

Geoff Heal:

Thanks very much. So at this point, we get to the first of several panels during the meeting. This is a panel on the economic and national security implications of fracking. David, in his introductory talk, gave a very good summary I think of the economic implications of fracking, which are huge. As he said, it's creating jobs, it's lowering the price of energy, it's making the US closer to big energy independence, it's increasing the competitiveness of the US economy, and sending a very positive environmental impact, as well, in a number of ways. So there are far-reaching implications in the economic field.

It also, as David indicated as well, far-reaching implication to the national security field. The US is used to thinking of itself as heavily dependent on the Middle East for its energy supplies, crucial energy supplies. As we've heard, the US's dependence on the Middle East is falling rapidly and will be close to zero in the very near future. It may not be energy independent but we'll certainly be independent of the Middle East. Trying to think we'll probably feel very comfortable about. That obviously is far-reaching the national security implications. Now about a third of the US's armed forces are currently in the Middle East or somewhere close to the Middle East including two carrier battle groups sitting in the Straits of Hormuz right now. It's costing us billions and billions of dollars a year and an interesting question is whether we'll wish to continue having to incur those costs once we'll no longer dependent on the Middle East for our energy sources.

Interesting enough, the main beneficiaries of those carrier fleets at the moment are probably Japan and China rather than the US. Japan and China get most of their energy from the Middle East these days, and so they're becoming dependent on the Middle East. This is when we're becoming independent of the Middle East. It's an interesting irony I think in many ways. That has a lot of national security implications, lot of geopolitical implications.

We've got a really great panel to discuss these issues; Dave Freudenthal who's two-time governor of Wyoming and has a reputation for having developed a very, very sensitive and a very effective regulatory framework while he was in that position, a framework rather unusually are applauded both by the industry and by the environmental groups. It takes quite some political skills to get that kind of reputation, I think, Dave, has to be credited on that. We've got Travis Bradford, who's a professor in the School of

International Public Affairs, also known as SIPA, who is an expert on energy and renewable energy, in particular, and Jason Bordoff also from SIPA, director of the energy center in SIPA, who joined us recently from President Obama's national security council, so we've got a very interesting group of people here. We're going to ask each panelist to talk for 12 or 13 minutes and that will leave us about half an hour for open discussion, and the discussion again, the format for discussion is please fill out these cards that you've got in front of you, hand them to the gentlemen on the left and right, and they'll get them up to me and I'll pick and choose and consult and we'll have a discussion based on that.

So Dave, over to you for the first time. Thanks.

Dave Freudenthal: I'm first?

Geoff Heal: Yes, you're first. You can stay there.

Dave Freudenthal: I thought I was last. Sorry about that. Prefer the last shall be first. Good morning, appreciate the opportunity to be here. I'm always very interested. I left office in 2011. I'm always very interested to hear people talk about sort of the theoretical aspects of regulation. I spent – it's always illuminating to know how I should've done it as opposed to how we did it. By way of background, you need to understand that most of what you know about Wyoming is probably the Grand Tetons, Yellowstone, Devil's Tower if you're old enough to watch "Close Encounters of the Third Kind," and that it's got a lot of open space and not very many people, and those of us who live there like it that way, so don't plan to move out. You're welcome to stay in New York.

What is not generally known about Wyoming is that it is essentially the largest energy exporting state in the United States by virtue of its production. It produces about 12 percent of the energy consumed in the United States and if you're governor of Wyoming, you like all of the energy and when you say all of the above, you mean it. You're not like President Obama who doesn't really mean it. You mean it because you've got coal, oil, gas, wind, and uranium, and you've got them all, and you've got them all in abundance. About 40 percent of the Class 5-7 wind is in Wyoming. It gets developed about as fast as you can get power lines sited which in this country is not very fast, pretty slow, so you end up with a lot of resource that's on the table but not developed.

The other thing that you should probably remember about Wyoming is that it's a very Republican place. It's the state that Dick Cheney claimed to be from so that he could be on the ticket. It gave you Al Simpson of the Simpson-Bowles Commission and our grand contribution to legal thought is a Supreme Court juror known as Evander Vander who hated everything FDR and was one of the four horsemen who went out of his way to oppose labor laws related to women and children, but other than that we're a fairly progressive place.

I will tell you that the dominant views in Wyoming are really very much focused on the outdoors, on the resources, and the opportunities that people have to live there. You live there by choice. It's not a place that you either like it or you leave it, and it's one of those places where the fundamental fabric – I mean, what people do on the weekend, not do on their vacations, is they go outside. When you see a picture of a beautiful place, most people think well, that's nice because they drive by it in their car. People in Wyoming think that's nice because I'm going to go up there and hike, I'm going to get out, so they're very much active users of the outdoors.

So when you talk about energy development in Wyoming, the balance is that it needs to be regulated, and the public generally supports that. Wyoming is sort of a hazard dichotomy. Out of the last 40 years, 28 years of those, the governors have been Democrats of which I was one, and in fact on most state issues, it's relatively positive if you talk about preserving the values of the environment not in the context of kind of the nuts and granola crowd that you find in Jackson Hole but in the context of people who recreate, hunt, fish, get out, and actually participate. It turns out that it's a fairly important issue.

It's also a public land state. Forty-seven percent of the services owned by the federal government, 80 percent of the minerals, and that places the governor of the state dealing with the federal government. They think they're kind of coal governor, a dispute that we've always had. Fortunately in the Mexico vs. Cleppi actually established that state law can apply to federal lands in the absence of direct preemption and so we do that fairly vigorously.

The state has a long history of owning gas development. It is culturally comfortable with it. It's something that it's adapted to, and it is something that it has vigorously regulated in various

forms since the 1950s. 1950 saw the advent of the Oil and Gas Commissions which were primarily focused on rights and waste, concept not applicable to this discussion but it's how it sort of originates, has a lot of the same technical questions with regard to the movement of underground materials and the development of oil and gas that also permeates question of hydraulic fracking.

Oil and Gas Commission is supplemented by the state's function through its own police powers with regard to environmental protection but also its function as, under cooperative federalism, which is a bit of a joke, but at least under those Clean Air Act, Clean Water Act, and some of the other programs that the state enforces on behalf of the federal government. It has very broad authority both under its own police power authority and also under the authority that it exercises on behalf of the federal government.

The reason that that gets to be important, and I learned this during my eight years as US Attorney is that the role of the federal government particularly in clean water and the Safe Drinking Water Act is very real and when they want to enforce that, if the state fails to enforce it, EPA through Region 8 will enforce it on private land, so you find that the state is equally vigorous on private and public lands in terms of the enforcement.

We adopted a program for regulation of hydraulic fracking for two reasons. One is that the technology had evolved past what we had on the books with the Oil and Gas Commission. That is to say that the technology in terms of the amount of pressure that can be applied underground has just gone up exponentially and the amount and number of fracks has gone up exponentially. So what we needed was a new set of regulations. We were the first state to adopt them and we adopted them in part because we needed to catch up with technology and in part because you needed to give the public confidence that somebody was looking after this issue because I think one of the key factors that allowed this debate to get out of and is that the regulators haven't really said how they're going to manage it.

In our case, what we did is we concentrated on well-born integrity, which was talked about a little bit, but it's really the fundamental question is whether or not you have the capacity to contain the materials at the pressure that it's placed in the ground So we updated everything with regard to the amount of concrete, the

amount of weight, the amount of casing that you have to use and if you look at it, it's a fairly strict regimen

The other thing we did is disclosure. Disclosure was relatively easy once we got it figured out which is you got to disclose everything to the state including the formula. So the only portion, though, that is actually put out on the website were the contents so that the formula part is actually protected as a trade secret, and that's being litigated and right now the state district court hasn't ruled in favor of those rules from the commission that in fact you have the right.

The reason that we wanted all the material is for public health and safety in the event – because one of the concerns you have if you live there is that you're going to have an accident because inevitably, accidents happen. You're going to end up with an accident on a rig and somebody's going to get exposed. You need not only for their safety but also for the safety of the people in the emergency room to have more information available than what is in an MSDS sheet. That's not enough, and so we set up a system where they can get access to the full range of materials if they need it and they can make it work.

The other thing is we concentrated on how you handled the water. In our particular formations, you get back about 80 percent of the water from the frack. Now, one of the things that people don't distinguish is between the frack fluid and produced water. The frack fluid is the stuff that comes back up that has been placed in there along with the water and whatever else. In parts of Wyoming, you actually get back more liquid than you put in. In other parts of Wyoming, you get back about 80 percent of it. Then after that and you're into production, you have what's called produced water, and that water can really vary in quality. Some of it is good enough water that in an arid place like Wyoming, they actually file for water rights on it so the rancher can use it. That's produced water, which is not always the case but in some cases, it is, and we have a provision to do that.

What happens is with regard to the flow-back, a couple things that we require. One is obviously they have to manage it. Most people try to recycle it. To the extent they can't recycle it, the portions that can't be recycled end up being put into an injection well, properly permitted injected well so you know where it's going to go, you know what formation it's going to go into, and you got a fairly reliable system.

Now the Oil and Gas Commission in order to protect itself against the bad actor, we have what's called the Orphaned Well Fund and it's a one mil or two mils depending on how badly it's getting hit fund by which you essentially socialize the cost in the event among the industry in the event that you have an operator who does a well and who is essentially not credit-worthy to begin with, their bond doesn't cover the cost of rehabilitation, so in effect, this Orphan Well Fund steps in and does what the operator should've done in terms of protecting the environment, doing the clean-up and the rest of it. In effect, you've socialized the cost of the bad actor.

The other thing that does is it encourages the rest of the industry to pound on the bad actor a lot because they really don't like paying for their problems through the Orphan Well Fund. Those protections have now been expanded to include the cost of fracking, which means that mil levy goes up because the scale of things is just so much bigger. It's not that it's different. It's just bigger and it's got more pressure behind it, it's got more contents in it, and it seems to work.

Now with regard to the air quality questions, we did what's called Green Completions which required them to capture, particularly in the early stages, the material that came back. It was initiated by some of the industry and then we compelled it on the rest of the industry because if you do a Green Completion, some of the real concerns about flaring go away because you captured the worst of the chemicals and you're not flaring them. Now you're going to have some post-completion flaring depending on how far you are from the production site, just happens, but the key is on the front end, there are ways to do it.

The way we set ours up is that the company is obligated to do Green Completion unless it's a true wildcat. That is, they're out in the middle of nowhere where there's just nothing there. Then if they clear out the middle of nowhere, they'll get a little relief on the Green Completion question. The question of water availability, Wyoming is one of those arid mountain states that collectively referred to as a high plains desert or under the census classification, it's referred to frontier There's water shortage, but water's regulated in our state by somebody called the state engineer because ours was called a prior appropriations state, very different than what you deal with in the east.

What happens there is rancher's got his water and he's not doing real well ranching, so what he does is convert his water right on a temporary basis and sell it to the oil and gas company or the service company who's doing the fracking. He'll actually make more money selling it to them for a couple of years than he will in agriculture just because of the price. It's a way to do it, but it's regulated by the state engineer. The key on all of this is to have a regulatory strategy. I made the mistake last night of saying I didn't like their best management practices because I don't. We can talk about that another day. I think that if you actually have to do it, what you begin to realize is best management practices is theoretical. What you really have to have is a fairly severe set of rules that force people to comply, but they have to be based on result, not based on the practice because you can't say that if they did everything the rules required, then they're off the hook because you're not sure that you know what everything in the rules is.

The last part that we did and then I'll sit down because I want you guys to have lots of time. The last thing we did is on disclosure. We made sure that to the extent the information is gotten by the state, we hold onto it so that if ten years from now you end up with a migration and you need to figure out how did something get there, you, at least, have some idea of what went in the wells and the formations around there.

Part of the problem is, is this causation question is, is really difficult. It is really difficult and if you've done any of it on a gas law or if you've drilled in oil and gas plates, you know that trying to predict what's really going on underground is difficult. It's easier today because the micro-seismic techniques and some of the stuff they've done are just amazing in terms of their capacity to tell.

The other thing to remember about hydraulic fracking is the company has no interest in its willing to be reliant with you on the gas commission because they have to submit their material to us. We approve it prior to the frack, right, and what are you approving? Well, you're approving their design and you're saying that design is only good to so much pressure. If they exceed that pressure, then they've got problems.

Then they get on the site and it may or may not go exactly the way they planned. If it goes different, they have to come back post frack and actually identify everything that they did so that you've

got a record and you know what happened but they can't violate the pressure.

The other thing I would say is that when you think about the regulatory regime I'm a big believer, obviously, that the states do it because actually the states know what goes on in their own place and if you go to EPA or you go to the Bureau of Land Management there's nobody there who even knows how to read mechanical integrity test or a cement bond log.

The states, particularly the gas states have that expertise and have developed over the years. When I make jokes about so-called cooperative federalism I do that from the perspective of when I was US attorney to discover how little respect the fed actually have for the states and then when I was Governor, how angry I got when they proved that.

What I would say is that this is not some sort of alchemy. This is really pretty straightforward stuff, there's a lot more known about it than people want to admit, there's a lot more understood about it than people want to admit, the question is, just regulating it because remember if you think about the economic activity it's a lot more fun to govern over a state where people have jobs.

The other thing that happens is you need to tax this and then I'll get off this stage. You need to tax the oil and gas development. What have we done with the revenues we've received? We create a wildlife trust fund so we can create wildlife habitat. We do that out of the tax revenues, but we also as Chuck Stanley will tell you later we might have blackmailed the industry into some money to help preserve wildlife habitat because it's a core of the state and you've got to figure out what your values are and then you use that to supplement it.

We fund our education, we rebuild schools, we rebuild buildings at the university. We've created a scholarship fund that essentially supports any high school graduate in Wyoming who wants to go to either the University of Wyoming or the community colleges. So there are ways to take that revenue, but you've got to be willing to raise it, which means you've got to have the leadership to say okay we want you to make money, but we're going to make some money too so we conserve the interest of the citizens.

You can fund the core values of the state. A place like Wyoming has to do with the outdoors, it has to do with education, it has to do with frankly keeping everybody else's taxes low. One of the ways we keep everybody else's taxes low in Wyoming, we have limited sales tax, no corporate income tax, no personal income tax and 60 percent of the revenue comes from the metal industry.

If you regulate it right and you tax it, it can be a net benefit for the citizens of the state. If you don't do both of those, then I can understand why the public is a little up in arms.

Thanks.

Geoff Heal: Thanks Dave. That was truly insightful and really fascinating. Now, Travis, your shot.

Travis Bradford: Thanks, Jeff. Thank you Governor thanks a lot. We gave a talk a couple of week ago that was partly sponsored by the Buckminster Fuller Institute and after a 20-minute PowerPoint slide description of all the achievements of Buckminster Fuller I was expected to get up and say something interesting.

I decided I never wanted to follow Buckminster Fuller again on a panel and I've now decided I also never want to follow Governor Freudenthal on a panel. I also, Governor, in the defense of the nuts and granola crowd Chardonnay is a form of recreation, so use some of your state funds for that.

My role here is to actually try to talk about some of the economics of natural gas and the impact of fracking. I think the session – the official title is the Economic Implications of Fracking.

I also want to think about fracking's role in determining economic development and some of the economic conditions within the fracking industry because I think that a lot of this has gotten very interesting partly because there have been technical innovations that have been combined to create a new technical platform and it's opened up a lot of additional volume of production, but volume is not economics. Volume is half of the economic equation and price is the other half and we need to talk about this.

I want to talk really just for a few minutes about the foundations of natural gas economics and how fracking is playing into this because I think there is some misconceptions in the general public

and I think that the experts are probably better aligned on this, but we can talk more about it when we get to the questions.

I think that the general public believes that we have entered an era when – the term that's often used and it probably goes back to Dan Ergon or someone like that who has spent some time talking about these issues.

Fracking has created an era of energy abundance. Abundance, of course, is a volume concept, again, not a price concept and so part of the reason that it came about and I was asked a question the other night, sort of, why did it happen. It really happened because prices had risen well below \$4 per million BTU to well above \$5 or \$6 and the expectation with the new importation of LNG and all of the controversy surrounding citing import LNG terminals my goodness, how quaint is that now that we wouldn't be in a permanent era of higher gas prices.

That actually created the investment environment and the certainty required to make the types of investments in the combinations of technologies that we now think of as the package of hydraulic fracturing. It started off some technical innovation. More volume breeds technical innovation, which helps bring down the cost and helps you find new places and optimize and all of that's been good, but remember that it only happened because we had an expectation of substantially higher prices permanently.

Again, how times change very quickly. So, let's talk a little bit about what's going on in the supply and demand of natural gas. On the supply side conventional natural gas in the United States is falling. It has been falling for a while. It is expected to continue to fall. We are not doing a lot more of it. We're not looking for a lot more of it.

We're still getting some associated gas with oil drilling, but we're not going after new gas wells because frankly those have just been determined to be not the first best solution versus some of the fracking plays that are available, wide volumes of fracking plays that are available.

It turns out though a number of the fracking plays have also hit their stride and in some cases are actually declining and only a few of the major fields in North America are still on the ascendant. The Marcellus in Utica and I think the Eagle Ford are the only ones that

are still meaningfully growing and then there are a lot of others that have peaked and particularly when you start thinking about the rig counts that have also fallen precipitously over the last few years there is a leveling off and the EIA has great data on this.

I'm actually ashamed to admit how much time I actually spend on the EIA site daily, but let's just say I look at all of the different volume and price implications across a wide range of industries to figure out exactly where we are. Gas from hydraulic fracturing across the United States has leveled off for a while.

Obviously, oil is continuing, prices are high and rig counts are still pretty good, but on the demand side we've actually seen a substantial increase in demand from fuel switching from coal to natural gas and there were some each pick-ups in that. There was some excess capacity in the power generation for the gas. There were some coal-fired power plants that fell below the margin and natural gas actually became a better alternative.

Demand has gone up. Supply has gone up, but is leveling off, demand has gone up, it's not clear that it's leveling off, and certainly this is all before we ever get to any meaningful or robust economic recovery in the US economy. We're talking about exports, but that's actually going to take a while to filter through to prices, but if we do, in fact, turn our import LNG terminals to export terminals, we will see additional demand there that will continue to push prices up.

What's happened? Let's talk about prices. Today the price for natural gas on the spot market is \$4.23. I'm sorry, that was the Monday price. The May delivery contract, which is coming up faster than I expected, is \$4.38 and the January 2014, so end of the year, just after the first of the year contract is at \$4.70 per million BTU, which is above the ten-year average price for natural gas, above the ten-year price for natural gas. It means that we are no longer below the average price of natural gas that we've procured over low-price environments and high-price environments, but we are getting back up.

Where was the spot price last year at this time? \$1.88. It is now \$4.23. That's meaningful. We have not yet really come to grips with the fact that gas isn't nearly as cheap as we thought it was and if we really want to do much more of this, the price is probably going to have to rise and there are a lot of estimates about what the

clearing price of this is going to be. I think you can find a thick part of the estimation distribution in the \$5.50 to \$6 range, although that has been creeping up a little bit. Some people would suggest that technology will do a better job of bringing costs down. I suggest that if depletion rates on wells, which we really don't have a good idea on over the long term since we haven't really been doing a lot of this in the exact geology that we're currently doing it that the depletion rates are subject to a wide error band and if we are off by a little bit in the wrong direction, you could actually see prices go up substantially higher than the \$6.00 range, probably up into the eights, nines, or even into the double-digit range in order to clear supply and demand.

That's just an economic characterization. Maybe it happens, maybe it doesn't. All forecasts are wrong, although I tend to get really cautious. The French have a wonderful adage about making money in the property market from the 18th century which says, "Sell when you hear the sound of trumpets," and so I've heard a lot of trumpets lately and I get a little bit concerned.

What does it matter? So what? Maybe it is expensive, but for lots of things, it's still worth it. Maybe it is still the best thing for us to do, better than not doing it. That's our alternative, to not do it, and we wouldn't have the jobs created in Wyoming or Pennsylvania or Texas. We wouldn't have – I think Jason will talk a lot about the energy and security implications if I know him well. We wouldn't have all of those things if we didn't do it, so it may still be worth it, but why does this matter?

It matters to the question of how do we regulate it? How do we deal with it. Tom, you brought up a really interesting point about how some of the strategies that we might choose to use if we felt that bankruptcies or insolvencies were going to be the order of the day at some period over the lifetime of potential damage. That's actually important. If you believe that prices are going up, which means margins will get squeezed, then I think we should evaluate those strategies a lot more seriously because of the likelihood of the occurrence Worth thinking about.

I also think that there are a number of other risks that we may want to think about, and I broadly classify these as – I have a new term, and it's called 'fukashima risks,' and fukashima risks are – I used to talk about them in some abstract, analytical, not real way like tail risks or low probability high cost outcomes, and there are many of

these in the world that we look at, and we even insure for many of these. I have a life insurance policy, for instance, which I hope is a very low probability event that I'm going to have to take advantage of that, but I think that there are a number of these that we just need to be cognizant of because there may not be enough money to correct for some of these, and they're just things we want to think about.

They may have as much to do with the economic risk as the physical risk that occurs, but I think that these include things like water contamination. What happens if, in fact, we do tracer chemicals and the tracer chemicals show up in an aquifer for a meaningful urban population? What kind of reaction will we get? You think we'll just maybe shut down all the wells within a mile or two of that, or do you think that we're going to put on watch every single fracking well in the country because it changes how we think about the possibility or the probability of this event? What about the notion of seismic and, in fact, just as a point of reference – I'm not a seismologist by any – I can barely pronounce it, but there are some recent reports of seismic activity from hydraulic fracking-related activity in the Netherlands, for instance, which actually resulted in low-magnitude earthquakes but noticeable on the surface and did create actual physical damage, and those are expected to increase if you believe some of the reports about it.

Again, I don't know, but what happens if we do? Do you think we'll just stop fracking near those seismic activities or will it actually call into question the entire industry? The last one I think that's really important is this notion that David, you talked about a lot, is the heat-forcing values of methane in the atmosphere and the new IPCC report's actually going to gross these up a little bit, but the instantaneous forcing is well over 100 times more potent to greenhouse gas to carbon dioxide. You don't have to lose much methane for something that's 100 times more potent to greenhouse gas and gas that's only 50 percent as greenhouse-emitting as coal, you don't have to lose very much methane for this to actually become what is considered in a full life cycle analysis dirtier than coal.

What happens if that occurs? What happens if there's even a credible argument to that effect? What happens if there's a price and it gets put in and it will change the economic dynamics? I think what it speaks to is that the opportunity that this industry has created for us and it is, in fact, an opportunity, not a guaranteed

success, but it is still new and it has wide error bands around a lot of these variables and we should treat it as such when trying to determine how we're going to regulate it going forward, so I look forward to the discussion. Thank you very much.

Jason Bordoff:

Thanks very much for having me here. I appreciate it. The Resources for the Future did a survey recently of expert views on unconventional gas production and it was actually really useful, I think, what they did because they went to industry experts, they went to environmental experts, and they found a broad consensus. It was a lot of shouting and a lot of yelling about this issue on both sides, but in terms of what we should really be worried about and where the real risks are, there was a broad consensus across the board from Republicans, Democrats, industry and environmentalists about where we were headed with unconventional development and what the risks were and I agree with almost everything that you heard this morning from the dean and from the governor about where the real risks are, where we need to be focusing, and where the opportunities are.

So I will say just a word about that. Dean Schizer actually talked through many of the economic and national security implications of what we're seeing happening in the unconventional oil and gas space, and so I'll provide a couple of pictures to put them in context, but you heard some of the numbers already, and it really is extraordinary. I mean, it is, and there's error bands and there's uncertainty about where we're headed, as Travis said, but the extent to which the North American energy landscape has changed in the last five years from an outlook of scarcity to one of abundance, and I do think that's an accurate word to use, is really quite extraordinary, particularly in the energy space given the magnitude and scale of the resources required to power the global economy. Things don't change quickly in this space. It's a big ship and it turns really slowly and for something to turn around this quickly is really quite extraordinary.

This is just a visual picture of how the world has changed. This is the Annual Energy Outlook from 2005 and then the most recent Energy Outlook showing projections for US natural gas imports. As you can see, just a handful of years ago, we were projected to import ever-increasing amounts of natural gas. The red is liquified natural gas which is much more costly than traditional conventional natural gas or unconventional gas, and so we were projected to import increasing amounts of costly natural gas, and

now that's gone. We have completely eliminated that need and we will soon be a net exporter of natural gas by pipeline and potentially by ship, as well. There was a question that the prior speakers got about exports and I'll come to that in a minute.

Again, I understand Travis saying there's uncertainty, and we don't know what the outlook is. Let me just say that every additional piece of information we get, surprises to the upside and exceeds what everybody thought would be the case six months or a year ago. So the potential gas committee at the University of Colorado School of Mines every two years does an estimate of the gas resource base in North America. They just put out their most recent estimate two years after the prior one. It's 26 percent higher. The production levels continued to outpace what we thought they would be. Gas is over \$4.00 today. It was \$2.00 a year ago, but nobody thought it would stay at \$2.00. It's also a little bit higher today because we had an unexpectedly cold snap in the spring. I think if gas stays at \$4.00, \$5.00, even \$6.00 and we'll see what the prices are in a minute in Europe and Asia, that's still pretty cheap gas. That has a huge opportunity for the US economy.

This is the oil outlook. Again, I took the Annual Energy Outlook from 2005 and the Annual Energy Outlook from the most recent one, 2013, and you can see in 2025, the amount of oil that we are projected to import is now 12 million barrels a day lower than people thought it would be in 2005. We consume 18.5 a day. That's a staggering figure, right? That is a really staggering transformation.

On the right-hand side, it's important to note that this is about unconventional oil production. It's also about consumption and demand and part of the reason that we can talk about national security benefits and reduced oil dependence is because oil demand is turning around and going down as a result of fuel economy standards; also as a result of low price of natural gas. I think I'm sort of skeptical that we'll see natural gas penetrate into passenger vehicles. I do think there's a real opportunity just driven by the economics and potentially by regulation for natural gas to displace petroleum in heavy-duty trucks, in rail, in marine transportation, and if we replace 30 percent of the truck fleet with LNG, that's 600,000 barrels a day of diesel consumption in the US.

We consume in the northeast 600,000 barrels a day of oil for heating, and you're seeing increasing – I mean, there are challenges

bringing pipelines into this area, but increasingly you're seeing pipeline development being built out of the Marcellus to take advantage of the cheap gas there, and those levels are going down and they're going to keep going down.

US oil production is up a million barrels a day year on year, 2 million barrels a day over the last two years. We don't know where it's headed. The growth rate is certainly going to slow, but every additional piece of information we get suggests reason to be optimistic about what those numbers will look like. As you heard the IEA projects we'll be the largest producer in the world by 2017 or 2020, that North America will be a net oil exporter by 2025 or 2030, I think, and I think there's good reason to think that the numbers from the EIA and the IEA are probably a bit too conservative. They get revised upward every year, and they are much more conservative than many in the private sector forecasts that are out there, and those folks track this stuff pretty closely, too.

It's also important to remember that this is not just about North America, but this is shale rock. There is source rock everywhere in the world. Argentina has the largest natural gas reserves in the world. We know that China has significant shale resources and Eastern Europe and other places, and there are challenges in all those places. I don't think this revolution would've happened anywhere else the way it happened here for a variety of reasons, but this technology will be brought to other places and beyond hydraulic fracturing, when people talk about the unconventional boom, that's other technology as well. That's oil sands, that's ultra-deep water activity like the pre-salt in Brazil, and there is a lot of resource potential around the world. So for natural gas, we want to talk about North American production because that's where prices gets at but for oil, you want to talk about the global market because for oil, that's where the price gets set.

This shows that this is a North American story, too, not just a US story, and you can see US production going up. EIA thinks US production peaks and then starts to decline. I think it's probably going to keep going up maybe a little bit further. Then Canadian production has been increasing rapidly and will continue to. Mexico actually has the potential. They've seen declining production and I think they have the potential to turn that around, too. They need some constitutional reforms to get there.

Let me turn for a minute to the economic implications and the national security implications of all this. You heard Dean Schizer talk about the economic implications, that the price of natural gas in the US, in North America, in Europe, and in the Pacific Rim has typically been pretty closely linked and that's falling apart. The pricing of natural gas has completely diverged as a result of the unconventional revolution in North America. In Asia, as you heard, it's about \$15, \$16, \$17 a million BTU. In the US, it was two; now it's at four. In Europe, it's in between. It's around nine or ten and you've started to see that's the geopolitical implication which I'll come to in a minute. That is in part because we've seen all the gutter built up huge capacity to ship us all that natural gas that they thought we were going to need because of that slide I showed earlier. Now we don't need it anymore and all these supplies of LNG are flowing into Europe. They're creating significant competition for gas within the European market and giving European customers leverage to push back on countries, particularly Russia that have particularly had a monopoly hold on Europe. So that competition is driving down the price of natural gas there and I suspect that will continue.

This creates huge economic opportunities for the US. Obviously we have a competitive advantage, which is why we've seen billions of dollars in manufacturing reinvestment come to the US, huge ethylene crackers and other investments happening. Increased production creates economic activities. Obviously just through the production itself, we've seen a new steel plant being built in Youngstown, Ohio to build fracking pipe for development that people need. We shouldn't overstate these. I think sometimes they are overstated. It is a fairly small segment of the manufacturing sector that is very energy-intensive, but for those it is a significant opportunity.

I'm going to use my final time to talk a little bit about the geopolitical implications. I already mentioned Europe and Russia and the leverage there. This shows the way the crude trade map is being redrawn because of North American production, much more trade within the western hemisphere and much less trade east-west. You're seeing increasing flow of Middle East oil not coming to North America but going to Asia. We've largely eliminated the need to bring African crude into the Gulf Coast and the amount coming into the East Coast is declining rapidly. This is going to raise questions about the understanding we have about burden-sharing in the Middle East, so if we do need to keep the Strait of

Hormuz open, if we do need to maintain stability in global energy markets. China's building up a strategical oil reserve of 200 million barrels a day.

How do we think about sharing the burden of responsibility for maintaining stability there? We can't disengage. Prices are set in the global market. Even if we don't import Middle East crude, we're still going to need to maintain that supply, not to mention the fact that about a million barrels a day of refining capacity in the Gulf Coast is actually owned, in part, by Saudi Ramco and they may want to make sure that they continue to have a role in the North American market, I suspect.

Then I think this has implications for the future ability of OPEC to hold together as a cartel. They're going to see downward pressure on prices globally. They're going to – the only country with any spare ability to produce is Saudi Arabia. Iraqi production is going up very sharply, and they're going to need to figure out to what extent they can coordinate and cooperate if they want to maintain production levels that support a certain price. Saudi Arabia needs about \$100.00 a barrel to meet their revenue predictions for their budget.

The last national security implication I'll mention, we have put much more pain on Iran through our sanctions regime than anyone thought we would a few years ago and that is largely because – we actually succeeded in pulling a million, a million and a half barrels a day of oil a day off the global market. The goal is to impose pain on Iran without imposing pain on ourselves by driving up the global price of energy. The fact that US production is up 2 million barrels a day over the last two years has helped to offset what we've pulled off the market from Iran.

I won't go through all of these. We can talk about these in the discussion, and obviously we heard a little bit about the environmental implications, the fact that US carbon emissions are down about 12 percent since 2005, although that's turning around a little bit now because natural gas prices are coming up, but if we have the ability to increase global gas trade and competition and drive the kind of de-linking of gas prices away from oil and bring down the price of natural gas in the Pacific Rim the way you've started to see happen in Europe and has happened in North America. Ninety-nine percent of the net increase in coal consumption, according to the IEA, comes from China and India.

If we can drive economic transition from coal to gas there the way we've seen in North American, the potential greenhouse gas benefits are very significant.

There are risks, and I'm not getting into those because that's not the topic of this panel. That's the next one, so I don't want to downplay them or say they're not there. They are real. I think they can be managed, as you heard, but they are real. I don't want to dismiss them, but I was just focusing in the time ahead on the economic and national security implications. I look forward to the discussion. Thanks

Geoff Heal: Well, thank you very much indeed. Already have a great collection of questions down here, enough to keep us going for at least another hour, which of course, we won't be. We've only got another 15 minutes, roughly speaking. Let me start off with a really challenging question here. Is there such a thing as energy independence when energy markets, especially oil, are decidedly international? Would the United States realistically isolate our petroleum resources and keep them for our own use? Jason, you want to kick off on that one?

Jason Bordoff: It's a good question. I think there's a lot of rhetoric around energy independence and it's helpful to actually describe what that means and what it doesn't mean. As I said in my remarks, it doesn't mean you disengage from the world. We have global prices for oil are set in the global market, and we need to – we're going to need to be part of those no matter what. There are benefits. It is true that reducing our import reliance has benefits. It has economic benefits because of increased production. It has benefits on our trade-in balance. I think the adverse impact – Jeff can tel me if he agrees with us – the adverse impact of an oil price shock is probably smaller if we have lower import dependence because more of that increased spending stays within the US economy, and I do think it force a fundamental rethinking about out strategic relationships with Middle Eastern producers and Asia given that that's where all the demand growth is coming from and how we share, as I said, the burden for maintaining that stability and how we engage in a conversation.

One of the important things I think we're going to need to figure out over the next couple of years is how to modernize and rethink the International Energy Agency, which is a group of OECD countries that get together and talk about how to use their – they

have a strategic sharing agreement for strategic oil stocks, and that was created in the 1970s in response to the Arab oil embargo with OECD couldn't consume three-quarters of the world's energy. It's now half and it's going down to one-third. It's not the right group of countries anymore to have a conversation about how to maintain global oil market stability and have a conversation about responding to disruptions that's going to need to change and the membership may need to change moving forward.

Energy independence is a term that probably is not super helpful, but increased energy self-sufficiency is real and actually does have meaningful impacts.

Geoff Heal:

Pick up one point there, Jason, if you don't mind there. The IMF recently published a study in which they looked at the flowing back in the 1970s. Oil prices went from \$3.00 a barrel to \$36.00 a barrel in a couple of years and moved the economy into recession, to a very serious recession in the 1970s and '80s. Recently – well, the last few years, oil prices went from \$10.00 a barrel to \$130.00, \$140.00 a barrel but there was no equivalent global recession. The IMF was asking the question why was the oil economy so much more robust against an increase in oil prices this century than 25, 30 years ago? The answer they came up with was most industrial countries are actually using oil much, much more efficiently today than they were now. The amount of oil per GDP in the US has gone down by a very significant factor, so actually energy efficiency has paid off in terms of one possible measure of energy independence, the ability to continuing functioning in the face of very much high oil prices.

There's a question which I'll direct first to Dave but other people can certainly try and answer it, too. To what extent can the expertise gained in sparsely populated Wyoming be applied to more densely populated areas such as the East Coast? That's a nice, local question for you, Dave.

Dave Freudenthal:

Yeah, that's right. First of all, since I hate to have people come to Wyoming, tell me what to do, I want to be careful that I don't do that to you. I'll tell you what I do believe, though, is that the fundamental principle of regulation works both in urban and non-urban areas. You have to figure out, though, some slight changes in the sense that you may have to have setbacks from houses that are different. We don't have to worry a lot about that. You may need – but remember, you need to talk about the setback for the well

location, not the down-hole location. They're very different, and so there are some modifications you should make, but I think the principles are applicable. That is, regulation needs to be done by the people who are actually competent to do it so that they're able to make it work. That needs to be done as close to local level as you can. Counties don't do it in Wyoming. Ours is a state in which the state is the dominant state so counties really don't have much authority, but you need to make sure that whoever does it understands the local geological conditions. They vary even in Wyoming. They certainly vary between what goes on in Wyoming and what is in the Marcellus or in the Utica.

The other principle is to make sure you recognize that your regulations need to take advantage of what incentivizes the company. The company does not want to waste money on a frack that gets away from it. The good operators are going to work with you. Then make it really high in terms of barriers for the bad operators; high bonds that they may or may not be able to get; make sure that you've got strict standards that they have to meet and if they fail to meet them, they don't get their next permit. Those principles work whether it's urban or rural. I think you have a different public relations problem in urban areas, and that requires that the public officials spend much more time actually talking to people about how the regulatory scheme meets its obligation to protect the citizen and the interest of the citizen. Other than that, I don't have an opinion.

Geoff Heal: Anybody else want to comment on that quickly? Here's a question I think was inspired by you, in fact, Travis. It's addressed to everybody. How high can the price of natural gas go before natural gas loses its economic appeal?

Travis Bradford: It'll depend a lot which demand sector you're thinking about. This is where I think that sometimes if you understand how the market's going to function, it makes policy somewhat easier. I'd love to hear Jason's thoughts on the debate around LNG export permitting which is obviously been a huge deal, but I actually – if I were king for a day – good Lord, no – my strategy would be to issue as many LNG permits as anybody wants. You want one? Would you like one? From Wyoming.

My believe is that about 6 bucks, which I think is the bottom end of the forward price curve over any meaningful period of time and certainly over the life of an LNG train or terminal which is

substantially longer, multi-decadal, time horizon, I just don't think anybody's convinced that the prices are going to stay low enough to matter. Now I don't – I think some of those terminals will still get built, but I think that they'll get built as a piece of negotiating leverage for people that want to break the indexing contracts on Qatari gas and get down to a more cost-based pricing model for imports into, say, Japan or China or Europe.

I don't think we'll be exporting much because I think at 6 bucks, that market kind of dries up because when you think about all the losses and then the transport costs and all the other things, plus you think about the breaking of the index on the other side and prices coming down, arbitrage happens and we just don't produce the cheapest gas for that type of demand market.

I think when you get into thermal electropower generation, so displacing of coal, either current coal or taking a lion's share of things going forward, I actually think you've got a ways to go, \$8.00-\$10.00 is probably reasonable and cheaper than coal, particularly when you start thinking about just the margin new dispatchable large-scale power plant requirements.

I think when you get into things like heating in the winter, gets kind of inelastic. We'll pay whatever the price is. They send me the bill, I pay the bill. I think there are markets there that will persist, but I think you'll see meaningful amounts of demand dropping off, certainly from forecasting expectations as you get into the \$6.00-\$8.00, but that's just my forecast.

Geoff Heal: Jason, you want to...

Jason Bordoff: Yeah, just make three points. On the export question, all the analyses that I know of that are out there except for the one funded by Dell Chemical reached the same conclusion that Travis does, which is that there is a huge amount of natural gas exports just will not be economic. The study that the Department of Energy commissioned as part of their permitting process from Nearar Consulting in their reference case actually found no exports would happen. They actually had to drive exports into the model by assuming some supply shock or some demand shock. All the analyses I know of suggest we'll see some but not a huge amount of natural gas exports.

There's a lot of uncertainty about the supply curve, but I think there's reason to believe that the supply curve for natural gas is pretty flat. There's variance. There's a lot of heterogeneity, but in the \$4.00-\$6.00 range, there's a lot of natural gas in the US that can be economically produced and industry has every incentive to drive those costs down and to get more efficient and to figure out ways to bring those costs down, and I suspect that has happened and will continue.

The last point I would make in terms of we've talked about coal to gas substitution and the ability for low natural gas prices to drive out coal. We saw a lot of that last year. It's actually turned around a little bit this year because natural gas prices have come back up. Cheap natural gas doesn't solve our climate problem. It's not the way you drive coal out of the US market. It can help lower the cost of meeting climate targets, and so we need policy to solve climate change, but an abundance of relatively low-cost natural gas helps lower the cost of achieving those climate policies, and that's an important point.

The International Energy Agency a few days ago put out a report at the Clean Energy Ministerial that found that the carbon intensity of the average unit of energy, after \$2 trillion of spending on clean energy over the last 20 years, has changed not at all. We've seen very large increases in renewable deployment in the OECD countries, and that's been more than offset by the dramatic increase in coal use in China and India and other place.

I think we need to get serious about in a world of an abundance of relatively low-cost fossil fuels globally – which is what climate change is – how we're going to address the climate problem. I think that low-price natural gas and figuring out ways through policy and increased production to drive natural gas into the power sector helps, and we're going to need carbon capture and storage technology, as well, because there's too much cheap coal to think it's going to stay in the ground.

Geoff Heal:

So we've got time for one more question, and there's an awful lot of questions left here, but I picked this one which I think is interesting and intriguing. It's directly primarily to Dave, so I'll give Dave the first crack at it, but everybody can have a go on it, too. It's a real fun question. Focusing on prolific oil and gas fields like the Marcellus Shale, how credible is the argument that taxing resources extracted discourages the development of these

resources? What level do you feel is an appropriate tax rate? You guys taxed in Wyoming, so you better answer that question first.

Dave Freudenthal: Yeah, the time period when Wyoming went through that argument was post embargo which is the last big energy boom, and all of the companies – and at that time, I worked for a guy who was governor, and the big pitch was if you tax this, we're going to leave. They never left, and the other thing was that if you regulate us in terms of SO₂, we're going to leave. They always have their bags packed, but they never get in the car. What I would tell you, though, is what we did do is we tried to keep those rates understanding – back to my point about understanding – business's perspective. What can they absorb?

Natural gas is 6 percent severance, 6 percent ad valorem. It's about 12 percent and then you got royalties on top of that depending on how it's distributed. It's not an unmanageable number. They will tell you it is. I can tell you that this particular governor I worked for, they came in and said if you do this – this was on an environmental matter – we're going to leave, and his response, which I think is the right response, is, “Don't let the door hit you in the backside,” because the truth is...

Jason Bordoff: That's exactly what he said?

Dave Freudenthal: No, but it's a G-rated version. I guess my point is don't over-tax because for one thing, it gives the public the wrong sense that public goods are free, and they're not. You're off-loading, you're exporting, but the other thing is that these industries do have a point at which they can't survive, but I'll tell you there are lots of people who can give you those numbers and if you have legitimate discussions with some of the industry guys, they're pretty honest about it. The trade associations aren't. Those guys get paid to beat their breasts, and I represent a bunch of oil and gas guys now and they pay lawyers to run around and say oh, my God, the world will end, and I just tell them I can't say that because I didn't believe it when I was governor and I don't believe it now.

You will find that there is a point, an inflection point where if you tax it too much – when you calculate your taxes, remember to take into account the environmental costs you're imposing if you impose any additional ones, and you may have to do that in some of the urban areas in terms of spacing, offsets, and some other things, but it's not – I know there's a fellow here from Montana

State. One of the things we loved about it was Montana taxed them til they didn't stay there, so they came to Wyoming, and we did pretty well. Remember, when they say they're leaving, there is a point at which you can force them out, but if they're honest with you, there's a lot of give in there.

The other key is make it stable. Make is so that they know what it is so that it is predictable so that if they're going to plan a 20-year field, they know what the tax rate's going to be. They can factor in just about anything if it's stable and they know what the rules are. If they don't know what the rules are – the other thing is on taxes, think about the private royalty holders. The other transfer of wealth that occurs in mineral development is the private royalty holder. One of the ways you protect the private royalty holder is we passed a law that said if the company fails to pay the private royalty holder, he gets the honor of paying an 18 percent per annum penalty.

Why was that passed? Because the Wyoming legislature is filled with land men, oil men, and agriculturists and who owns the minerals? Land men, oil men, and agriculturists, and so that is one of the ways that the system will police itself because lawyers – and I did this when I was in private practice – then organize the royalty owners and you go do a class action. When the penalty's 18 percent, the industry gets religion, so don't just think about the state side of the revenue – public side; think about the private side and what can you do to make sure they actually get the rewards that they anticipate.

Travis Bradford: You can't beat on that practical experience.

Geoff Heal: Jason. Okay, so we're actually out of time at this point, so let me thank the panelists very much indeed. Thank you.

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Duration: 62 minutes