2000 feet. Now the Shale's at 7 or 8000 feet. Let's say it's the potential for fault...for causing faults that are...that may have unforeseen consequences. It isn't benzene pumping into the shale. You're not pumping benzene to the shale. It's the fact that you maybe opening up some pathways for benzene that's already there, you know, into ground water. That has been I think the issue, not the water.

**Ben:** And I would say as a final point that the company has taken this very, very seriously with or without regulation, so proper well completions is absolutely the top priority of the Safety and Environmental Integrity. If we have not even a spill, an incident which could have lead to a possible small spill, that's the top of the agenda, at the very senior level in our production organization meetings. And always very detailed

postmortems about how to avoid and minimize those risk because it's not just about responding to regulation, it's about reputation, protecting public safety, and maintaining the integrity of operations. So, without any regulatory overprint we take it very seriously.

**Glenn:** Okay, very good. So then let's then move to the overall balance then. Given what you've all said about production and the potential for production and the outlook for consumption and increase in the power sector, I mean, does this look about right to you that gas import dependence for the US declines from its current 13% to about 6%? Do you see we won't be that dependent? Do you see though we'll probably have more LNG imports?

**Andrew:** Well this chart includes flows from Canada as well.

**Glenn:** Yes, yes.

**Andrew:** It's not just LNG. But it looks a very reasonable outlook to me.

**Michelle:** Yeah.

**Ben:** I think the interesting point is how huge the swings will be on a seasonal basis. I think we're likely to get a deal of LNG coming into the Gulf in summers because of our storage capability. And likewise in the winter, we'd like to get a good deal of energy in the Northeast. As our, you know, winter demands rise there, looking evenly out, I think direction is probably...it may even be...you know, it may even be a higher...it may even go to exports at some point. And I mentioned this about 6 months ago, and we heard through stuff in the conference and you know I had to sit down. I had a broken arm that's, you know. But the fact is, you know, is we may see a period of exports if there was half as much shale. You know Michelle is probably mad at me because it's a thousand year statement.

**Michelle:** *[Laughs]*

**Ben:** That's just what I try not to...

**Glenn:** Right. So hold that thought. But if it's only a hundred –

**Ben:** And then we're likely to get export.

**Glenn:** So hold that thought and talk a little bit about what does this mean for the gas in Alaska? I mean, we're currently re-injecting 6 PC *[inaudible]* up in Alaska.

**Michelle:** Right. I think there's a demand for Alaska gas that's you know apart from Lower 48; it's a factor, it's something that needs to be developed. Alaska needs gas itself. There are customers in Canada. If you go to Canada, there are customers for LNG if you go the LNG route. So I think that's kind of a whole distinct question. Really it's a resource that has to find a home. It has to find a cost structure *[laughs]* in order to find a home. I mean that's biggest challenge.

**Ben:** I agree. These people need the gas, they need to find a way to perhaps pre-build a major system over the Brooks Range to, let's say to, the rail belt to Fairbanks and then be able to use that gas, come down the rail belt and to South Central Alaska and use it to backfill exports. I think it's imperative to get moving with something like that because there a need for this gas. There just isn't a need in the Lower 48 at this point. Maybe many years before there is, but I see that the conversation that Alaska's beginning to move toward kind of an interim step like that.

**Glenn:** So it's used within the state?

**Ben:** That's right.

**Glenn:** You see it exported there?

**Ben:** It's kind of a prevail, you're not going to get to cross the Brooks too many times *[laughs]*.

**Michelle:** Right.

**Ben:** But so you do it once and you do it big.

**Glenn:** Okay.

**Ben:** And then you rather than continue on another, you know 2000, 3000 miles to Alberta which is a bit like carrying coals to New Castle with the Horn River in Montney, you know in Alberta, gas. It's probably best to move south down the rail belt to Anchorage into Cook Inlet area, back feed the LNG, go into the Pacific with LNG

supplies. I realize this is a higher cost structure than a lot of LNG that's coming into, let's say, you know, Tokyo as a point of reference.

**Michelle:** But it's a shore-shipping distance. So you kind of offer price that way.

**Ben:** The prices, you know, may be favorable and it's a good way to move...to continue development and, you know, in the *[inaudible]* of Alaska. But they really do need this way.

**Glenn:** Okay, okay. Well I think we've covered the US pretty thoroughly. Let's shift our focus now to Europe, Western Europe, OECD-Europe, and is the picture there the same in terms of the demand outlook? Looks like most of the growth really is in the power sector there. Do you see gas backing out coal there?

**Michelle:** A lot of the same battle lines are being drawn. A lot of, you know, it looks like, you know, switching from coal. Displacement of coal is the debate that everyone is having. There are a lot of similar debates in Europe on how to balance renewables and make all of these work on grids the right way so they're struggling with a lot of the same issues that we are here. And cost allocation, who pays, who pays for back-up generation? Who's paying to deal with liability issues with renewables? All of those kinds of things, but I think basically the market structure looks about right. I think, you know, they're watching the development here of our shale place really closely because they have a bit, and they might want to test their own shale basins in certain locations and see what they've got. And, you know, certainly from their point of view, it's an energy security parameter. They'd like to have something that balances their major importing, collaborating sometimes, sometimes not, country that they deal with which is Russia.

**Ben:** From what we've seen in Europe, I'm you know very concerned that they need to...you know, gas is viewed differently in Europe than it is here. It's a very scary situation for people in Europe to see the battles that are taking place east of them over transit. They do not have an open access industry the way we do. It's only in a few

locations. So it's still basically a planned and country *[inaudible]* dominated industry. Europe, however, is under enormous pressure from potential shale supplies. Not so much that we're going to export shale to Europe tomorrow, but we are releasing, in effect, LNG that was put in for our market, that the world ginned up for our market, into Europe. That's literally what's taking place. They have to –

**Michelle:** That's good. I mean that's one of the things that we're worrying about.

**Ben:** Yeah, it's good but I guess my concern is –

**Michelle:** Was having to bid our LNG prices.

**Ben:** Just where I was going...this is my, you know, with no-knocking as for *[inaudible]*

**Michelle:** *[Laughs]*

**Ben:** But the fact is the shale places in the United States were not developed by majors for the most part. They were developed by independent, the independent sector. While majors were developing place elsewhere in the world, both gas and oil. It's been something where the majors have had to come back in. And I hate to generalize this, as we all know, there are many, many exceptions to this. Chevron, rather Chronicle Philips, has been active. But for the most part, what's happening in Europe is that majors are leading the shale development in Europe, and I guess that is okay. It worries me a little bit whether they will really be able to reach their potential because in effect this gas may be offsetting other gas of some of the same companies or supply. That wasn't meant to be some kind of a knock or anything, it's just a concern that the Europeans need to be sure that they try to develop a diverse gas producing sector and they don't really have one, I'm sure.

**Glenn:** Yeah, Andrew, do you see it the similar way?

**Andrew:** I see it quite similarly. I think on the supply side, shale gas clearly has potential in Europe. It will take longer to develop than in North America 'cause they don't have the same market structures or supply change in place that we do here. I think the

strategic importance of shale gas in Europe is that it's in places like Poland or Hungary which are traditionally dependent on Russian gas much more than Western Europe does. Western Europe has the old EU, if you like has more options. But those Eastern European countries — Ukraine, Poland, Hungary, etc. — they're really looking for more diversity of supply. And if they can do that, then that will embed some this demand in electric power sector in those countries. If they don't manage to do that, then probably some of these electric power demand growth re-remains with coal.

**Michelle:** Yeah.

**Andrew:** Because they're also...that is also a coal rich region of Europe. So that's what's in play there. I think, you know, old EU traditional Western Europe is very mature and won't change much but those dynamics will play out in the former Eastern Bloc.

**Glenn:** Right. So, when we look at the supply-demand balance for Europe, we see a different picture than we do for the US, and this has some pessimism about shale developing as robustly in Europe as it has here. But Europe really has this abundance of sources. Obviously the gas from Russia, the LNG terminals that have been built, and that's created stresses in that market. I mean do you see...we had talked a little bit about the take or pay problem in Europe, and do you see gas diverging from oil equivalent pricing in Europe?

**Ben:** This was kind of a substance in my talk, you know, last month. I...and without going over the whole thing, I think that, you know, of course we've seen gas prominence at 15% of its supplies will be pinned to spot prices which is a real breakthrough. I think the French work very hard to negotiate that *[laughs]*. And of course it's for a triennium. Your paying contracts are often in triennium pricing periods just like we used to have bienniums before price controls were released in the United States. They have triennium contract pricing and the triennium business in effect for, has already begun this January 1st, 2010. Having said that, yeah, they maybe on the cost of

a kind of contract's crisis; ours was brutal in the 1980s. Many people are you know too young to remember it. I think I hate to say that. Speaking as the old man in the crowd, the reality is European contracts do have. in general, more market responsiveness than US contracts had in some respects.

**Glenn:** Okay.

**Ben:** They have triennium renegotiation periods. Now the renegotiation in many cases may only be as exactly which type of oil we use, which oil products were *[inaudible]* percentages among oil products that we're going to price the gas to...it's not...these are not, you know, available as spot gas instruments the way our long term contracts are now into industries. But they are looking hard indexation as they are in Europe, at ways to try to broaden indexation.

**Glenn:** Do you –

**Ben:** It's possible they may survive.

**Glenn:** Do we have a similar situation where marketing companies would go around the incumbent utilities to serve markets at lower prices?

**Ben:** That's begun, of course.

**Michelle:** Well, you know, after the first big brawl after a couple of years ago on the Ukraine transit issues and things like that, I think people...or at least it looked arms length, like more serious discussion about liberalization would start up and to provide more flexibility in the system and kind of break-up some of the monopoly contracting, long-term contracting and that sort of thing. You know, I think there's still a lot of debate about that. And I think, you know, from the European perspective there is still...there's a major seller of gas to be dealt with. It impacts politics a lot, and more than one would think given all of the modern options that people have, and it creates sensitivities and that, sort of, still seems to affect how people think.

**Andrew:** Yes, but I think –

**Michelle:** But that's slowly changing.

**Andrew:** I think the...if you look at the mix of suppliers to Europe, whether it be Russia, Algeria, Norway...I mean the traditional set of supplies. They're all used to the oil link...oil index contract model.

**Michelle:** And comfortable with it.

**Andrew:** And they've used it for many, many years. So it's not a question of there's a new competitor on the block who want to blow that system away. I think they're all used to pricing on that basis, and it will take more than just market pressures or competitive pressures to destabilize that. I think on the sup...on the balance side, it's quite significant that we've seen you know yet another delay in the Stockmen development, in the Yamaha development. I think it's the second or third set of delays, which shows that maybe gas *[inaudible]* is pulling back from assuming that it can control some of the market as it has in the recent past.

**Michelle:** Right.

**Ben:** Now I think a lot of it is also...relates is the commercial mechanics in Europe and we've been kind of talking around. The fact is, in this country, we've evolved with an independent pipeline sector. For better or for worst, we've got one and it serve us quite well in the transition to open-market pricing. So as marketers came in, they could deal directly with pipeline, and the pipeline was an independent entity. It was required to be that way under law going way back to the 20th century. Europe doesn't have an independent pipeline sector as such. The pipelines are a branch of something. Either they're the national government or the gas and oil producing sector or the electric. It's not an independent. As such, it's tougher to, you know just kind of command. You know, we have an army who's been trying for 20 years to waive the magic wand and have them to go to open access.

**Glenn:** Okay. So I'm hearing that it's still not likely that we'll have divergence between gas and oil prices which is –

**Michelle:** Yeah.

**Glenn:** It'll create some interesting trade and opportunities in the LNG market.

**Andrew:** Well not in here. I think pressures are enormous and they can rule at times.

**Glenn:** Yes, yeah. So let's move to a region then where there's less decades of historical gas used. Let's move to China then and talk about the market there. Shall we? Lot of growth there, still relatively small in the grand scheme of total Chinese energy consumption, so lots of room for more growth if you think...do you think that's likely?

**Ben:** Well what we're seeing is, it is a kind of pressure on the major LNG importers in East Asia — Japan, Taiwan, South Korea. With China coming on to the market, they are not willing or they have a...apparently they have indicated an unwillingness to contract the way the traditional contractors are running contracts for LNG. In addition, they have a source of pipeline gas although it's 4000 miles. The Turkmen pipeline is complete. So Chin...and third, China, if we go to a P50, we go to a P50 kind of, you know, reserve expression, China maybe way up there. They claim in papers that we've seen to have a lot of shale gas potential. Often this goes hand-in-hand with coal bed methane and coal seams. So it's not surprising given their enormous reliance on coal that the Chinese may wind up as a significant shale producer and with those things put together, we can see some real pressure on pricing in the long run created by the Chinese with their enormous demand. I think it's great that they've got shale gas. Thank heaven, you know.

**Glenn:** Right. So you're...it sounds like you're saying the Chinese will put down more pressure on prices?

**Ben:** They will.

**Glenn:** Or -

**Ben:** They will. It...you know clearly the demand is very high but they've also got a lot of coal and they're, of course, proceeding headlong. Having said that, people are all kind of...the conventional wisdom is Copenhagen was a failure, Copenhagen was a

failure.  Copenhagen was not a failure. Copenhagen may have proved to be a raging success if, in fact, it had the effect of embarrassing the Chinese into not going so headlong on coal but focusing more on energy efficiency, gas, renewables and natural gas.

**Glenn:** Okay.

**Ben:** They may well have that effect on them. It's hard to tell overnight.

**Glenn:** Yup. Not showing up in the numbers yet but maybe soon, yes.

**Andrew:** I think, you know, this would be interesting if you showed history on this. If you go back to 1990, gas was less than 2% of Chinese energy demand; now it's somewhere around 4% I believe, so that's either a doubling of gas or it's a 2 percentage point increase and I'm not sure if it comes to the same thing but it sounds very different. Going forward, I think the numbers potentially could be quite higher...a lot higher than this. Remember that China, despite its coal resources, is just about to become a coal importer. They don't like exposure to long supply change and global pricing if they can avoid it. So that is certainly an additional pressure to maybe switch some growth to gas. That's on top of the local environmental quality issues that they are having to deal with increasingly, and, so, if they have both...a bigger domestic gas resource than we think and then also developing pipelines from Central Asia and from Russia plus a lot of LNG terminals around the coast...that gives them a diversity of supply options which could support a significantly bigger market than shown here.

**Michelle:** I think that's true. The one caveat on the domestic resource space is that Chinese geology is very complicated. Developing this shale place, I think, is going to be challenged by that. If then to take what we do here and across the Pacific with the same approaches, the same strategies and technologies, the desirable thing is basically a blanket reservoir and then...and that doesn't exist in China. There's a lot of fracturing, a lot of tectonic activity, and so that's going to need to be tested and we'll what happens, and certainly, if you look at their coal bed methane resources, it certainly has

been challenging for them to try to extract that. It's also, you know, different there as opposed to what we're accustomed to here and what we see in our own basins. So I think there's some caveats there on their own domestic production.

**Glenn:** But it sounds like this 37% import dependence maybe in the right ballpark in terms of –

**Michelle:** But they're going to be aggressive, I think.

**Glenn:** In terms of imports. So you'd say higher than that then perhaps?

**Michelle:** I think it's going to be at least that much, you know. It's...I think time will tell, but I certainly think their positioning for I think, you know, maybe a bit in contrast to the experience with coal. It looks like actually they're trying to participate in the LNG supply change globally. It looks like they're positioning that way and so I think there might be some different market dynamics with that as opposed to the coal business for China. So I think that might actually favor, you know, a little more of an aggressive outlook.

**Ben:** So maybe you've got the right number. I think it's high. I think they will aggressively develop their domestic resources, particularly their gas resources. Complex as the geology is, it's complex here too. It's complex even within Pennsylvania. But, you know...and it's a lot more than shale. You know, a lot more than the geology. They're going to need pipelines, you know. They need a good gas using infrastructure but I kind of think they're...it's going to be less. I don't think they're going to let this happen.

**Andrew:** Well I think you could get to the same result volumetrically with a larger market and a smaller import share but the molecules of gas could be in the same ballpark. I mean it's very tough to distinguish between those 2 impacts.

**Ben:** You know what, maybe like ours, looking at the chart that Glenn showed...showing that kind of steady and declining US import, this thing of...as I mentioned there the, that's an average of a lot of things that are going to be taking place

on a seasonal basis. It could be that China with a very cold northern climate, you know, maybe a large importer in the winter.

**Glenn:** In the winter, so they got a seasonal storage resource.

**Ben:** So they develop backward storage resources, yeah.

**Glenn:** Okay, well, so let's sort of move from looking at the individual regions to thinking about how do we put this whole market together? What I've shown is just a chart that came out of the hard truth report that other people had mentioned a couple of years ago. And it was this view that, although historically most of the LNG business had been Asia, in Japan, Taiwan, South Korea, and that really was where all the action was historically. We were expecting, or they were expecting, a shift to growth in LNG into Europe and growth in LNG into the US so that it would be a much more balance market that way. But given what we said about shale gas now, you think that this picture changes?

**Michelle:** I think *[inaudible]* is going to be skinnier *[laughs]*.

**Ben:** Yeah, there's noted change, I think, and you captured it in a couple of slides that you're going to be showing. I think the...that should not be taken as a message that the LNG business is somehow dead and –

**Michelle:** Not by any means. I mean one of the things and by the way is that we don't import LNG just for the methane, we import it for the liquids. And so for the Gulf Coast facilities, that's still a consideration in terms of traffic there and so, you know, I think that it has to be taken into account.

**Andrew:** Yeah, I think the flows will probably be a little lower and the Atlantic basin then shown here, probably the Pacific trade is about right, but there's certainly...it's as everybody says, this is not going to go away. It has an important role in...

**Michelle:** Very important role.

**Andrew:** Regional and seasonal load balancing. An important role is a backstopping case shale gas development doesn't go as fast as people think it will. So it's very important to have the option to remain connected to these markets.

**Glenn:** So a lot of option values associated with those reclassification terminals we built.

**Michelle:** We just have to figure how to pay for the option *[laughs]*.

**Glenn:** Right, someone may lose on their bets perhaps.

**Michelle:** Yeah, right *[laughs]*.

**Glenn:** So we do have this big ramp up and liquid action capacity. So what I'm hearing you're saying is that it could come to the US seasonally but it's going to have to compete against our prices here. It sounds like we're going to be at oil parody prices in Europe but that maybe with the other side of the seasonal trade.

**Andrew:** I don't necessarily see it that way, Glenn.

**Glenn:** Yes, good.

**Ben:** I think that oil pricing in Europe is...maybe, I didn't make clear where I was heading with my, you know, my thoughts on structure and market mech-

**Glenn:** I might have missed it.

**Ben:** I think will...no, I apologize. I sometimes just kind of go on and with a thought. I think that it will weaken. Oil pricing, oil indexation is going to substantially weaken in Europe. And it may well weaken in Asia too for the reasons that I'd discussed. And I think markets will already...you know markets will balance in a way that will send LNG, you know, in both directions, and, again, this may only be seasonally but we'll see that, you know, for example, right now the spot markets such as they are in Europe and in a lot, it's the NVP, you know British market...North Western Europe *[inaudible]* and a few other points that are not *[laughs]*, that are pretty liquid but still these points are lockstep, and lockstep not with Henry Hugh but with Northeastern and Eastern Canadian, North Eastern US, and Eastern Canadian points. Take for

example, Algonquin city-gate. The price of NVP gas, you know, Zebro and the Algonquin city-gates price are almost in lockstep. The difference has appeared in the winter when there's a storm on one side of the Atlantic and not on the other. That's about it. For the last 14-15 months, they've been so close, you know, time will heal wounds. I'm not saying the Europe will necessarily all price turn. There will be times that the pricing signals may flow the other way. But Michelle referred to price signals flowing eastbound across the Atlantic. I think that is what we are seeing right now we haven't been seeing for the last year and a half.

**Glenn:** So it is interesting to talking about maybe the US becoming a little less volatile in terms of gas prices but the global LNG market may be coming more volatile?

**Andrew:** Well remember, too, that in North America, spot prices, they are the market price. They cover 100% of the trades in the LNG market, and in the pipeline market in Europe, spot markets are there, but they cover a much more smaller portion of market activity. Most gas, even now, is traded on this index, link contracts, and so what we're talking about is not something that's going to completely change the whole structure of Western Europe market. It's relatively small portion of the volumes that are out there.

**Glenn:** And we'll stay segmented. In other words it will be price...the pricing terms will be different.

**Ben:** You know, it's hard to generalize. Only the Spanish have their own situation because it's about 75% LNG dependent and they are already kind of—to some extent—experiencing a world price. The Eastern Europeans, the extent shales developed in Poland and they break off...they reduced, you know, their total dependence on Russian gas. We're going to see some spot pricing that may come on both sides of Central Europe from Poland and from Northwestern Europe, kind of...and from Spain because it's attacking the middle. It may happen.

**Glenn:** Okay.

**Ben:** It may happen within...I would say, I keep using this 2 to 5 year timeframe. I predict that oil pricing will come down substantially in Europe. Now of course there'll be times in gas 'cause it's expensive. Only 2 years ago it was $13 somebody said so.

**Glenn:** But are saying this for the bulk of the vines or are you just talking about that proportion.

**Ben:** Substantial portion, Glenn. You know it's...once we unleash it in this continent where there was no stopping, it was like a prairie fire. Once it passed about 5 or 10%, that was it. And many people feel, "Well, it will go to 10 or 15%." You know, conventional wisdom is top 25%. There's a prairie fire, and it took over the entire business as Andrew points out. I don't know whether that's going to happen in Europe because I think only...only because I think their contracts are somewhat more flexible than ours were. Ours were highly rigid, they were upward only, and there was nothing that you could do except just, you know, abandon them. I don't think that's necessarily true for European LNG and pipeline contracts, but the pressures are enough to substantially change them. They may grow into this but...

**Michelle:** I...it depends on oil prices, partly too.

**Ben:** Okay.

**Michelle:** We haven't talk about that...so it depends on, you know, what one's view of the world is and consequently how actually big that premium is.

**Glenn:** You also talked about 2 different cases. How do these help think this through?

**Michelle:** Well, I think if oil price has drift down for a variety of reasons, then there's a lot less pressure to make these changes because people are comfortable with them, as Andrew as has pointed out.

**Glenn:** Sure.

**Michelle:** And it's not just the Europeans; it's all of the Asian customers as well that met...that, you know...the big experiment for a Japanese customer is thinking about 1 or 2% of its LNG portfolio being index to gas. I mean that's a big experiment.

**Ben:** Yeah but they're not producers. We tend to producers.

**Michelle:** They don't look at *[laughs]*...it's this, you know. That's

**Ben:** But, Michelle, but then the producers are the conservative ones.

**Michelle:** Very conservative.

**Ben:** They're going to want to price the gas.

**Michelle:** Well, the...I mean, you know, producers enjoyed the oil index pricing too *[laughs]*, right? I mean, you know...

**Ben:** Not when it's cheaper than gas.

**Michelle:** It's not you know, so. But, so, if you have a little bit of a softer oil price, then there's probably a lot less pressure to try to do something about it. If oil price stay firm or go up, and you end up with-with, you know, this really, really big premium. Well they'll not take the pressure to do something; it grows because you're leaving money on the table from a customer point of view. You have to think about it. So, I mean I think that's a dynamic that we just have to watch and see. And that will kind of guide us as to how much of the market will be restructured. I think, you know, one of the things that are really true in the LNG business, and we now have a model contract for it. The Association for International Petroleum Negotiators finish all the work, the committee work, on this, the model form, short term LNG supply contract, is out there; diversion clauses are a fact of life. Everybody wants that flexibility to be able to make changes and destinations depending on price signals, customer needs, and of that. So conversion conditions in the business are starting to reflect that, and it may be that that sort of pulls things toward common pricing mechanisms, but then again that's happening with different kinds of contracts and place as well. So, you know, I think

that…that it's…we're still in the very young stages of a lot of this. So we'll just have to see.

**Andrew:** And on the supply side, clearly if you look at the new liquefaction that's coming on, on this chart. Although the slope...there's still growth, the slope modulates a little bit, but very few, if any, of those new liquefaction plants that are coming on will go ahead based on spot prices.

**Michelle:** Right.

**Andrew:** They're on a 20-year-off date contract that agreed on a predictable price mechanism which makes the project economic; otherwise, they won't go ahead. So, you know, if these things do start to unwind for whatever reason, it's going to take 20 or 25 years to go through that process and go to a different pricing basis in these markets. It's...I don't believe it can happen very quickly in Asia or Europe, right.

**Michelle:** Right.

**Glenn:** Okay and not even in China, you're saying, you don't think they would have a different form, something more like a gas index contract than an oil index contract. Think the producers will hold firm on that?

**Andrew:** Well they're in the market and –

**Michelle:** Yeah.

**Glenn:** And they're doing oil deals now, oil link deals. Okay, good. So when we think about then the big players, when you think about Russia *[inaudible]* and the other major gas exporting players, how do you see their strategy? Do you have any views on the gas country or gas exporting country forum and does that become an old pack? Is that a sort of slow act a little bit like the *[inaudible]* in Stockmen to slow down the production and investment of new capacity?

**Ben:** Yeah, I think it can have an effect. I think, you know, given the disparity that I see continuing between oil and gas prices on the international scene. I think now to the extent there's a move to begin to seize upon gas-based industries which we're seeing.

That will feel a move by producing countries and I think they may have some more...I mean there were issues on the oil side, there are going to be issues on the gas side. In the case of, you know, the gas side, there are some major production in consuming countries. Here in the US, I mean, we burn 3 barrels of oil for every barrel we produce. That's not that way with gas. North America is basically self-sufficient. It looks like it's going to stay that way, you know, apart for some differences and, you know, imports that now that they may turn into exports, but let's suppose that there's a small import level, that's okay. It's still basically a self-sufficient continent. And so North America cannot really be buffeted necessarily by changes, arbitrary changes, in world gas prices. So, there are some real issues, but I think that they will certainly want to consider trying especially if gas sinks in the $3-below range.

**Andrew:** I believe there's a real difference between gas and oil. In this respect, the capital intensity of the gas export project, many billions of dollars in liquefaction and shipping for long distance point, you know. This is going to shot in at $5-10 billion capital investment to get 50¢ extra on the gas price. So it just doesn't make sense. Those facilities are being developed and once they're on the market they will operate. Whereas with, you know, the capital intensity of oil exports is much lower, assuming you've very low-cost development in countries like the Middle East and just you know some storage tanks and a shipping jetty and they need to-to export. It's a very different profile. So they can more readily hold back production and market environments like this. Gas doesn't work like that.

**Ben:** Yeah, also gas is...we used to say this in AGA hundreds of years ago when I was there. The AGA is...rather gas is kind of a voluntary fuel in a large respect. Oil is much less voluntary. You know, we run the entire 250 million vehicle fleet in this country on oil. And the world –

**Glenn:** And gas has to compete more is what you're saying because...yeah, you were going to say something?

**Michelle:** I agree with Andrew. We've been watching the forum in the evolution of, the forum pretty closely. And really it's a bit like a country club for the country members. It's really a place where they're having a conversation about different kinds of commercial arrangements. For some of the countries they want more equity participation in projects. They want to understand better how these flexible destination clauses are going to work and supply agreements. You know those are the kinds of things. Trying to set some sort of a pricing mechanism or some...or I mean it's just...and it's trying to reach agreement on that would be an amazingly difficult and tough thing.

**Glenn:** Yeah.

**Michelle:** And they're not even trying as far as we can tell. It's just not, you know, in the mix.

**Glenn:** So what I might do here. I've been able to address some of these questions from the audience by working them in, but there are a number of them here that I haven't been able to work in. So maybe now I sort of switch modes a little bit here, and first one here is on the Nobuko pipeline. Is there a chance that will be built and if not what is the alternative and what could help to build the Nobuko?

**Ben:** Well, I think supply would help...a commitment of supply and a commitment of carriage.

**Glenn:** Okay. Are you saying this being...not having the supplies right now they –

**Ben:** I don't think they have, you know, firm commitments at this point, and I think without these, it's going to be difficult. There's also, of course, the presence of Russian gas to the southstream pipeline which is committed on both ends.

**Glenn:** Okay. Andrew, anything different?

**Andrew:** I'm not an expert in that. I think it's one of these projects which would theoretically give more diversity of supply to Europe, but, at the end of the day, it needs some pretty robust commercial arrangements and they're very slow to emerge so we'll just watch this space. I can't call it right now.

**Glenn:** Right.

**Ben:** More input.

**Glenn:** Now we've gotten a couple of questions here that sort of...I put in the category of...and back to the US with gas prices going down to compete with coal. Don't you think the coal industry will respond either with lower prices or maybe politically it's –

**Michelle:** They have been responding politically *[laughs]*, as far as I can tell anyway. I did actually volunteer once in a meeting with a bunch of coal folks that it would...we should flip the outlook curves and show the higher growth and the higher share for natural gas than coal given, you know, kind of how things are likely to work. That was not a popular suggestion. But anyway, no, I think they're already responding. I think, I guess I'm a little different than some folks. I spent the early part of my career working on coal projects in the Rockies, and 80 to 100 feet of coal in the West is pretty impressive. But you still have to...you have to have an acceptance to use the resource and I think that, you know, both industries are equally, have what you called market resource constraints the other day. There are definite resource constraints in terms of being able to deliver them into the marketplace in a way that-that is publicly acceptable. But I think coal has the bigger challenge on that front than natural gas does. That's a reality. And so the question is, to use that resource, you know what is it that we're willing to absorb in a price difference, publicly? What's the public interest trade-off on that? And I think that's kind of where...that's where the politics are and there's a lot of sorting out to do there.

**Glenn:** Okay.

**Michelle:** We had an adventure in Texas. We had 2 sites that were funnel less sites and the future gen competition. We'd learned an awful lot during all of that experience about IGCC and storage, carbon storage, and integrated projects and the cost structure of those and the difficulties of those. It has a long way to go.

**Ben:** Okay. Well I hope not. I think, you know, gasification really is the future of coal in the long term, and I think the sooner the coal industry develops an understanding of that, focuses even harder on solving some of the challenges that Michelle, you know, first to...you know, I think the better off of their future is going to be. I think it's, you know, we do have one full scale, large scale coal gasification plant operating in this country that's lost a lot of money for a lot *[laughs]*.

**Michelle:** That's the, you know –

**Ben:** Just to finish my thought, the...this plant is now cut-losing really. It's more of a recapturing 90% of the carbon, and the carbon is going to oil production and the C02 sequestration in *[inaudible]*. I think that should be...that is one really good model.

**Glenn:** Ben I think your microphone is –

**Ben:** It keeps falling off.

**Glenn:** I didn't mean to distract your thought there.

**Ben:** Sure. Somewhere here there's a *[inaudible]*, you know, I'm going to sing about this coal gas plant *[laughs]*. You know I think it's really an important model which is exactly what it was intended to be, you know, for the coal industry. You know, I hear the problems that IGCC, and it could be that the problems are tightening with China. Devote the field with single, you know, demand, namely electricity. The problem with IGCC is that it's locked into a single market in effect where it is. Whereas, as methane, you know, methanizer enables the plants to produce natural gas. Prices are not great, the study is necessarily paid now, but I think there a lot of technologies in promising developments that can enable this to happen. Lots of...lots and another panel, you know, to talk about coal...gas.

**Glenn:** Right, right. Okay. In terms of financing the shale gas, there's some questions about if any of you see an emergence of long term contracts again in the US or has everything stayed at spot?

**Michelle:** I...

**Ben:** Okay. No, go ahead.

**Glenn:** You see the emergence of long term?

**Michelle:** Well, I...you know, there are a lot of ways of mitigating price risk, and long term contracting is one of them if you can find willing parties to come to the table to negotiate that. And I do think conversations are taking place on that front. And I think it's driven by needs among the large feedstock customers and the desire to be able to take advantage of what's going on, but, you know, the reality of their businesses, business models being what they...being what it is. You know, I think there's going to be a use of that mechanism more than perhaps we've had in the past.

**Andrew:** I think if you look at the structure of demand, much of the gas market is in regulated utilities or regulated LDCs, and I think it's being difficult to move regulators...

**Michelle:** Yeah.

**Andrew:** To acceptance of long-term contracts when they have such a high degree of price transparency in the short-term market. So it's...that's going to be hard sales. So here we're talking about a smaller segment of the market, potentially the large industrials. It could happen, I haven't seen any signs of it yet, and I, you know, it's watch this space again. It's...but it's not going to take over the whole market for sure.

**Michelle:** No, it will be strategic, but it will be interesting. You know, it would be...there are going to be some interesting experiments, I'm pretty sure about that.

**Glenn:** So you mentioned, Michelle, that it was really the independence that sort of blazed the trail there. We see some...

**Michelle:** I think Ben mentioned, that but I think it's true. I mean, I think if you look at the list of companies you'll see, you know a lot of the new faces that have evolved as specialists, shale gas specialists, as well as large companies, certainly Anadarko, EOG, outfits like that, or it's kind of tough to look at them as the pure sort of classical wild cutting independents, they are, large organizations with lots of business

interest and mixes of assets and that sort of thing. But I think that, you know, there has been sort of this early wave of critical adventure seeking, ready to develop independence, proving it up, but the long term money and the long skills and that sort of thing do come out of the major company population, and I think when you look at the industry and how things develop, this is, you know, kind of a typical pattern. You'll see the risk taking independents out there. They can mobilize equity capital very quickly. They can lease, they can drill and prove up, but, you know, sustainability comes through cash flow and a strong balance and so some of them will graduate to that level, others will provide very good deals for the majors to acquire *[laughs]*. I mean I think that's, you know, that's the history of our industry.

**Ben:** There may be an additional step in. You know, I had a wise old boss once who said that every industry goes through 4 phases. The first phase is the development of an understanding that there's opportunity and shale; you know, we're kind of still partly in that phase. The second phase is the on-rush of participants.

**Michelle:** Yeah, we had a land-rush, that's for sure.

**Ben:** We're...we've had our land rush, we've had our opportunity, and we...you know the third phase is kind of a shakeout. Something goes terrible wrong, I think, shakeout. The weaker parties, you know, drop away, and the fourth phase is kind of a more of a steady-stead phase. So I think it's a natural evolution, you know, for shale development like any other new industry who moved toward larger enterprises and able to sustain, you know, the kinds of production it's needed. There may not be same parties, they may not be the same major constituents and major, you know, 10 years from now maybe a little bit different from our constituents today, major, maybe not.

**Glenn:** Okay.

**Michelle:** I think sort of a parallel point to that is that this is largely private land in the most active locations, the biggest locations that has...that allows a faster decision making process because you're able to go out and negotiate with private sub-surface

owners. You're not waiting around for years and years for decisions about different areas that are...that are going to open up exploration. I think that's been a big, big factor in the phase of the timing and the phase of activity that we've seen.

**Glenn:** Okay, good. So we've got a number of questions here about climate change policies. What role do you see for gas if there are climate change policies or limitations or on carbon remissions or carbon prices. And also the strain of...if there are energy taxes and are some of the states are going to put additional taxes on the shale gas as a way of sort of helping out the state budgets. So you all talked a little bit about how you see the role of gas in the US and these policies and in globally too.

**Ben:** Well a quick 10-minute discussion of that *[laughs]*.

**Michelle:** Quite a change *[laughs]*.

**Glenn:** Right we've got about 10 minutes.

**Andrew:** Yeah, I mean I think it really depends on the shape of the climate policies that come through. And even at this late stage, after so many attempts, it's still a little unclear as to what the shape of the final outcome will be. Everybody is assuming that some mechanism for carbon pricing will come through in the next several years, but we're not quite sure of how it affects each sector and how it affects each fuel. Normally you would think that natural gas would benefit from that because the power sector is very important and gas has a much lower carbon footprint than coal fired utility, but you can imagine the scenario in which climate policy accelerated. They move away from all fossil fuels including gas and wanted to jump straight to renewables, which is kind of a risky strategy given the difficulty of getting the scale in some of these things. But you could imagine a climate policy that was designed to do that. I think that would probably not end up in a very good place. So, if it's...if you get something which is a level playing field across all fuels, recognizing the relativity carbon contents, I think gas will do quite well under a climate pri-...carbon pricing regime.

**Ben:** I think one point that and CC, you know, carbon capture, and same as CCS world, the CC is what bothers me about. 'Cause the sequestration, the S is fine. We put the carbon in oil wells and produce another couple of million barrels, and that was great and it pays –

**Michelle:** It depends on what price CO2 is.

**Ben:** To do this, of course, of course. Yeah the CO2 price, the oil price. But the CC that really starts to concern me, capturing...I have a hard time imagining capturing stack gases, you know, and extracting carbon and let *[inaudible]*, but it seems to that ultimately CC, carbon capture, is going to be have to done, you know, by pre-treating the fuel, and in fact for coal means gasifying the coal so that you get a clean stream of carbon dioxide that you can actually process either by piping at somewhere for, you know, injection or liquefying, whatever you need to do. In the case of gas, there are also may a pre-treatment that would be *[inaudible]*. It would be a reforming process breaking gas into hydrogen, you know, fundamentally into hydrogen and carbon dioxide you can treat, you know, deal with the carbon dioxide and then just burn the hydrogen. And I don't know, you know, if *[inaudible]* study to know what the cause are of each of those and whether this expands the advantage of gas or diminishes the advantages...the advantage of gas.

**Ben:** It's assuming that CC does not take place to the stock gas mechanism but instead pre-treating fuels.

**Glenn:** Pre-treating it, okay.

**Michelle:** I think the devil's in the details. I agree with Andrew. I mean it's all in how the policies are designed, and then at the execution level, we have good managers all over the country and negotiated good rules that are different everywhere and if what you're doing is you're trying to increase the use of something that requires a lot of backup and balancing like renewables. And if that backup and balancing results in more emissions because you're not using your thermal generators as efficiently as you would

otherwise or you're having to use older less efficient thermal generators like single cycle turbines and things like that, you're really not getting what you should be getting in practice as the result. So I think there's a lot to think about in all of these. And on the tax front which nobody addressed. Everybody wants more tax revenue.

**Glenn:** Right.

**Michelle:** I think that's all we have to say about that *[laughs]* I mean it's...I mean where...there's the reality out there *[laughs]*.

**Andrew:** And correlated to that is that you can get tax through taxing the well hard activity at the state level.

**Michelle:** Yup.

**Andrew:** Or you can get tax from the employment and value added from the...actually MK -

**Michelle:** From the activity.

**Andrew:** and supply chain activities. From the real economic value added of that activity. So it's not just taxing the molecules. I think there's an alternative way that states can look at his to get more taxes just by encouraging the activity in and of itself. On the carbon capture side, we very much support CCS and think it really has to move forward in any world where you've got to put...push carbon emissions down significantly. CCS is clearly a big part of that, but you've got to recognize that the scale of what you need to do, the investments, the coverage, it's going to take many decades to get to…

*[BREAK IN RECORDING]*

**Andrew:**…a point where you have the infrastructure in place to handle CO2 from most of our generation infrastructure. It's a big, huge, huge potential activity. Getting starting it...it's getting started early will help, but it's going to play out of decades not years.

**Ben:** And just the transportation side of the business strikes me that, you know we've got 250 to 300,000 miles of natural gas pipeline. We have 3000 miles of CO2

pipeline. If we are going to be capturing carbon in one way or another, it's probably going to be made available in places where it's not necessarily going to be sequestered as a result. We're going to need it to foster a CO2 pipeline industry. It's able to move the stuff to where it needs to go and do so economically. I don't know how much of a focus I think there was one line in *[inaudible]* marking.

**Glenn:** I see. So the big challenge there. So we still have some questions. People asking about CNG vehicles, natural gas vehicles, and LNG vehicles, and what I heard is this is a big infrastructure issue that –

**Michelle:** Well outside of fleets.

**Ben:** I don't know if the infrastructure's the problem.

**Michelle:** Outside of fleets. Fleets are where -

**Ben:** I think the infrastructure is there actually. We have 1500 fill stations in the United States. Now I...when people say it's the infrastructure, trust me it's not. You're 10 miles from one wherever you are in the urban area. I think some of them had been taken out of service because there were so little interest, but we peak at 1500 fill stations for CNG vehicles. The problem wasn't the infrastructure, the problem was the availability of vehicles. People didn't know they existed and those that were around didn't really have any visibility. Did you know that the Chrysler Mini-Van was available as a natural gas vehicle for 4 years? Nobody did. I read the Chrysler Mini-Van brochure; there was a 2-page spread about how good it is for the environment. There's nothing about the fact that you can order it. I think  when the Chrysler guy would call me and say, "Get your gas utility friends to buy these things. They're going to take us out of business. We only sold 700 this year." I said, "It's like Dr. Strangelove, you have to tell it to the world. It's no good if you don't tell it to the world." I think now that people are talking more widely about CNG vehicles; you know, we should have had 20 million of them by now. Hopefully we can get up to 20 million, which will be less than 10% of our fleet.

**Glenn:** Okay.

**Ben:** That's where at a minimum in my view, that's where we're on.

**Glenn:** And when you do that, it's still going to be small compared to the increase that we're looking at for power.

**Ben:** I can see electric generation.

**Glenn:** I mean we don't look at these...it's not that we're going to run up in the supply constraints there when we switch to fleets.

**Ben:** No, not at that level. I mean...and again I think as we begin to draw on the supplies and as Andrew points out these take decades to build a kind of fleet of 20 million, what does it mean to draw supplies? Well, we'll see price effects and generate more gas.

**Andrew:** Right, I hesitate to put this forward next to our gas vehicle expert but –

**Ben:** Advocate.

**Andrew:** Or advocate. If you remember the...if those of you who were here yesterday morning, remember a chart that *[inaudible]* put up with energy densities of different fuels. You would have seen that natural gas was about a third of the energy density of diesel or gasoline, something that's above a third. So that means much bigger fuel tanks on the vehicle to cover a similar range. So you're adding weight, you're potentially taking away amenity for storage space or passenger space, and so there's a whole issue of, you know, consumers saying that versus the more usable amenity they get from the traditional fuel vehicles. So it's –

**Ben:** Hopefully you know technology can deal with this. Now Johns Hopkins Applied Labs have developed a flat tank. For years the problem was this trade-off that you know Andrew rightly points to. Either he had a big tank in the car and no trunk or vice-versa. You know then I can...with a big tank you could go 300 miles, with a small tank I go 80 miles, better nice big trunk. Johns Hopkins had solved that. That's been solved like 10 years ago. The flat tank...there's actually a pod containing some smaller

tanks. It can be located at various points around the vehicle and you get your 300 mile range and you get your big trunk. It's over, that's over.

**Glenn:** Okay, yeah.

**Michelle:** Well, we haven't...we haven't talk about another possibility that may be remote but it is interesting to think about especially given this big premium for...in price premium that crude oil gets over-over gas and that's gas to liquids. And you're having adventures with that at Shell and there've been various experiments and in the refining business, the state of the refining business right now, it's hard to think about adding a lot of petroleum product capacity, but the infrastructure is there and we know it and we know how to use it. And, so, one of the things we keep wondering is for all of the trade-offs in converting from gas to a middle distillate, environmental or emissions, or cost or other things, do you get more in benefit? Because you can go right into the existing petroleum product infrastructure and deliver it and get, you know, the energy benefit that way and the energy density benefits that way. That's a fair, it's a fair question it seems to us but, you know, we'll just have to see how things go.

**Glenn:** Right. Yeah. Okay. Well I think we're really ready to wrap up now then. So I just...I hope you could join me in thanking our panelist for all their contributions.

**Michelle:** Thank you for all the preparation and everything.

**Audience:** *[Applause]*

**Michelle:** Yup, excellent, excellent, excellent, yup.

**Glenn:** Thank you very much.

**Michelle:** And good luck to EIA.

**Glenn:** *[Laughs]*

END OF RECORDING