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P R O C E E D I N G S

DR. LEIBERTHAL: Good morning. I'm Ken Lieberthal, Senior Fellow in the China Center, the John L. Thornton China Center, and also in the Foreign Policy Program at Brookings. I want to welcome you to this morning's panel. It is motivated because there are huge changes taking place in the global energy situation with enormous consequences for climate change, geopolitical issues, and so forth.

Oil and gas production in the United States has exploded in ways that no one anticipated even five years ago with tremendous consequences across the Board. The nuclear disaster in Japan and its ripple effects in Japan and Germany and other countries on the nuclear industry and nuclear plans is creating an additional set of issues. China has seen an explosion of interest and concern about air pollution and has announced major reforms to change the structure of its economy, to focus more on environmental outcomes, and to up its game in changing its energy composition, energy efficiency, and energy outcomes.

And there is increasing evidence, as we all know, of what Tom Friedman, a few years ago, termed not global warming, but global weirding. The greater incidence of weather extremes, weather catastrophes that strain infrastructure, budgets, and put lives at risk.

Now China is now at the forefront, both of greenhouse gas emissions globally, it became the largest annual emitter of greenhouse gasses about five years ago. The gap between it and the United States in terms of overall emissions per year has grown very rapidly so that it is now way out in front, not a position it wishes to be in. It's also in the global forefront in terms of the scale of its compliments to affect more sustainable outcomes virtually across the energy spectrum.

So the scope of the energy issue in China is vast, it is complicated, and it is inevitably too broad to cover in full in any single panel discussion or even any single morning. We therefore are focusing on three key elements of the broader energy picture in

China in the course of this panel. One is on coal, which continues to be the major source of energy in China and the major source of its greenhouse gas emissions and of its air pollution and so forth. Shale gas, a new development in China reflecting the technological revolution in unconventional gas production in the United States and the finding that China has perhaps the world's largest shale gas resources if they can figure out how to exploit them and bring them into their energy mix. And then finally nuclear power where China also has had for some years now, the largest plan for development of nuclear energy in the world; but then has to execute this in a context that is in part affected by Fukushima and its outcome, but also affected by changing popular sentiment in China, and therefore a mix of concerns there.

So overall in these three areas, especially we seek to evaluate China's changing energy priorities and policies and plans and also their implications for U.S.-China, relations in U.S.-China cooperation. Each

of our speakers will have up to 20 minutes to lay out her presentation, and then Charles Ebinger will provide commentary on what's been said and perhaps some additional issues that he will want to raise. That should leave us with about a half hour or a little more for Q and A. And we always look forward, especially at Brookings, to getting your input and your questions on what we should explore in greater depth.

Let me mention ahead of time, for those of you who are concerned about taking adequate notes, there will be a full transcript of this event along with an audio of the event posted on the event page of the Brookings website. It will almost certainly go up by the end of next week. You know, it takes a little while to get the transcript done. Along with that, we will post papers done by each of our three presenters -- Charley Ebinger is a presenter, but as a commentator, so that accounts for my terminology -- by Jane Nakano on nuclear developments in China, Kelly Sims Gallagher on coal and especially clean coal, and

Sarah Forbes on shale gas development and the issues it raises.

These papers do not have the same focus as the presentations today. They were all commissioned by Brookings a while ago, have been completed, and so we are putting them up there. And I think you'll find a lot of interesting analysis there, and so encourage you to turn to them when they're posted next week. Let me ask finally, before introducing the speakers, that everyone turn off your cell phones or anything else that may go beep or buzz during the course of this panel.

We'll have the three paper-writing -- not paper-writing -- three presenters speak in order of Kelly Sims Gallagher talking about coal issues; Sarah Forbes, shale gas; Jane Nakano on nuclear issues. I am not going to stand up and introduce each, at the end of each presentation, rather let me introduce all three now and Dr. Ebinger, have them go through their presentations in order, and then we'll have Q and A afterwards on whatever you wish to focus on.

Kelly Sims Gallagher is director of the Center for International Environment and Resource Policy and is Associate Professor of Energy and Environmental Policy at the Fletcher School at Tufts University. She also directs the Center's Energy Climate and Innovation Research Program and maintains affiliation as a senior associated member of the board of directors at Belfer Center for Science and International Affairs at Harvard University. Her new book, The Globalization of Clean Energy Technology: Lessons from China, is going to be out, I think within a month or from the MIT Press.

Sarah Forbes, who will be talking about shale gas issues, has been a Senior Associate at the World Resources Institute since May of 2008 where she has lead the WRI initiatives on shale gas and carbon dioxide capture and storage, the CCS effort. Prior to joining WRI, she worked at the National Energy Technology Laboratory serving in a number of capacities. Notably she lead the roadmap development for the Department of Energy's carbon sequestration

research program and conducted analyses on environmental aspects of CCS, the energy-water nexus, and climate change.

Jane Nakano, who will be focusing on nuclear issues, is a Fellow in the Energy and National Security Program at CSIC, Center for Strategic and International Studies. Her research focus includes nuclear energy policy and technology transglobally, energy security issues in Asia, and shale gas development in the United States. Prior to joining CSIC in 2010, she was with the U.S. Department of Energy and served as the lead staff on U.S. energy engagements with China and Japan. Her most recent publications include, Prospects for Shale Gas Development in Asia, and in a separate publication, China - Leader or Laggard on the Path to a Secure Low Carbon Energy Future?

And then finally delighted that Charlie Ebinger has agreed to join this panel as a commentator. Charlie is director of the Energy Security Initiative at the Brookings Institution and a

Senior Fellow in the Foreign Policy Program. He previously served as Senior Advisor at the International Resources Group where he advised over 50 governments on various aspects of their energy policy, specializing in institutional and economic restructuring of their utility sectors. He was also previously an adjunct professor at Georgetown University School of Foreign Service and at Johns Hopkins University's Nitze School AIS. He has 30 years experience advising the highest levels of government on a variety of USAID; World Bank; ADB, Asian Development Bank, Inter-American Development Bank, and European Bank for reconstruction and development energy projects.

So delighted to have this array of expertise here. I hope you enjoy the presentations. You will have substantial opportunity to raise questions in the wake of the presentations. And let me turn it over to Kelly, please.

DR. SIMS GALLAGHER: Thank you.

Well, good morning everyone. It's

great to see all of you and see some old friends in the audience. So I'm here to talk about coal and focus primarily on coal. And I just have to sort of preface my initial remarks by saying that the paradox of China's energy system is that China is not only the biggest coal consumer in the world now, but also the biggest developer of clean energy.

And so what I want to try and do is spend most of my time today trying to talk about how to reconcile China's inevitable continued high coal consumption for some time with the climate-change challenge and the air-pollution challenge that's becoming so acute in China. I'm sure most of you know that last year, 2013, was a landmark year. It was a year in which global concentrations of carbon dioxide in the atmosphere crossed, to me, a very symbolic threshold of 400 parts per million, briefly, it came back down. But for those of us who have been working on climate change issues for a long time that was a sobering moment.

And I think, you know, we're

experiencing a trend now, two trends that are very important where the U.S., which historically has been the largest single emitter in the world, is beginning to flatten off and hopefully begin a downward trajectory, whereas China's emissions are still growing very rapidly and is now by far the largest aggregate current emitter, not on a per capita basis, in the world. But together these two countries really still matter. Together they account for 40 percent of global greenhouse gas emissions. And a big reason why these countries have struggled so hard to get their emissions under control is because both countries rely heavily on coal.

China alone accounts now for 50 percent of global coal consumption. And coal accounts for 66 percent of China's total energy consumption. So it's still a huge component of the Chinese energy system. Both countries are also endowed with significant coal reserves, and this natural abundance, you know, lends coal to energy security arguments, use of coal to energy security arguments. It is the most

abundant fuel in both countries with the possible exception of shale gas, which we'll hear about soon.

As of 2012, U.S. coal reserves are estimated to be 238 billion tons, and Chinese reserves are considerably less at 115 billion tons. So the U.S. accounts for 28 percent of global reserves, and China 13 percent; but an important difference is that China is using its reserves up much more quickly. So its reserve to production ratio is only 31 years at current rates of consumption compared with 257 years in the United States. So this explains why coal imports have been rising very quickly in China as China sort of uses up its coal reserves and particularly good quality coal.

So I would argue that, just as a de facto matter, coal is certain to continue to play a significant role in both countries, even more significant in China, but a significant role in both countries in the medium term, which is hard to define, in large part to its relative low cost and the energy security benefits related to not having to import

substantial foreign supplies of energy; therefore, without tackling the coal challenge, it will be exceedingly difficult for both countries to meet their climb at goals.

Meanwhile, I think most of you must be aware that the air-pollution challenge in China has become just significantly more pronounced in the last few years. And I go to China, you know, three or four times a year at least. And I've just been particularly struck in the last year how much worse it seems. And I guess for me it's been viscerally felt by everyone starting to wear masks. So I have a research group I work with closely in China, and they sent me a picture late last year that was intended to be a funny, silly picture of all of them wearing different styles of masks like it was sort of a, you know, fashion statement, the different styles of masks. And they knew I was on my way over for a trip, and they said, which kind do you want, we'll buy one for you. And honestly that picture almost made me cry. It just was such a, you know, sobering moment

for me that they were all having to wear masks just to, you know, go through their daily lives.

I have a colleague who recently returned to Beijing to live there, and his son immediately developed acute asthma. So, you know, we're seeing a lot of people really struggling with their health in China today. And I think the severity of the problem, in a perverse way, might be very helpful in terms of tackling the challenge related to coal, because there's much more popular pressure that I can detect in my conversations with government officials, seem to indicate that the government is very worried about how to deal with the air-pollution challenge in a way I've never heard them talk before.

So bright spots in the U.S., I think I won't spend too much time with this, but of course we are experiencing a pretty rapid transition away from coal-fired power, mostly due to the economics of shale gas, which has, you know, made it just, it's been hard to do anything else but move to gas-fired power generation if you're a power plant developer in the

United States. That is not happening in China, that phenomenon is not happening in China yet.

So what's happening in China is that most old coal plants, to the extent that they still exist, are being placed by very efficient new coal plants or renewables and nuclear, as you're going to hear about more. And most new construction is advanced very efficient coal-fired power plant construction.

So a crucial difference has emerged between the two countries because of the shale gas revolution, whereas the U.S. is finally beginning to turnover its very old coal fleet of power plants; China is still, essentially still adding to its fleet, its existing stock of coal-fired power plants. And I would then argue it's getting more and more locked into a coal-dependent future because of course each one of these plants will last at least 30 years. We have some in the United States I think that are older than 70 years old. So, you know, in a worst case scenario, these plants would last up to 70 years. And

nobody likes to prematurely retire an investment before it's completely capitalized. And so the more of these plants that are getting built, the more locked in we are to a coal-dependent future.

However, if there's any country in the world that is willing, you know, to tear down a relatively new investment, it's China. You know, you see that in building construction and so forth where relatively new buildings, you know, are torn down and rebuilt. You see less of that in the power sector frankly. There has been a willingness to shut down small inefficient coal-fired power plants. But I'm not aware of; I'd be interested to hear if anybody else has heard of any instances of tearing down, you know a relatively new modern coal station. It's just a really big investment that's hard to prematurely retire.

So how do we cope with coal in China? You know, I think that it's inevitable that we're going to be moving, needing to move to carbon capture and storage technologies, especially in the Chinese

case, perhaps in the U.S. case as well. And the good news is that the Chinese have invested significant amounts of money in their RD&D programs, research development and demonstration programs in advanced coal technologies, and they've been doing so for decades. Most of the Chinese plants being built now are state-of-the-art, highly efficient. Most of them are supercritical or ultra supercritical coal plants. There's an increasing push towards coal gasification as well, but not so many integrated coal gasification plants, IGCC, integrated gasification combined cycle coal, IGCC plants. But we do see a lot of coal gasification in China for chemical production and synthetic gas.

So I would say we're starting to see the fruits of all of that investment in the sense that at least China is moving to high-efficiency coal. And the average efficiency of their coal plants is significantly higher than the average efficiency of U.S. coal-fired power plants.

Now does any of that help with

pollution? It's an interesting question and a complicated question. Really there are two main technology options for reducing CO2 emissions, one is efficiency, and so clearly they're doing that, they're making their generation more efficient. And then the second is capturing and utilizing or sequestering the CO2 from the coal consuming industries. And there I would argue that China has made significant investments and making tremendous strides on capture technology, but much less so on storage. So let me talk about that a little bit.

A few years ago, and this is sort of the current state of play which Ken wanted us to talk about, a few years ago, China was widely perceived to be leapfrogging the United States, and I don't use that term cavalierly, in IGCC technology because it began construction on a facility called GreenGen, which was modeled on the U.S. FutureGen plant, ill-fated plant, in the United States. And the GreenGen plant, which is in Tianjin, is an IGCC plant that is using a Chinese homegrown technology gasifier,

the TPRI gasifier, which is owned by Huaneng, one of the largest electricity companies in China. And it uses a general electric gas turbine for the combined cycle component of the plant.

And initially in the original plan, the GreenGen plant was going to capture and store CO2; but that's now been moved, that phase has been moved to the next phase, so the capture and storage part is now separated though still very much part of the plan. And the GreenGen plant has reportedly begun operation. I haven't been out to see it, though I've not seen a formal announcement. So, you know, an important development I think is that the Chinese have essentially indigenized gasification technology. And I have a whole case study of that in my new book for those of you who are interested.

And this is really an amazing story of, you know, a classic technology catchup story where China has been able to develop its own gasification technology in the space of about 30 years. And it is now licensing it internationally. And I think they

are, you know, should be considered leaders in this technology now.

On the other hand, so despite this good progress with the GreenGen plant, there are many other IGCC plants that have been designed and developed, but have not received -- with support from the Ministry of Science and Technology in China which have not received approval for actual construction from the NDRC, the National Development and Reform Commission. And so this raises an interesting question. If they're trying to develop IGCC technology, which allows you to significantly reduce conventional air pollution as well as capture and potentially utilize or store the CO2 somehow, why aren't they proceeding with more of these IGCC demonstration plants?

Presumably the Chinese would want to bring the cost of these technologies, you know, down some kind of learning curve and would be doing so through approval of additional plants. And there are a number of very advanced proposals that are just languishing. Dongguan, for those of you who are

familiar with these, the Lianyungang one in Jiangsu, Wadien, Bonchon, Lonfon. There's many. There's many, many. So I think we're seeing a -- I mean, there has been a long pause in the actual demonstration phase of IGCC, especially, and we still essentially have not really begun with commercial scale CO2 storage in China.

There is one plant that is proceeding with it, and that's a Shenhua coal-to-liquids plant in Ordos. So I think perhaps this long pause, we know that part of it was strongly driven by a senior official in NDRC, who was just not convinced of the merits of IGCC technology, but he's no longer in his position. And I think there is evidence that the NDRC may have had a change of heart fairly recently. It released a position paper last April stating its firm commitment to advanced coal technologies including CCS. So this was quite heartening because it seemed like it was a pretty pronounced policy statement from the bureaucracy that's held up most of these projects.

On the other hand, you know, none of

those projects I just mentioned have received approval since that policy statement. So it's hard to interpret what's going on. And I can only say that my guess is that the state of these projects has not really reached a high level of attention from the most senior people in the Chinese government.

So when I think about which factors might affect coal consumption into the future, I have, I think, six factors that I wanted to mention; and then I'll quickly review a few policy recommendations. The first one is this question of domestic production versus imports. Because coal quality in China is declining, there has been a pretty strong shift to importing coal. And imports have doubled in the last three years. So we're seeing actually the coal mining industry in China beginning to suffer significantly. And that is either a good thing, from a political economy point of view, because the government is sort of being, you know, indicating that it's willing to let go of this sector, or that's going to cause, there's going to be a reaction to that, a kind of

political reaction to that and the government is going to say, no, we need to protect our domestic workers and these jobs. I think related to this question is domestic economic growth in general. Will the slow down continue? And if so, is that going to continue to affect coal demand?

Number two, the relative prices of these fuels, domestic versus international. China has been able to import very cheap coal recently, and so that has lead, you know, contributed to this trend. Third, the effectiveness of efficiency measures. Indeed the government is working very hard to reduce the resource intensity of its economy. And so the more it's able to do that, the less coal demand we should see. Fourth, popular opinion and political pressure about air pollution, does it lead to regulation, more effective regulation and enforcement? And if so, what type? Because there's a lot of ways to regulate that won't improve the carbon dioxide problem, but would improve the conventional air pollution problem.

Now fourth, will there be more substantial climate regulation? And then I think I'm on six. Sixth, technology development and particularly on carbon capture and storage. I think the Chinese are quite advanced on carbon capture, but really still lagging significantly on storage.

So a few quick policy recommendations. And this is really aimed at U.S.-China, things that the United States and China can do together, because as an American I feel uncomfortable making policy recommendations to the Chinese. I'd say first of all supporting policy and economic research as well as technical R&D, both countries have a sort of bias towards the technical side; but we need to understand how these technologies are adopted and what is the economic environment and how to adjust that economic environment. I would encourage a more robust program of researcher exchange. I'd also look at the development of low interest government financing mechanisms for pursuing joint ventures in both countries. I think we need to be more integrative in

the way we're approaching policy, to combine conventional air pollution and CO2 in an integrated fashion to send consistent signals to the market.

And many of you know I've advocated for years, so I'm just going to reiterate this, the establishment of joint large-scale carbon storage demonstration projects, so that the two countries could share the costs and sort of double the learning opportunities about carbon storage and consider imposition of CO2 performance standards, which we're moving towards in the United States and I think might be an effective approach in China.

So let me stop there, and I'm happy to take questions once we get through the other talks.

(Applause)

MS. FORBES: Good morning. So it's a pleasure to be with you today. I think my remarks are going to follow Kelly's well because I'm actually flipping the organization a bit. I'm going to start and I'm going to give you an overview of the current status of shale gas development in China. I'm going

to talk about the opportunities in a broad national sense, and then I'll talk about some of the challenges that shale gas in China presents. In conclusion I'll pick up on the theme of U.S.-China collaboration, why it matters and specifically what it means for U.S. companies.

So China is short of natural gas. The natural gas consumption outpaced production recently, and China became a net importer of natural gas in 2007. Boosting natural gas consumption is precisely what's being encouraged as part of the rebalancing of China's energy profile. And that's all designed to reduce the acute reliance on coal that Kelly talked about. The 12th five-year plan had a target which doubled natural gas and primary energy consumption to 8.3 percent by 2015, that's up from roughly 4 percent primary energy today.

China aims to double the share, so you're essentially doubling the share of natural gas broadly in the energy mix, but not all of that is shale gas. The 12th five-year plan also included some

very specific targets for shale gas. And those were 600 -- 6.5 billion cubic meters per year of shale gas by 2015. That translates to 990 horizontal wells drilled by 2015. It's a big number. It's very big when you consider that when the plan was written there was very few wells, I think a handful that were drilled; however, if you put that in the context of the shale gas revolution in the United States, it's actually still small.

The U.S. in 2011, the U.S. production totaled 239 billion cubic meters, and that was in one year alone. So China's goal of 6.5 billion cubic meters per year by 2015 is big, but put in the context of the U.S. production and the scale up that we saw over between, you know, beginning in about 2005 to 2010, it's actually, you know, perhaps on the scale of what you could expect to happen.

Now if you look at what's happening right now in China for shale gas, they're at half of the 6.5 billion cubic-meter-per-year goal. The Ministry of Land Resources put out some numbers in

2012 that said production was between 25 and 30 million cubic meters. So the goal is billion, we're still talking in the millions. At the end of September of 2013, there was a news report that mentioned 142 shale gas wells drilled in Sichuan, Jiangxi, and Chongqing. And they were drilled by PetroChina, Sinopec, as well as a few other companies.

Right now you're seeing the majority of development happening in Sichuan and Chongqing, but it's worth noting that those aren't the only places shale gas development is happening, and there are a lot of little projects happening by the provincial governments. In Anhui, for example, some of the early wells were drilled by the provincial oil and Gas Company.

China has also already done a lot to develop policy for shale gas. In 2012 the Ministry for Land Resources approved shale gas as an independent mining resource. And that what did was that meant that it wasn't only the state-owned enterprises who were going to play in the shale gas

industry, there were also opportunities for private Chinese companies. In the same year the NDRC, the Ministry of Finance, and the NEA issued the shale gas development plan. And that plan was designed to cover the five-year plan period up from 2011 to 2015.

In 2012 the Ministry of Commerce issued a subsidy policy for shale gas. And most recently October of 2013, the NEA put forth a shale gas industry policy. And I think it's worth talking just a little bit about the five things that policy did. First of all, it designated shale gas as one of the nation's strategic emerging energy industries, so it gave it a national importance as an emerging industry. Second, it clarified that there are subsidies available for shale gas producers. Third, it encouraged provincial governments as well to subsidize the producers. And fifth, it also gave custom tariff exemptions for imported equipment for shale gas.

So those are things that have happened at the national level. If you're interested in hearing about the auctions that the Ministry of Land

Resource held, we can talk about that during the question and answer. The state-owned enterprises do have a lot of control of the majority of what many people believe are the best shale gas blocks. But in those auctions, you also saw some new entrants playing and some companies that are not traditional oil and gas companies that have a potential to develop shale gas in China.

In addition to what's happening at the national level, there's also a lot of activity at the provincial level. And many of my colleagues went on a trip recently to the Sichuan province together with some government officials. And what we found out was that the provincial government has goals that by 2015 they expect to explore eight development zones and reach 3 billion cubic meters of shale gas production. So just less than half of the goal by 2015 at the national level. It's ambitious, but Sichuan is considered one of the richest areas in shale gas. The government, in addition to, you know, just the numbers and the goals for production, the provincial

government also has plans to do technology research and development, to look at environmental transportation and fiscal policies that are at the provincial level that will support shale gas development.

So that's what the government has done. And then a little bit about the current status. I would describe the status of China's shale gas industry as very nascent. It's new. It's very new when you compare it to the United States. That said, I think if you look at shale gas in any country except the United States, it's new. I recently asked a friend, I said, well, you know -- the shale gas revolution came as a surprise to a lot of the energy analysts, you know, I worked with back at the national lab. We knew the research was going on, but people were skeptical. We were skeptical that it would ever really play out and change the world the way it did.

And I asked my friend, I said, well, you know, so what's the next shale gas? What's the issue that we need to be looking at for tomorrow? And

the answer was, shale gas is the next shale gas. That shale gas, even though in the United States we've seen the revolution happen and come through, it's not happened in the rest of the world, and there's a lot of potential resource out there. So Ken mentioned in the introduction that China's reserves are estimated to possibly be the biggest in the world. In terms of opportunities, it's also in China's national interest to develop that resource for two reasons, both for energy security and for environmental reasons.

And so as Kelly has mentioned, China has made a lot of advancements in renewable energy and clean energy technology. They've done a lot. Their power plant fleet is more efficient than ours, but there's still a lot of coal, and China is remaining on coal to sustain. Now the extent to which you can replace that coal with natural gas, if you manage things like the fugitive methane emissions and manage the environmental issues throughout the life cycle of natural gas, it can result in decreased carbon dioxide emissions as well as an improved economy.

So the promise of greater energy security and the need to meet the environmental goals, I think, are the two things that are driving China's very strong interest in shale gas. And the interest is strong. It's something that when you visit, you all probably visit Beijing. And it's something that people are talking about and asking about, but there are some challenges and I think we need to be honest about those and we need to talk about them.

The first challenge is that I said the resources are possibly the biggest in the world, there's a lot of uncertainty around that. The range of estimates that's out there ranges from, and I'm going to give it to you in trillion cubic feet, that the high end, the EIA's estimate is 1275 trillion cubic feet. And there's also a Baker Institute that looked at, that factored out the water issues and came in at 230. The official estimates from the Chinese government are at 883 trillion cubic feet, that's from the Ministry of Land Resources. So somewhere in between the two.

The only way to find out what the real reserves are is to drill wells and to get more information about the geology. And that's something that's happening in real time as the early stages of development go through. In addition to the uncertainty in terms of the resource, how much there really is, whether or not it can be produced; there are also some, I'll call them geological difficulties. Relative to the oil and gas reservoirs in the United States, fewer wells have been drilled in China and less is known, but what we do know is, based on oil and gas development in China so far, the geological structures in China are more complex, and by that I mean, they're physically complex, they contain more faults and fractures compared with those in the United States.

And what that does, that doesn't mean you can't develop shale gas, that means that it's more difficult to characterize it and it's more difficult to develop it. You can't use the plan that you used to frack a well in the Marcellus shale, take it to

which China, and try to frack a well there; the gas isn't going to flow. There's a lot of know-how and a little bit of art to getting it to work.

Some of China's most -- now so in addition to what's underground and the challenges that that complexity adds, there are also some issues around terrain. Some of the shale gas in China is under really rugged mountains. You know, when they were first doing shale gas in the Barnett shale in Texas, yeah, you know, it's a plane, it's very easy. And in China the shale gas reserves, there's just logistical challenges with operating in the mountains. Imagine getting a drilling rig up a dirt road that's winding up a mountain. With those challenges come costs. The estimated cost for China's shale comes in at, in the U.S. terms, $5 to $12 million per well. And that's a lot more expensive than what we see in the United States which averages $2.7 to $3.7 million per well. And that difference comes from those geographical differences in terms of terrain.

Another challenge, you know, I

mentioned the Ministry of Land Resources and the auctions and the fact that the, you know, there was an opening up and you have some new companies playing; the onset of new entrants is an opportunity, but it's also a challenge. They're not traditional oil and gas companies and their lack of experience in the blocks that they own will influence the pace of development there. According to the IEA, the biggest challenge to China shale gas is the outdated pricing mechanisms for natural gas. So natural gas prices in China are currently set by the government.

It's a little bit complicated, but it's basically, it's best described as a cost-plus model. So and that that cost-plus model is based on three elements. The first is the wellhead price. That wellhead price is set by the developer, but then it's approved or adjusted by the government. The pipeline tariff, that's a fixed price for the pipeline no matter who uses it and its set by the government and it's also specific to the location. So your pipeline tariff in one province may be different than it is

somewhere else. It's also set by the government. And then the enduser price is the third component, and that's also set by the government.

So price controls, you know, they're a legacy of the planned economy. And one of the things that we're seeing in some pilot policies, you know, most people have heard about the pilot carbon trading that's happening at the city level, for natural gas prices, you also have some provincial level testing of new pricing structures for natural gas. And I think it's going to be interesting to see how those turn out.

Another challenge, and I don't mean to harp on the challenges, but I think it's good to be clear about them, are the water resource constraints. So they're, some of the shale gas reserves are in areas where water is scarce. Reaching the 6.5 billion cubic meter target would require 13.8 billion cubic meters of water. For comparison, the entire Chinese industrial sector uses about 35 billion cubic meters of water a year. It's, even in areas where water is

rich, and Sichuan I think is one where the provincial government describes, well, we have water resources; there's the actual availability of water for fracking very seasonally. And that's going to affect your operations. It's going to affect the way projects move forward. And there are also differences in water availability throughout the region.

Risk management, China is densely populated, and some of the shale gas development, certainly the transport of natural gas from the areas of development is going to bump up on population centers. These are risks that we can manage, but it's really important to ensure that the demonstrations that are happening now in the first developments, as well as future developments, have regulation standards and best practices are in place. And that's not the case yet.

You know, for example, there's no standard for flow back water in China. So if water is used to frack a well, I actually that in China you may see some non water alternatives to fracking, but where

water is used, there's no standard for how you deal with the discharge and the flowback water. So if those pollutants enter, we saw what happened in Charleston, recent Charleston, West Virginia recently, if those pollutants enter the water, it can cause a lot of problems.

There's also some administrative fragmentation, which is, I think, which is the last challenge I'll talk about. The administrative responsibility for natural gas in China is fragmented. It spreads, when I gave the update of what's happened in the policy, you heard me mention a number of different agencies. I mentioned commerce. I mentioned NEA, NDRC, Ministry of Land Resources has played a leading role. Provincial governments also play a role in project approvals. When there are that many ministries involved in anything, it takes time and it adds an additional complexity.

Overall the challenges result from a series of complex factors. For the industry to succeed in China, a number of critical gaps must be

addressed. And I like to describe and think about those around, there are challenges around geology and geography that need to be addressed. There are challenges are technology that, you know, getting the gas to flow and taking the fracking process and applying it to new reservoirs. There are policy gaps. And then there are also some challenges around players, the new entrants making the reserves, different numbers of companies, and price.

So I'm going to talk just a little bit about why the U.S. and China collaborate on shale gas, why it matters. We're both continent-sized countries. We both have geographically dispersed energy resources with demand centers that are often far from our energy supplies. Both countries currently rely heavily on fossil fuels to power our economies that include coal, although in the U.S. we're decreasing our use of coal, it includes natural gas and it also includes imported oil. Both the U.S. and China actually have similar levels of crude oil imports.

So both countries fundamentally are

seeking their own energy independence by diversifying the energy mix, ramping up domestic energy production; and unconventional fuels offer a unique opportunity to do that. Bilateral collaboration between the two countries on shale gas is already taking place. And I'm going to talk just a little bit about what's already happened because I think it's notable. On the business-to-business side, China has welcomed U.S. entities to strike up partnerships with Chinese countries, primarily the national oil companies; however, China has prohibited foreign countries from fully entering the onshore energy production sector on its own. So U.S. companies can play on the onshore oil and gas, but they have to partner with Chinese entities. So several of the big companies have already been participating and formed joint ventures with Chinese entities.

Early on you saw joint ventures between PetroChina and Shell, CNOOC and BP; but that's only a part of the picture and that's the part we hear about a lot. Additionally a lot of the U.S. service

providers like Schlumberger, Baker Hughes, Haliburton; they have well-established offices and research institutes in Beijing, and they provide services to Chinese companies. They do that in traditional oil and gas, and that extends to the future shale gas world.

In addition to what's happening in China and those partnerships that are helping develop shale gas in China, China has also invested a lot in shale gas development here in the United States. State-owned enterprises have established joint ventures with U.S. companies. These generally take the place of acquiring stakes in the U.S. companies. So investments in specific shale gas plays, not investments in the companies, themselves. A couple of years ago I totaled it, and it was quite impressive. I mean, every day it seems like there are new announcements where some of the majors, the state-owned enterprises from China are making really significant investments.

What I understand from talking with the

U.S. companies is those investments are providing the capital that's needed to keep the development going in the United States, that in some cases, and I'm not saying this is true in all cases, but in some cases where U.S. companies are capital short, that investment from the Chinese companies is helping keep the production going. So that's business to business, government to government.

In 2009 President Barrack Obama and then President Hu Jintao announced the launch of the U.S.-China Shale Gas Resource Initiative. And a lot of things have happened under that initiative. DOE has a U.S.-China oil and gas industry forum which brings some of the companies from both countries together. The U.S. geological survey and DOE have worked together with their Chinese counterparts to get better, you know, to get better bounds around the uncertainty on the estimated reserves in China.

TDA has done a series of educational workshops that have been in China. I know they've brought U.S. experts there, and they've hashed out

some of the technical details. And in July at the strategic and economic dialogue, there was an announcement about the U.S. and China reaffirming a desire to work together on the legal and regulatory frameworks for shale gas.

So in conclusion, although we're at really different places with shale gas, the U.S. has a very mature industry and China's industry is extremely nascent, the two countries share some key reasons for collaborating to address the barriers. And I'd describe those as; the first is environmentally smart development. So I talked about the potential for shale gas to offset coal. It's only possible if you manage the risks. The second is energy, both countries need energy. And the third is economy. Partnering on shale gas development in both countries can provide opportunities for companies in the private sector in both countries.

Thanks. (Applause)

MS. NAKANO: Well, first off, thanks so much, my thanks goes to both Ken and Charley for

having me here. I'm delighted to not necessarily go last, I mean, although it doesn't matter, but the nuclear is part of the focus today because nuclear is still a viable part of China's energy economy. And in fact, China today is the center of the global nuclear energy activities. China now has only 20 units online, that provides about 20 percent -- I'm sorry -- two percent of the total generation capacity for the country. And also it's rather a late comer when it comes to the civilian side of it, but, you know, today it has 28 units under construction. That is equivalent to about 40 percent of the total global construction that's going on around the world.

So China is number one as far as the under-construction plant goes. And followed by Russia, but Russia has 10 units that are under construction. So in many cases, I mean, Chinese civilian side nuclear program is starting from rather small base, but it has the most robust build-out plans in the world.

And why is nuclear among the focus

areas for China? For this audience maybe it's obvious. I mean, nuclear is a technologically proven source of base-load power with very low to virtually non-carbon emitting profile. And nuclear has become an attractive source to help China address its air pollution concern. And obviously that's very much related to China's efforts to advance its energy mix diversification to some extent away from coal, heavy coal dependency.

And so the nuclear power generation program is supported by, if you will, sort of national, concerted national efforts to decrease China's energy intensity as well as a shift away from heavy focus on fossil energy sources. For example, in the 11th five-year plan, China came up with a mandatory 20 percent energy intensity reduction target. And it very much provided this momentum for China to develop clean energy sources, including nuclear, certainly not limited to nuclear, but including nuclear.

And I think that was around the time

when China actually came, constructed the four nuclear power plants -- I'm sorry -- that was -- I'm sorry -- so during the 10th five-year plan, China constructed four nuclear power plants. Even though government approved the first nuclear power plant construction back in '82, but it really wasn't until sort of 10th and 11th five-year plan period, sort of that decade where the Chinese started investing a lot more into the power plant construction.

And also during the 12th five-year plan, which I guess is still running, from 2011 to 2015, the Chinese government raised its share of non-fossil energy target to 11.4 percent of the total primary energy use. And the government also called for a 17 percent reduction in carbon intensity. So in many ways, nuclear just became one of the obvious options for Chinese energy planners. And China has very ambitious expansion plans, and it is on track even after Fukushima, the Fukushima nuclear accident happened in March of 2011.

And I can definitely go into details of

some of what they've done, but perhaps I can save it to the Q and A; but essentially, I mean, the energy policy white paper that was released in October of 2012, you know, roughly a year and a half after Fukushima, reaffirmed nuclear energy's central role in boosting the proportion of non-fossil energy in China's primary energy mix.

And it also included plans to invest more in nuclear power technology innovations and to promote application of advanced technology. And China has -- so today -- so prior to Fukushima, according to the 2007 mid to long term nuclear power development plan, China's goal was to increase the nuclear installed capacity from roughly about 13 gigawatts or actually back then probably about 10 gigawatts to about 40 gigawatts by 2020. But then in months or perhaps half a year leading up to Fukushima accident, there's quite a bit of ambitions to actually increase the target to 86 gigawatts by 2020, but then Fukushima happened and consequently the target through 2020 was revised downwards to 58 gigawatts. However, the

longer run, I mean, it has a lot to do with how Chinese stopped the approval of new constructions and such, but in many ways its much longer term visions remain pretty much intact despite Fukushima.

And however, Fukushima did something to China's plans. In fact, it provided the momentum for greater awareness for nuclear safety issues within China. And I think that the Chinese government's actions in the aftermath of Fukushima were quite swift and decisive. And there are a couple different things that the Chinese government did. One was that China helped approval of all new planned reactor construction, plus four approved units, two, within a week of Fukushima, the Chinese government announced safety inspections on 11 units that were online and then also 26 units that were under construction. And this inspection was actually carried out quite efficiently. It was finished by the fall of 2011, but it provided a lot of room for policymakers to start thinking, both, some of the obvious lessons learned from Fukushima, but some of the longer term safety

issues that they had been thinking perhaps about giving closer attention to, but very much gave the officials time to review China's safety plans, the status of Chinese nuclear safety guidelines in a systematic manner.

The third, Chinese started formulating a new nuclear safety plan. It was later approved officially by the State Counsel in October of 2012. So the actions were carried out quite swiftly and decisively. And to some extent to me more importantly, Fukushima made the environment conducive for nuclear experts both inside and outside China to openly discuss some of the concerns that had been there since before Fukushima, in fact, about the growing gap between China's very ambitious nuclear buildup targets and some of the institutional capacity that was starting to be outpaced by these ambitious plans.

And I highlight just three key areas. One is the legal framework that China does not have the basic atomic energy law to date. There are about

eight to ten different regulations that do cover different aspects of nuclear energy. There's also one law that does, it's all in sort of nuclear energy, but it primarily deals with radiation issues, but there's no overarching atomic energy law. And that's been in the making for roughly three decades by now. And I understand that there has been a lot of draft, a lot of study group, many, many experts certainly inside China, but outside experts as well just looking and giving feedback. And hopefully we'd be able to see a sort of concrete drafting and hopefully within this year. There's always a little of a report that it might come out this year, later this year and such, but I've been sort of waiting for it for the past couple of years.

And then the second area is the regulatory framework. China's commercial nuclear power plants are regulated by an entity called National Nuclear Safety Administration, NNSA, and the scope of its authority and the sort of degree of its independence have been questioned actually by Chinese

thought leaders for quite some time. Because currently this NNSA is housed, it's under the Ministry of Environmental Protection and NNSA does not have direct reporting to the State Counsel, so many Chinese thought leaders that are interested in seeing, greater, the higher level of nuclear safety in China, would like to see much stronger bureaucratic status for NNSA including the ability to report directly to the State Counsel and have its views heard. And also NNSA currently does not have complete independence over personnel and budgetary matters from the Ministry of Environmental Protection. So there are things to be perhaps improved for China to have the regulatory framework strengthened.

The third area that concerns sort of expertise, sort of human factor. And I am not saying that China does not have expertise, it's simply that the current very ambitious plans are starting to outpace the pool of nuclear talents within China. That goes both for the safety inspection side, but also the planned operation side. But particularly on

the regulatory side, the state research -- I'm sorry -- State Counsel Research Organization, which is basically a sort of independent thinking body that's attached to the State Counsel, has done extensive review before Fukushima that for the safety regulation to be effectively carried out within China, the NNSA needs to expand.

And in fact, after the Fukushima, the number of staff was expanded from about 360 to roughly 1000, a little over 1000 staff; however, if we are to see the ratio of staff experts to a power plant that's quite common in the U.S. and elsewhere where the commercial nuclear program is quite mature, then NNSA probably needs to double the size of its expert staff by 2020 if China is to have 58 gigawatts capacity running.

On the technology side, China's focus on indigenous development or to have, to develop sort of newer design reactors, advanced nuclear reactors as much with sort of an in-house expertise and capacity, has pretty much hampered the design turnover, if you

will. Many nuclear power plants that were on order or being built within China prior to Fukushima were older model nuclear power plants, the so-called generation two power plants. And I am not saying that there's something wrong with the second generation nuclear reactors, it's just that those were quite pretty much developed first in the west back in the '60s or '70s. So the second generation, the older generation nuclear reactors do not come with many advances that have been added to the newer models, such as passive safety features, or fuel technology thermo efficiency. And but those are, so to some extent the, that there's not just the regulation safety side, but the technology side; the Chinese fleet did not have the optimal, the most advanced state when it comes to safety issues.

And then so as I've outlined, China has the most ambitious build-out targets in the world, but with some institutional capacity challenges. On the other hand, although I did not go into details, but as many of you probably are aware of, the United States is home to the largest nuclear reactor fleet in the

world and with the wealth of expertise both regulations side and also operational side, but is facing a declining demand at home.

So these key contrasting characteristics I believe actually provide a unique synergy and basis for growing bilateral cooperation. On the regulatory side since the late '80s, the U.S. and Chinese regulators cooperated on issues like assessment and inspection of construction and decommissioning and also emergency preparedness. And the two countries have had a rich experience of personnel exchange, information exchange, workshops, and collaborative research. And since the sale of Westinghouse AP1000 reactors to China in 2007, I think that there is actually, that the bilateral relationship has become much more mutually beneficial as beneficial to the U.S. side as to China in that U.S. inspectors and regulators have sent staff to China to learn from the experiences the Chinese are having by constructing AP1000 reactors in both Sanman and Haiyang.

And so for example, in 2011, the NRC inspectors spent about half a year in China and visiting the sites, talking to workers and also engineers in China, to gain lessoned learned. On the technology front between the two governments, DOE and China's nuclear -- I'm sorry -- the National Energy Administration, sort of oversee a range of technology operation projects and activities. And especially since Fukushima, workshops like issues on, PSA, the probability safety assessment, have become quite active. And there are many lessons that are learned from Fukushima, but then also things that both countries are seeing from the Chinese construction of AP1000. Lessons have been shared among, between not just regulators, but more of technical experts within governments.

But then the technology engagement is actually emerging most prominently at the industry level. The Westinghouse sale of AP1000 reactors to China accelerated Chinese efforts to strengthen its technology development capacity. As I mentioned, the

Chinese philosophy on the civilian nuclear has included sort of a focus on indigenous development. So to do as much at home, you know, let's not rely as much on foreign expertise and such, but that also poses Chinese experts a challenge associated with the sort of capital stock turnover, if you will. Certainly not the necessary economic side, but the challenge, the technical challenge sort of dominating lead to the generation two reactors dominating the Chinese fleet.

So this AP1000 sale definitely helped Chinese on that front, but then also provided Westinghouse, which is now sort of a U.S.-Japan corporate partnership, with a foothold in China's growing nuclear sector. And there are couple more -- and since -- so the AP1000 at Sanman is to become the first U.S. based advanced pressurized water reactors to be built in the world later this year. And furthermore, Westinghouse now is working with China's state nuclear power technology cooperation in Shanghai Nuclear Engineering Research and Design Institute to

jointly develop conventional-sized pressurized water reactors based on AP1000. And furthermore Westinghouse is working with Chinese partners sort of exploring opportunities to develop a global supply chain for, not just AP1000, but future small module reactors, to market them globally together with the Chinese partners.

So I just wanted to conclude by saying that these emerging commercial ties, especially since the sale of Westinghouse 2010 to China began shifting the tone of relationship between the two countries' nuclear industries from some variation of coexistence to a nascent version of mutual dependence in the global energy nuclear energy sector. And we, I think we'll be seeing a lot more announcements down the road. And we'll see how much the two countries will collaborate and advance nuclear as a source of clean energy.

Thank you very much. (Applause)

DR. EBINGER: Those were three of the most interesting presentations I have heard on China in a

long time, but in a broader context I'm befuddled, because I know we were only discussing three major energy sources, but I hear people like Amory Lovins, and people at the Lawrence Berkeley Laboratory envisage of China that basically uses no fossil fuels or limited fossil fuels. And I hope maybe in the short question-and-answer period we have, I'd love to hear people say, if you were looking 20 years out, what is the Chinese energy mix? Because they note, for example, Amory Lovins in a recent article which staggered me, assuming I'll take for granted it's true, he suggested that in 2013 12 gigawatts or 12,000 megawatts of photo vault hagues came into the Chinese market. I was -- if that's true; I am totally unaware of it.

But let me quickly go down each of the presentations. And in an interest of time, I don't expect the speakers to respond to all of these, but maybe points that for further discussion at some point in time.

Kelly, on your coal, you were smartly

guarded on what is the medium term when we look at how much is coal China going to use. But we keep hearing this around the world, the medium term, but let me remind you that if we go back to Dr. Socolow's Wedge Theory on climate change of a number of years ago, you know, so much to meet the climate change goals, we had to meet so much capacity from different fuels; but we had to do this according to him, we had to have all this in place by 2050 so we would begin a downward turn in emissions after that.

And the longer we go into the medium, the medium term becomes the near term. And the years it takes to develop alternatives, I wonder, are we not on a collision course if China is going to continue to use the volumes of coal that I think you were at least hinting that will still be significant. I also would love to hear more about the employment issue. To what extent, India, a country I know far better than China, you know, changes in the coal sector are politically catastrophic potentially throwing millions of people out of work. And how serious a threat is that if coal

really were to be reduced in China, and does it ultimately potentially even pose a threat to the legitimacy of Communist Rule in China?

You mentioned it I think quickly in passing, but the whole issue of, are the Chinese doing anything dramatic in coal-to-liquids technology, which would seem -- I heard no discussion, and this would be on the whole question of liability, how big of question is that in China in terms of whether it's pollution or in the case of Sarah's paper, you know, one of the big concerns about sequestration is what if there's leakage down the road and a major accident happens, is anyone thinking about the liability for either coal or shale gas in China?

Sarah, one thing that always bothers me about China and people talking about shale gas, and you did a marvelous job I think, best I've ever heard talking about what the state of the industry is; but, you know, one of the things people forget, why it developed so quickly here. Two reasons; one, we have a huge oil and gas infrastructure, you know, drilling

infrastructure, rigs, bits, huge, and underutilized before the shale gas revolution, and nothing comparable exists in China. And to what extent is just getting the infrastructure a constraint?

And the most important factor, not that a command and controlled society can't order it to happen, but remember the most important factor in the United States shale gas development, I would argue, was the fact that landowners owned the subsoil rights and become, poor ranchers, poor farmers become multimillionaires overnight if they're fortunate enough to have shale gas under their situation. I'd love to hear more from Sarah about non-water drilling techniques. I already stabbed that Schlumberger now has a technology that uses 85 percent less water for fracking. I'd also like to know is there public concern about fracking? Is this something that's entered the body politic yet and if not, what do you think will happen? And the whole issue of water as we have more and more water constraints in China and rifle claimants for rifle is this potentially an area

of conflict?

Jane, is there any popular reaction against nuclear development in China such as we've seen in India where we've had very sizable demonstrations against the government's attempt in India to build new nuclear reactors? Particularly often also centering on the question of water tradeoffs between farming and the need for power. I'd be interested to know what the Chinese are planning, with at least their projected rapid expansion, on nuclear waste storage. Is this something that's underway?

Any information on what is, do we have any good information on the indigenous reactors, of what their cost is in comparison to what might be an average cost for nuclear reactors by the traditional international vendors? Are there concerns and how is citing regulated, either by the central government or by provincial governments? And finally, so we have some time left for the audience, let me ask, do you foresee, because I think most people in the nuclear

industry do believe that China may emerge as a major international nuclear commercial vendor, is there any prospect that down the road that China could emerge as a provider of commercial enrichment or reprocessing services, and what might that mean for the nonproliferation regime?

DR. LEIBERTHAL: Well, thank you very much both to the speakers and to Charley for raising such a rich array of important questions. Let me give the speakers, say, two minutes each to pick up on whatever they want to comment on with what Charley raised, and then we'll turn to the audience as Charley was admirably brief in the time he took for his comments.

But I'd ask you as part of your two minutes, to give your judgment 20 years from now, what is China's energy mix? Okay. And that is especially taking into account that the third plan announced, at least as a goal, a major restructuring of the Chinese economy, prioritization, more prioritization on environmental outcomes, but also had, I think, a total of 300 initiatives that it endorsed, many of which if

you look at carefully, potentially contradict each other or, you know, it's very hard to have your cake and eat it, too; so bottom line judgment, where do you think we'll be 20 years from now. And I recognize just a quick take.

Why don't we start with Kelly and just go down the line.

DR. SIMS GALLAGHER: That is a really hard question, Ken.

DR. LEIBERTHAL: Twenty years from now no one is going to look back at these notes and --

DR. SIMS GALLAGHER: Yeah, right.

DR. LEIBERTHAL: -- call you out.

DR. SIMS GALLAGHER: I hate predictions. You know, I guess the point I'd like to make about that is that I think it all depends on efficiency, which we haven't talked about, you know; but the demand side is the key to everything in China. And so if the Chinese are really successful at aggressively improving the energy efficiency of the system, then it makes it much easier all across the board or all

across all the technologies to achieve these transformations in the mix that we're talking about.

But I think, you know, most optimistically something like 40 percent coal, you know, down from 65 percent today. I mean, I think that would be an aggressive very optimistic target.

DR. LEIBERTHAL: And that's a huge increase in the absolute level of --

DR. SIMS GALLAGHER: Yes, yes.

DR. LEIBERTHAL: -- absolute amount of coal consumption.

DR. SIMS GALLAGHER: Yes.

DR. LEIBERTHAL: I mean, China currently adds 200 million tons of coal consumption per year.

DR. SIMS GALLAGHER: Yeah.

DR. LEIBERTHAL: Right.

DR. SIMS GALLAGHER: I'm just, because of this locked in effect --

DR. LEIBERTHAL: Uh-huh.

DR. SIMS GALLAGHER: -- you know, and all the capital stock that exists, it's just really hard

to imagine getting lower than that --

DR. LEIBERTHAL: Uh-huh.

DR. SIMS GALLAGHER: -- as a practical matter. That's not what I would prefer, that's what I --

DR. LEIBERTHAL: Obviously.

DR. SIMS GALLAGHER: -- think will happen. Just a couple of comments.

Great comments, Charley.

I think this question about reconciling the climate -- you know, I was trying to kind of build my case on reconciling coal and climate and I think we just have contradictory impulses and challenges in China right now. One of the most senior climate officials in China made an observation that I just couldn't believe not too long ago, Xie Zhenhua, who said, you know, we want to reach the peak, but peak as in the total amount of CO2 emissions as soon as possible and that we can't afford to go -- you know, and he was indicating in the pre-2020 timeframe, so that's great, but it's totally inconsistent with what

needs to happen, that sentiment isn't inconsistent, but the trends are completely inconsistent with what needs to happen from a climate point of view.

And that's why I'm so worried about the lack of focus and seriousness on the RD&D on storage, which is just so puzzling to me, because if you're investing in carbon capture technology and getting pretty good at it, but you're not investing in carbon storage; then what's the plan? Does that mean you're --

DR. LEIBERTHAL: I'm sorry. Can I interrupt for a second? Because what I keep hearing in China is we aren't as interested in carbon storage as we are in carbon utilization.

DR. SIMS GALLAGHER: Exactly. So --

DR. LEIBERTHAL: So let me --

DR. SIMS GALLAGHER: -- there's two explanations. One is they intend to utilize it, right --

DR. LEIBERTHAL: Uh-huh.

DR. SIMS GALLAGHER: -- and redeploy that

CO2 somehow for --

DR. LEIBERTHAL: Yeah.

DR. SIMS GALLAGHER: -- enhanced oil recovery or what have you, some other industrial application; or it means they're not that serious about climate change. I mean, there are two interpretations, but I think it's probably the former, they intend to utilize it. But can they utilize so much and make an appreciable difference from --

DR. LEIBERTHAL: Uh-huh.

DR. SIMS GALLAGHER: -- a climate point of view? I'm not so sure, and so I'll just kind of conclude here in my little two minutes by saying that this creates a dilemma I worry about a lot, which is that if you don't have the technical or economic confidence in the ability to capture and store the CO2, then as a government you will be reluctant to impose serious climate policies on your country. And so I feel like they've created a Catch-22 for themselves.

DR. LEIBERTHAL: Very interesting. Thank

you.

Sarah.

MS. FORBES: So the question about the energy mix is a great one. And I think I'll answer it, you know, really simply. And this is based on what I've seen coming from models in China. I agree with Kelly, I think there will be less coal. There will be more gas, more nuclear, and more renewables. And on the renewables, I think China is really bumping up against what's possible. And I tend to be a technology optimist, if case you can't tell, and I'm holding out hope that there will be research in China and the U.S. and elsewhere that will make what seems impossible today possible in 20 years and that we'll have something like shale gas that changes the energy picture and changes the mix in unexpected ways. And I believe it will be clean energy.

On the questions, and I think a lot of good questions, it's hard to know where to start. I'll say that on the technology side with the waterless fracking, you know, there are a number of

different options. One that sometimes people talk about is CO2. There are drawbacks to all of them. But the reason that I'm a little bit optimistic that, you know, Schlumberger's reduced water technology works, I've also heard of one in Texas; the reason I'm optimistic is because when you look at enhanced oil recovery in the United States and in China, we're actually using different things. And the United States conventionally up until recently you did a water flood and then you switched to CO2 for tertiary recovery, and that worked pretty well. And now they're going straight to CO2 in some cases.

Well, in China, the water doesn't work as well. They sometimes use it, but they tend to use a lot more fluids and chemicals and things that are not CO2. They've tried CO2. They've doing pilots. It works in some places, but not in others. And I think that's a good capture of the, you know, shale gas is different than oil and gas, but the differences in the geology I think mirror the two.

The question about liability and land

use, really good question. Property rights in China are not a nonissue, there is some negotiation with the collective land unit and how the land is currently used for a new development, but it's obviously a very different discussion about liability, especially compared to the United States. And different costs and benefits for local people.

DR. LEIBERTHAL: Thank you.

Jane.

MS. NAKANO: Sure. I feel like, you know, China has been doing this, all-of-the-above energy strategy for quite a while, and I think they will probably pursue it for the next couple of decades; but I do agree generally that coal may become, I mean, coal will likely remain as sort of an at least somewhat political target area for reduction. And I think nuclear is an interesting one, because it could be seen as an indigenous resource, but then at the same time, Chinese experts are very much aware of the uranium supply, potential supply constraints; and they're already looking at the next generation

technologies of sort of fact reactors. And so I think nuclear will remain in the Chinese energy option, but the fleet may not look the same way. And, you know, so probably shift away from the pressurized water reactors to the fast reactors in the coming decades.

When it comes to, in our, China has been working on both enrichment, but particularly on the reprocessing side there have been some announcements with very, you know, like scant details, but like some announcements that the Chinese has reached a sort of, some sort of a benchmark on their efforts to perfect its reprocessing capacity. And whether there will be a nonproliferation implication, I mean, since China is already a weapons state, I'm not as concerned as perhaps some of my colleagues in sort of nonproliferation areas may be.

I mean, they already know how to make bombs and how to keep them safely. But, you know, when it comes to enrichment, I think looking at the way the global nuclear industry marketing tactics are going, having reprocessing capacity seems like a great

feature when countries and companies want to sell its hardware. So I would not be surprised if China tries to highlight reprocessing as something that they can offer to potential customers down the road.

And then lastly the public demonstration, certainly one of the things that Fukushima did was certainly more integrated discussions on safety even among the general public as well. And earlier last year public demonstration and basically scrap this, what I believe is a fuel assembly, a nuclear fuel assembly plant in the southern part of China. And to some extent that may be the one factor that could slow down the nuclear expansion in China, I mean, together with the food safety and air quality issues and such; there's a greater awareness among the Chinese population about the qualitative aspect of these projects. And so yes, the public sort of sentiment or awareness may be an interesting factor going forward. Thanks.

DR. LEIBERTHAL: Thank you very much.

The floor is open now to questions.

Let me just make a couple of comments first. One since we are going to post an audio recording, please wait until the person with the traveling mic comes to you and gives you the mic. Please start off with your name and affiliation, and then feel free to direct a question either to the panel as a whole or to a particular person on the panel. And where is the traveling mic? Okay, fine.

Right down here first. I'll go back and forth around the room, you know. If -- thanks, Iris. Please.

MS. FRIEDMAN: Thanks. Lisa Friedman from ClimateWire. This was fantastic. Thank you for doing this. I think my question is probably mostly for Kelly, although I'd welcome any thoughts or insights from others on the panel. I wanted to see if you had any thoughts on China's new climate targets. Countries, as you know, are supposed to be signing this treatise agreement in 2015. They agreed in Warsaw last year to put on the table their new midterm, I don't know if that's 2025 or 2030, targets

by early next year. Any Intel that you have I'd love, but also I mean, if you --

DR. LEIBERTHAL: So the question is, what will China's target be, right?

MS. FRIEDMAN: What will China's targets be, but also any insights into what technical or political considerations they are going to have to take into account as they come up with these new targets.

DR. LEIBERTHAL: Okay. Thank you.

DR. SIMS GALLAGHER: Okay. I'm not going to try to hazard a gas on the target, but I can talk about some of these political and economic factors. I actually think the air pollution issue may give rise to a lot more political momentum than there might have been otherwise, and so I'm optimistic in that regard that they may be more aggressive. I think factors that would be pulling it back would be very practical, like how will they achieve the targets? Which set of policies are they going to choose?

And I think there's a lot of debate

right now about the policy mechanisms, studying the cap, you know, the pilot cap and trade. There's a lot of discussion about carbon taxation again. A lot of observation about the United States pursuing a regulatory approach. And so it's calling into question, sort of these big questions about, you know, what the best way to do this is and can we really pull it off in terms of achieving the targets.

And I think that's where there's much less certainty in China than there would be in the United States where we can model all of our, you know, policy scenarios and have pretty high confidence that we're actually going to meet the targets. I think there's much less confidence in China that policies that are employed will actually work and achieve the targets. So I think that's a real dilemma for them.

DR. LEIBERTHAL: Okay. Does anyone else want to jump in or no? Okay.

Yes, back here.

MR. FLAVIN: Yeah, Chris Flavin from Worldwatch. Great panel. I wanted to take the bait

from Charlie in terms of the role that renewables play. I certainly agree that getting to 100 percent or anything close to 100 percent renewables in, you know, in the foreseeable future is ridiculous. And Amory, as we all know, tends to exaggerate. I mean, they've always said, take Amory and divide by three and you usually get a good optimistic projection.

But I think the better source is the Chinese government. And I have had discussions with high-level officials at the NDRC. And the last conversation, they indicated that their expectation, I haven't seen this in writing, so we should try to verify this, that they expected renewables to be more important than CCS and nuclear combined just in terms of contribution to their electricity system, you know, within the next 10 or 20 years.

You know, and again, that's not an opinion, I mean, that's a factual, you know, question. So we should all look into it and see if that's true. The reason I think it probably is true is if you just look at the momentum, you know, where the renewables

are in China versus either CCS or nuclear, I mean, renewables are frankly far ahead. You know, China has the largest wind and solar industries having gone from scratch in 10 years and is adding, I'm not sure what the figure is, but I'm sure it's well over 10 gigawatts. The global market for wind and solar is 70 gigawatts a year.

And interestingly wind and solar are both, you know, really market driven. They're part of the new Chinese economy. There is some involvement of state-owned enterprises, but a limited amount. Nuclear is really, you know, entirely state-owned enterprises. It's very much a government-managed thing. It's the old China economy, not the new China economy. And then CCS, I mean, it's basically a set of experiments right now. It's nowhere near commercial whereas, you know, billions and billions are going into the others. So I'd be interested in anybody's sort of comments on that. I think, you know, ideally we would have had a renewables person on the panel.

DR. LEIBERTHAL: We'll have to try to address that next time, but let me, does anyone want to make a --

DR. SIMS GALLAGHER: Yeah, I'd like to.

DR. LEIBERTHAL: -- quick comment on this? Yes.

DR. SIMS GALLAGHER: So I'm totally optimistic about renewables. And in my book I have a case study on the development of the PV industry in China. And I agree with you, it's going gangbusters. I mean, it's really faltered in the last year in terms of production, but in general I agree with you that, you know, we're seeing much more movement on renewables than we are on any of the three sorts of technologies we've talked about today. It's just a scale question, and so that's why I emphasized, you know, the importance of getting the demand side under control, because it's then much more possible to achieve scale at renewables if you're able to reduce total demand, which I know you understand and agree with, but I really think that is the challenge.

Because right now China is growing, and even though I mentioned that paradox at the beginning, it's the largest clean energy, you know, economy, too. You know, it's hard to make a bigger dent in the total percentage of supply without getting demand, you know, to somehow peak and reduce.

DR. LEIBERTHAL: Thank you.

Jennifer.

MS. TURNER: Jennifer Turner, director of the China Environment Forum. And we're going to have a crazy talk about renewables being 100 percent on the 19th next week, so we'll pick up that slack for you there, Ken.

No, it's a tough topic.

DR. LEIBERTHAL: Always happy to help promote the Wilson Center's program.

MS. TURNER: Yeah, yeah, I know. Well, no, but I need to get you over to come and talk more.

DR. LEIBERTHAL: Well, please go ahead, yeah.

MS. TURNER: My question, Kelly, is that

when you're talking about capture, you know, carbon capture used in sequestration, that you were focusing mainly on the energy sector; but what about the coal to chemicals, which is highly energy intensive, water intensive, you know, well, we can talk later on the water issue, but and these plans on these massive, you know, 15 coal bases; is there talk, even if it's not happening, about trying to capture some of the carbon that comes out of those? Because they're going to be even bigger in terms of development than the power sector, I think.

DR. SIMS GALLAGHER: Right. Well, and this allows me to pick up Charlie's question about coal to liquids.

And, Sarah, just jump right on in.

Because Sarah actually knows a lot about this in the Chinese context. You know, the one significant carbon storage project is attached to a coal-to-liquids plant. But China has more coal gasification, so coal-to-chemical plants, than any other country in the world. And those are all great

targets for capture and storage, but they're just not doing it right now. So there is some capture and some utilization, so I really do feel like the Chinese are making significant investments on the capture side and probably, I haven't been able to get data, but probably there's significant cost reductions that are starting to occur in capture.

And I think they've done a lot more work on post-combustion capture than we have in the United States. And, you know, you hear these unbelievable stories about the costs, the really low costs of capture that they're achieving in post-combustion storage, so -- I mean post-combustion capture. It's a tongue twister. But I still am just so puzzled why they're not doing more on storage. It is just hard for me to reconcile that.

DR. LEIBERTHAL: Sarah.

MS. FORBES: So I'll jump in just really quickly. I agree with Kelly's characterization. There are storage projects underway, but they're on the order of magnitudes of hundreds of thousands of

tons of CO2 injected. Many of those are going for utilization for enhanced oil recovery. On the side of the coal to chemicals, I think it presents a really interesting opportunity. And the one thing, Kelly mentioned it in passing in her remarks, but there was a policy circular that the NDRC put out last October. And one of the things that policy circular did was it set the tone for a series of demonstrations throughout China. And it didn't -- it specified two things that I want to note.

It specified that those be diverse in terms of the regions and it terms of the types of projects, and it also specified that the CO2 used for those projects cannot come from natural sources. It has to be anthropogenic CO2 that's captured, and I think that's quite significant.

DR. LEIBERTHAL: Okay. Thank you.

And towards the back of the room, yes, back there towards the right.

MR. MEYER: Yeah, Ken Meyer, (inaudible). I have a comment and a question. Two of

the panelists mentioned the transition in this country from natural gas to coal -- or from coal to natural gas in the generation of electricity, so I feel compelled to point out that that was true in 2012, but last year the share of coal in electric generation went up by six percent while the share of natural gas went down by 12 percent. And that was when natural gas was selling in the $4 range. Now that it's selling in the $5 range, I suspect it's still true. My question is, do provinces in China have the capability to ban hydraulic fracturing as New York state has done in this country? And if so, has any of them done so?

DR. LEIBERTHAL: Sarah.

MS. FORBES: So that's a great question. I assume it's for me, but, Jane, Kelly, please jump in. You know, it's the balance between the national decisions and the provincial decisions, as I understand, it's pretty complex. And for example, the permitting process if it's a state-owned enterprise looks quite different than if it's a provincial-owned

enterprise or somebody else. I haven't seen any announcements that fracking has been banned at the provincial level. It may be possible, but it's not something this that I've seen. And I think even if it were to be adopted, how it plays out could be complex depending on who the players are.

DR. LEIBERTHAL: I see affirmative nods from the other members of the panel. Yes, back here. Yes.

MS. HU: Hi, everyone. My name is Na Hu. I'm a first year MB student from the George Washington University. I'm very interested about the renewable energy and the air pollution issue in China. So actually I went back to China last December and I witnessed a very serious situation in the (inaudible) weather in China, I just noticed it's not really an issue only in big cities such as Beijing and Shanghai. And I think it's kind of like national issues. Because it took me like 20 hours by train from Shanghai to my hometown, and I witnessed the situation is really worse along the whole trip on my way back home. So I'm very interested about renewable energy,

especially in the biodiesel industry.

So we know the biodiesel is the technique which converts vegetable oil, animal fat, or even restaurant grease into clean power; so it creates less greenhouse gasses, it's cleaner, it's easier to produce. So I'm wondering, how do you see the future of biodiesel in China? Thank you.

DR. LEIBERTHAL: Can anyone pick that up or --

DR. SIMS GALLAGHER: Well, let me just, I actually had wanted to talk a little bit more about the air pollution problem because we have a tendency to blame it all on coal, and certainly coal is a big component of the problem, but in many of the more urban locations, vehicles are a big, big source of the pollution problem, too. And one of the things I'm sort of concerned about is that we're not diagnosing these problems correctly, and so the response measures that have been announced lately by the Chinese governments of capping coal in certain provinces and cities may not be very effective if they are not

getting to the heart of some of the issues.

And with respect to vehicle pollution, fuel quality has been a persistent problem that really has to be addressed in China. As for biodiesel, I'm no expert on that in particular, but I think there's certainly a lot of scope for biofuels in China. The government has sort of pushed forward and pulled back on biofuels in terms of their technology policy a number of times as they wrestle with the food security issue. But the biodiesel, I think is more promising than ethenol in a sense that it can use a lot of waste products and be, you know, more effectively utilized in the Chinese context.

DR. LEIBERTHAL: Thank you.

Yes, right here.

MR. ALTMAN: I'm Fred Altman, and my question is for Jane. From what I understand, there is -- it's not a lot of publicity, but there is real progress being made in fusion. Is there any chance that's going to have an affect reason the next 20 years or so?

MS. NAKANO: Fusion. I have also heard about a lot of progress that has been made in the U.S. of course, but then also in China; but I do not know -- I mean, I think just last year I think there was the, I forget the name of the labs, but they did have some milestone achievements and such. But I think that's definitely an area that I think the Chinese are open to or the Chinese system is set up to be able to keep putting resources in, but I do not know the specifics of their sort of the blueprint, if you will, for their fusion project.

DR. LEIBERTHAL: Yes.

Did you still have a question? You were waving your hand before and I -- no, okay.

MS. AKERLIND: Hi. Ingrid Akerlind from Third Way. Both Kelly and Jane, you both talked about sort of the technology that's being developed. I was wondering if, Sarah, you could speak a little more to as the joint ventures are developing between U.S. and Chinese countries to explore these shale gas plays, are they importing U.S. technology now? Are

they setting up joint development centers? Who is going to make the machines that actually gets the shale out of the ground? Thank you.

MS. FORBES: So thank you, Ingrid. That's a great question. So the interesting thing is from the oil and gas industry, the way technology transfers from one country to another and the way it's developed is really different than what happens in the electric power sector. And you really can't think of it in the same terms. The oil and gas industry is globally integrated, and companies all over the world form joint ventures and they share technologies and they go to the same service providers for these technologies. And so there are centers that are being set up by some of the service providers, by some of the companies. They include a research component, often one that's focused on China, but when you think about technology transfer in oil and gas in any country, it's just a little bit different because the industry is already has such a global view and companies are partnering.

You know, PetroChina partners in

projects in Australia and, you know, it's a very global picture. And technology, it's often the know-how that you need to purchase from the service provider, and not the technology, itself.

DR. SIMS GALLAGHER: Can I add one quick point?

DR. LEIBERTHAL: Please, yes.

DR. SIMS GALLAGHER: Here's where Sarah's and my talks connect, because on the other side, like the consumption side of gas, I think an interesting and important and unappreciated issue is that the Chinese do not have strong gas turbine capacities. So they have very weak technology capabilities in gas turbines. And this is a problem for them if they want to move to IGCC technology. And it's a problem for them if they want to start having a lot of natural gas generation. This is one of the cases in my book. And it's a case of total failed technology transfer. You know, it's just, they are completely in a position of having to purchase gas turbines from foreign providers and have to pay very high prices for them especially

if they want the high efficiency ounces.

And this is going to be, I think, an increasing point of friction between China and the United States and China and Japan and China and Germany.

DR. LEIBERTHAL: Why, because they --

DR. SIMS GALLAGHER: Because they feel --

DR. LEIBERTHAL: -- suspect price gouging?

DR. SIMS GALLAGHER: -- like they're getting ripped off. Yes.

DR. LEIBERTHAL: Yeah, okay.

DR. SIMS GALLAGHER: -- they think there's price gouging and they're very frustrated that they're not able to license more advanced gas turbine technology. Now, you know, the Chinese expert, you know, sort of scientists argue that there have been a lot of mistakes made by the Chinese government over the years and failing to invest in R&D in gas turbine technology. And I think the reason for that was that they had no vision of shale gas ever coming to fruition and they knew they had very limited

conventional gas, so they didn't really see why they might need gas turbine technology in the future.

DR. LEIBERTHAL: Thank you.

Charlie.

DR. EBINGER: Well, while we're on the issue of gas, I just think we'd be remiss not to point out the relationship of what may happen in shale gas versus China's importation of both LNG and of course for potentially more pipeline gas from either central Asia and possibly even from Russia. Of course a lot of that will have to do with pricing policy --

DR. SIMS GALLAGHER: Right.

DR. EBINGER: -- and other issues. But, you know, if China develops shale gas and didn't need the prodigious volume of LNG that's projected to be used, it would transform the international gas market and completely --

DR. SIMS GALLAGHER: Yeah.

DR. EBINGER: -- create a new giant in geopolitics of internationally traded gas.

DR. LEIBERTHAL: Do you wanted to

characterize that?

DR. EBINGER: What?

DR. LEIBERTHAL: Do you want to characterize that transformation? I mean, what are a couple of takeaways from this?

DR. EBINGER: Well, I mean, the transformation is China is projected to take a huge amount of the LNG in the world market and everybody is scrambling now for LNG and if all of a sudden China didn't need that LNG and it was freed up to probably stay mostly in Asia, but nonetheless, it would probably drive LNG prices down, I would argue, quite dramatically and independently, you know, would change geopolitics as different people with different production costs scrambled to pick up new markets. It would truly be transformative. It would also be very deleterious, I think, to all of the talk about huge volumes of LNG exports coming out of the United States.

DR. LEIBERTHAL: Thank you.

Yes.

MR. WALKING: Jonathan Walking with China Environment Forum. Sarah, I'm going to dig a little more into the point that Charles just brought up about, not really about LNG, but about gas supply. I'm going to ask this question; probably many people wonder the same as I do, when do you expect China is going to have the same kind of shale gas revolution as U.S. has? And if you say it's somewhere around 2020, do you worry, considering from the 12th five-year plan, from last year's air pollution action plan, China's new effort to dramatically increase natural gas consumption, do you worry about the supply of that kind of targets? Thank you.

MS. FORBES: So I think gas supply is coming from a number of different sources. Shale gasses are one source. You know, one of the things in what Charles mentioned with the gas that's already projected to come in from LNG and from pipelines, you know, one of the things that may influence the pace and scale of shale gas development are the contracts on some of the pipelines. And the contracts for gas

are actually pretty long term. And I think that really matters in the context. I think in general, yes, the goals for gas are ambitious.

I still think there's some uncertainty in how fast shale gas will happen in China, the challenges that I mentioned are things that everyone is talking about. I think they're surmountable, but I think they're going to affect the pace. And the goal, you know, I mentioned in my talk they're about halfway there, I think, you know, it could be achieved by 2015, but I wouldn't necessarily say that then by 2020 shale gas in China already looks like the United States. I'm not sure that it happens that fast.

MS. NAKANO: Can I add just a quick comment? I agree with Sarah that, you know, there's still sort of a range of challenges that China needs to address. And to some extent I think it will never look the same way the U.S. shale revolution has happened, including, you know, the resources, that in the U.S., you know, it has happened pretty much on the private lands because the mineral rights ownership belongs to the

property ownership rights and such. But at the same time, what fascinates me is that because, you know, NOCs, the major Chinese NOCs pretty much hold the best shale acreage, I sort of wonder if they put their mind to it, then they might be able to do it a lot quicker than in a lot more of a sort of market-based economy such as the U.S.

And I, you know, and it has a lot to do with, you know, their distribution making process. They do have a lot of resources that are perhaps already prioritized for conventional side oil gas, so they need to figure out, you know, say, you know, the Sinopec and CMC, those folks have to figure out, well, do they want to go into the unconventional side right now. Even within unconventional gas, there is, you know, methane. So there are a lot of different things going on. It would be fascinating to see, what, you know, I mean, I think they have the right ingredients pretty much. Of course there are sort of above-ground challenges and below, you know, sort of geological challenges, but they, I feel like they have many, many

things going for them. But, you know, when it comes to the stakeholders, then there are a lot of different issues going on, so you know.

DR. LEIBERTHAL: All right.

Yes, back, either one of you sitting next to each other there.

MR. GROVES: Peter Groves from the Energy Information Administration. One of the benefits of the natural gas shale gas boom here has been the natural gas liquids, ethane, propane. And that's one of the reasons for all of these announcements about chemical crackers coming online. We've become a net exporter of LPG. And I'm wondering if this has entered the calculus in the Chinese government's minds about their exploitation or potential exploitation of shale gas? It has infrastructure implications, but it also has implications on the chemical sector, maybe weaning away from coal. So it has -- I'm just wondering if that has entered the calculus.

DR. LEIBERTHAL: Sarah, that's

probably aimed at you.

MS. SIMS GALLAGHER: So I'm not sure that it has. I do know that the decisions about, you know, there's discussions underway about coal to synthetic natural gas for power and the efficiency of that relative to using coal straight for power. On the chemical side I think it's going to matter, you know, if what are the liquids contents of China's shale gas reserves and what does that look like. I think that will influence it. And the context for coal to chemicals in China, a lot of it is already happening. Those plants are already built. There are many more underway. But a lot of that coal-to-chemicals production is already underway. And so I think the chemical industry looks quite a bit different and the way shale gas enters into that mix, therefore, is going to be quite a bit different than it's been in the United States.

DR. LEIBERTHAL: We only have about two minutes left. I'll go there and then up here. And just please ask your questions succinctly, and then

we'll open it up to the panel for any final comments including responding to these couple of questions, please.

MS. JONES: Okay, thank you. This is Iaga Jones from EIA. One question for Kelly; one for Jane. For Kelly, could you just provide a little bit more details on the capture? You mentioned they are very advanced. Are they actively seeking to reduce costs or do they have their own indigenous demands or process or they are just capturing for industrial use like to carbonize a drink or anything?

And the question for Jane is, you mentioned the expertise for nuclear is outpaced by the plans. So because of the technology difference, will -- is there any constraint to how much China can utilize the experience in the western world? For example, can they send operators into the U.S. for training? Would that expertise be applicable in China?

DR. LEIBERTHAL: Thank you.

And last question here, yes.

MS. ERICA: Yes. My name is Erica. I'm from the Center for Clean Air Policy. And my question is for Kelly and the other panelists about the uprise of the coal caps in some of the provinces and the cities and how this would interact with the mission's training pilots. Since in China right now there's a lot of concern that some of the coal caps would make the ETS ineffective, so in your experience and work, do you have any insights on how they would be regulated and how the companies would have to comply with both regulations?

DR. LEIBERTHAL: Thank you very much. We've only got about two minutes left. So let me just go down the line in reverse order starting with Charlie and then Sarah.

DR. EBINGER: I'll pass to the panel.

DR. LEIBERTHAL: You'll pass.

Okay. So then Sarah, Jane, and Kelly, any wrap-up comments you wish to make including any comments on these last few questions.

MS. FORBES: Sure. I'll be very brief since

the questions were for Jane and Kelly. I just want to say thank you for the opportunity to be here today and for the excellent questions. These are important topics that are really going to change the energy picture for the future, not just of China, but the world, and it's been a pleasure to be here with you all today.

DR. LEIBERTHAL: Thank you.

MS. NAKANO: So on the nuclear expertise, the Chinese commercial fleet has a mixture of international reactors. They have French, Russian, and also Canadian reactors that are in existence in China. So I think they're used to working or learning from foreign experts, but specifically for example, on this AP1000, Westinghouse did build a massive sort of mockup of an operator room, a control room, and trained hundreds of Chinese experts so that they would be able to pass Chinese regulators exam to become certified operators and such.

So there are all these things happening. Also, the -- I believe it was Excellence

Subsidiary that had some consulting business helping China's mid to senior level managers on safety, some of the decision making, like, issues, how to run plants safely and et cetera. So there's a lot of, not just the hardware, but there's like know-how transfer happening. So thank you.

DR. LEIBERTHAL: Thank you.

MS. NAKANO: I hope that addressed your question. Thanks.

DR. LEIBERTHAL: Thank you. Kelly.

DR. SIMS GALLAGHER: And I'll pick up the coal cap and pilot question. You know, I hadn't actually thought about that, so it's a really interesting question; but I do think that kind of gets to the point I was trying to make about the sort of lack of understanding in China about the, how policy choices they are making are actually, you know, ending up materializing in terms of the outcomes. And I think there is incoherence now and, you know, that these coal caps, I think, are just sort of a panicked response, that's why I'm interpreting them to

political pressure about air pollution.

Okay, caps; great, but it's not deeply thought through. And I think we are seeing a number of policies that are either incoherent or misaligned. And I think the real challenge, you know, getting back to Lisa's question about the longer term climate policies, is what's the overall plan and how are the policies going to work in alignment to achieve the goals? And that's a pretty hard question right now in China.

DR. LEIBERTHAL: This has been a rich varied panel and the questions have enriched the content of the overall session quite a bit. I want to remind you that we will have a full audio of this panel discussion plus a transcript plus related papers on nuclear, shale, and coal respectively. And they should be on our website, on the Brookings website by the end of next week. And so I encourage you to look at those. And I encourage you to join me in thanking our panelists and our commentator for this morning's session.

(Applause)

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CERTIFICATE OF NOTARY PUBLIC

I, Carleton J. Anderson, III do hereby certify that the forgoing electronic file when originally transmitted was reduced to text at my direction; that said transcript is a true record of the proceedings therein referenced; that I am neither counsel for, related to, nor employed by any of the parties to the action in which these proceedings were taken; and, furthermore, that I am neither a relative or employee of any attorney or counsel employed by the parties hereto, nor financially or otherwise interested in the outcome of this action.

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