U.S.-CHINA CLEAN ENERGY COOPERATION: STATUS, CHALLENGES, AND OPPORTUNITIES

HEARING

BEFORE THE

U.S.-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION

ONE HUNDRED THIRTEENTH CONGRESS
SECOND SESSION

FRIDAY, APRIL 25, 2014

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UNITED STATES-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION

WASHINGTON: 2014

U.S.-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION

The Commission was created on October 30, 2000 by the Floyd D. Spence National Defense Authorization Act for 2001 § 1238, Public Law No. 106-398, 114 STAT. 1654A-334 (2000) (codified at 22 U.S.C. § 7002 (2001), as amended by the Treasury and General Government Appropriations Act for 2002 § 645 (regarding employment status of staff) & § 648 (regarding changing annual report due date from March to June), Public Law No. 107-67, 115 STAT. 514 (Nov. 12, 2001); as amended by Division P of the "Consolidated Appropriations Resolution, 2003," Pub L. No. 108-7 (Feb. 20, 2003) (regarding Commission name change, terms of Commissioners, and responsibilities of the Commission); as amended by Public Law No. 109-108 (H.R. 2862) (Nov. 22, 2005) (regarding responsibilities of Commission and applicability of FACA); as amended by Division J of the "Consolidated Appropriations Act, 2008," Public Law Nol. 110-161 (December 26, 2007) (regarding responsibilities of the Commission, and changing the Annual Report due date from June to December).

The Commission's full charter is available at www.uscc.gov.

July 02, 2014

The Honorable Patrick J. Leahy
President Pro Tempore of the Senate, Washington, D.C. 20510
The Honorable John A. Boehner
Speaker of the House of Representatives, Washington, D.C. 20515

DEAR SENATOR LEAHY AND SPEAKER BOEHNER:

We are pleased to notify you of the Commission's April 25, 2014 public hearing on "U.S.-China Clean Energy Cooperation: Status, Challenges, and Opportunities." The Floyd D. Spence National Defense Authorization Act (amended by Pub. L. No. 109-108, section 635(a)) provides the basis for this hearing.

At the hearing, the Commissioners received testimony from the following witnesses: Ms. Leocadia Zak, Director, U.S. Trade and Development Agency; Dr. Joanna Lewis, Assistant Professor of Science, Technology and International Affairs, Georgetown University; Ms. Sarah Forbes, Senior Associate, World Resources Institute; Ms. Jane Nakano, Fellow, Energy and National Security Program, Center for Strategic and International Studies; Dr. Jerald J. Fletcher, Director, Advanced Coal Technology Consortium, U.S.-China Clean Energy Research Center; Dr. Huei Peng, Professor, Mechanical Engineering and U.S. Director, U.S.-China Clean Energy Research Center-Clean Vehicle Consortium, University of Michigan; and Dr. Valerie Karplus, Project Director, China Energy and Climate Project, MIT Joint Program on the Science and Policy of Global Change. This hearing examined, among other things, China's energy needs and clean energy policies, the recent developments in the U.S.-China clean energy cooperation, and the implications of such cooperation for the United States.

We note that prepared statements for the hearing, the hearing transcript, and supporting documents submitted by the witnesses are available on the Commission's website at www.USCC.gov. Members and the staff of the Commission are available to provide more detailed briefings. We hope these materials will be helpful to the Congress as it continues its assessment of U.S.-China relations and their impact on U.S. security.

The Commission will examine in greater depth these issues, and the other issues enumerated in its statutory mandate, in its 2014 Annual Report that will be submitted to Congress in November 2014. Should you have any questions regarding this hearing or any other issue related to China, please do not hesitate to have your staff contact our Congressional Liaison, Reed Eckhold, at (202) 624-1496 or via email at reckhold@uscc.gov.

Sincerely yours,

Hon. Dennis C. Shea
Chairman

Hon. William A. Reinsch
Vice Chairman

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U.S.-CHINA CLEAN ENERGY COOPERATION: STATUS, CHALLENGES, AND OPPORTUNITIES

FRIDAY, APRIL 25, 2014

U.S.-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION

Washington, D.C.

The Commission met in Room 608 of Dirksen Senate Office Building, Washington, DC at 9:00 a.m., Commissioners Carte P. Goodwin and Robin Cleveland (Hearing Co-Chairs), presiding.

OPENING STATEMENT OF COMMISSIONER CARTE P. GOODWIN HEARING CO-CHAIR

HEARING CO-CHAIR GOODWIN: Good morning, and welcome to the fifth hearing of the U.S.-China Economic Security Review Commission's 2014 Annual Report cycle. I'd like to thank our witnesses for being here this morning. I'd like to thank them for the considerable amount of time they have put into crafting their excellent written testimony.

In today's hearing, we will examine China's domestic and international clean energy policies, as well as look at recent collaborative efforts between the U.S. and China on clean energy.

After decades of rapid economic growth and heavy industrialization, China is currently one of the world's top energy consumers and the largest emitter of greenhouse gases. As a result, Chinese leaders have recently enacted a number of plans and directives with a specific focus on developing a cleaner energy policy and a lower carbon economy.

In the 12th Five Year Plan, the Chinese government set ambitious goals in this regard, including increasing the use of clean and renewable energy sources, such as natural gas, wind, and solar.

However, as China builds up its own clean energy industry, it has also adopted some policies that may disadvantage U.S. energy companies seeking to operate and sell their products and services inside of China. Indeed, China's "indigenous innovation" policy may preclude certain foreign manufacturing companies from qualifying for government-funded projects. We hope to explore these barriers to competition and others during our panel discussions today.

Despite these differences, however, bilateral cooperation on clean energy is an area that both countries have indeed embraced. As witness Dr. Jerry Fletcher, who will testify later today, noted recently, China and the U.S. account for nearly 60 percent of all the coal burned in the entire world. By working together and making joint budgetary commitments, the U.S. and China can accelerate advanced clean coal technology and enhanced environmental protection and help the economy in the meantime.

To help us better understand these issues, we will be joined today by experts from research institutions, like Dr. Fletcher, from the administration, and the private sector.

In particular, we are pleased to welcome Leocadia Zak, Director of the U.S. Trade and Development Agency, to present the administration's views on commercial opportunities in the

U.S.-China clean energy sphere.

But, first, I'd like to turn the floor over to Commissioner Cleveland for her opening statement.

PREPARED STATEMENT OF COMMISSIONER CARTE P. GOODWIN
HEARING CO-CHAIR

U.S.-China Economic and Security Review Commission

Hearing on U.S.-China Clean Energy Cooperation: Status, Challenges, and Opportunities

Opening Statement of Commissioner Carte Goodwin
April 25, 2014
Washington, DC

Good morning and welcome to the fifth hearing of the U.S.-China Economic and Security Review Commission's 2014 Annual Report cycle. I want to thank our witnesses for being here today, and for the time they have put into their excellent written testimony. Today's hearing will examine China's domestic and international clean energy policies, and the potential for cooperation or competition between the United States and China on clean energy.

As a result of decades of rapid economic growth and heavy industrialization, China is currently one of the world's top energy consumers and is the largest emitter of greenhouse gases. In order to curb the resulting environmental damage, Chinese leaders have enacted a number of plans and directives with a specific focus on developing a low carbon economy. For example, in the 12th Five Year Plan, the Chinese government set ambitious goals. They include increasing the use of clean and renewable energy sources, such as natural gas, wind, and solar, while reducing reliance on coal.

However, as China builds up its own domestic renewable energy industry, it has also adopted policies that disadvantage U.S. clean energy companies seeking to operate and market their products in China. For example, China's "indigenous innovation" policy appears to prevent foreign renewable energy manufacturing companies from qualifying for government-funded projects. We hope to explore these barriers to competition in our panels today.

Regardless of the differences between Beijing and Washington, bilateral cooperation on clean energy is an area that both countries should continue to embrace. To give one example, West Virginia University, working with other U.S. and Chinese academic and industrial partners, leads the research into advanced coal technology including carbon capture, utilization and storage. Such collaboration benefits the United States and China, as well as the global commons. Our goal is to see how we can expand this cooperation in the future, without harming U.S. interests in the process.

To help us better understand these issues, we will be joined today by experts from the Administration, academia, and the private sector. In particular, we are pleased to welcome Leocadia Zak, Director of the U.S. Trade and Development Agency to present the

Administration's views on commercial opportunities in the U.S.-China clean energy sphere.

I now turn the hearing over to Commissioner Cleveland for her opening statement.

OPENING STATEMENT OF COMMISSIONER ROBIN CLEVELAND
HEARING CO-CHAIR

HEARING CO-CHAIR CLEVELAND: Thank you, Commissioner Goodwin, and thanks to all of our witnesses for being here.

I'm pretty parochial when it comes to politics so in Kentucky, there are three things that matter: bourbon, basketball and coal. And that's in alphabetical order, not priority order. So I'm delighted that we're talking about coal today. Basketball is a sorer subject right now.

In November 2009, President Obama and President Hu Jintao announced the establishment of the U.S.-China Clean Energy Research Center, which is focused on spurring innovation, improving efficiency and achieving a low carbon economy through joint efforts by U.S. and Chinese researchers and industry partners.

The three initial research priorities are: developing advanced clean coal technologies, including carbon capture and storage; developing cleaner vehicles; and improving building energy efficiency.

We're pleased to welcome U.S. directors of two research consortia and the director of TDA to give their views on CERC research and efforts.

I would like to highlight some of the work achieved through the joint efforts at CERC. UK, University of Kentucky, for example, is working with Tsinghua University to develop membranes and solvents to separate or absorb CO2 from the burning of coal. But such efforts require considerable energy themselves. One project has managed to reduce the "energy penalty" or the use of electricity to scrub the CO2 from flue gas.

Another joint project with West Virginia and--I'm going to really mangle this one--Qinghua University is examining China's Ordos Basin and the Green River Basin in Wyoming for geological storage of CO2.

The scope of these projects and their implications for the future of global carbon reduction and energy sufficiency are really impressive, and I look forward to hearing more on their progress.

I'm particularly interested in the fact that I think one of our witnesses talks about in the statement, about the fact that bilateral work on clean energy has been far more effective than working on these issues in a multilateral context, partly because we do bring the two largest economies and consumers of energy to the table.

So before we begin, I'd like to thank Chairman Patty Murray and her staff for letting us use this room this morning. And so let's proceed with Director Zak, who I now have to introduce.

You have an impressive background, but the most important thing to me is the fact that you were a career civil servant, and the administration chose to promote you and make you the head of the agency.

We can go through all your degrees here, which the staff has carefully prepared, but I think what impressed me in our brief conversation before we began is the fact that you are collaborating so closely with OPIC and Ex-Im because I think it's that cycle of support that really truly helps American businesses when it comes to positioning themselves at the beginning and through a trade cycle to assure their success.

So if you'd like me to mention where you were a law partner, I'm happy to do so, but otherwise, I think let's just get to your testimony and hear your thoughts on how this process is going.

Thank you.

PREPARED STATEMENT OF COMMISSIONER ROBIN CLEVELAND
HEARING CO-CHAIR

U.S.-China Economic and Security Review Commission

Hearing on U.S.-China Clean Energy Cooperation: Status, Challenges, and Opportunities

Opening Statement of Commissioner Robin Cleveland
April 25, 2014
Washington, DC

Thank you, Commissioner Goodwin. And thanks to our witnesses for being here today to help us understand China's clean energy policies and U.S.-China clean energy cooperation.

In November 2009, President Barack Obama and President Hu Jintao announced the establishment of the U.S.-China Clean Energy Research Center (CERC), which is focused on spurring innovation, improving efficiency, and achieving a low-carbon economy through joint efforts by U.S. and Chinese researchers and industry partners. CERC's three initial research priorities are developing advanced clean coal technologies, including carbon capture and storage, developing cleaner vehicles, and improving building energy efficiency. We are pleased to welcome the U.S. directors of two research consortia to give their views on CERC research.

I would like to highlight some of the work achieved though joint efforts at CERC. The University of Kentucky, for example, is working with Tsinghua University, among others, to develop membranes and solvents to separate or absorb CO2 from the burning of coal. But such efforts require considerable energy themselves. One CERC project managed to reduce the "energy penalty" or the use of electricity to scrub the CO2 from the flue gas, from 12.7 percent to 10.2 percent. Another joint project with West Virginia University and Qinghua University, among others, is examining China's Ordos Basin and the Green River Basin in Wyoming for geological storage of CO2.

Another project involving the University of Kentucky and Duke Energy involves the use of CO2 from flue gases at a power plant in Rabbit Hash, Kentucky. The CO2 is captured after combustion and fed to algae. Eventually, the algae, which absorb the carbon dioxide, can be harvested for biogas fuels and for animal feed. The research involves finding the optimum methods for growing and harvesting the oil from the algae, picking the best varieties of algae, and picking among a variety of growing media.

The scope of these projects, and their implications for the future of global carbon reduction and energy efficiency, are truly impressive, and we look forward to hearing more on their progress.

Before we begin, let me take a moment to thank the Budget Committee, and specifically Chairwoman Patty Murray and her staff, for securing this room for us today.

We thank you all for participating and we will begin by hearing testimony from Director Leocadia Zak.

OPENING STATEMENT OF MS. LEOCADIA ZAK
DIRECTOR, U.S. TRADE AND DEVELOPMENT AGENCY

MS. ZAK: Thank you very much and thank you for that kind introduction.

Senator Goodwin, Commissioner Cleveland, and members of the Commission, thank you for the opportunity to testify about the U.S. Trade and Development Agency's clean energy cooperation with China. We appreciate your invitation to describe our efforts to foster public-private partnerships between the U.S. and Chinese energy sectors.

Congress established USTDA in order to, and I quote, "promote United States private sector participation in development projects in developing and middle-income countries with special emphasis on economic sectors with significant United States export potential," end quote.

USTDA's dual mandate requires that the agency both foster overseas private infrastructure development and support U.S. job creation through exports. In USTDA's history of linking U.S. businesses to export opportunities, the agency has generated over $45 billion in U.S. exports.

USTDA accomplishes its mission by providing grants to overseas sponsors for priority infrastructure development activities in their countries.

The funding may be used to perform a feasibility study, provide technical assistance or launch a pilot project.

The agency also connects project sponsors with U.S. businesses through its reverse trade missions. We tailor these missions to bring foreign decision-makers to the United States to observe the design, manufacture, and operation of U.S. goods and services.

We also support cooperation programs that integrate government resources and industry innovation for win-win results. Ten years ago, we helped establish a public-private partnership to promote commercial, policy and technical collaboration between the U.S. and Chinese aviation sectors. USTDA led the primary stakeholders in developing a framework for the U.S.-China Aviation Cooperation Program, which has grown to include over 40 U.S. industry members and five public sector partners since it was founded in 2004.

However, after experiencing the benefits of working closely with their Chinese counterparts in a public-private aviation partnership, several U.S. industry leaders approached USTDA to propose a similar structure for energy cooperation.

In 2009, USTDA again convened government and industry stakeholders to launch the U.S.-China Energy Cooperation Program. The ECP's primary goal is to connect U.S. businesses to the enormous opportunities that exist in China's $1 trillion clean technology market.

Today, the ECP provides a platform for its 52 company members to share information and experience while working together to address important issues. One such issue is access. The ECP often paves the way for U.S. companies, including small and medium-sized enterprises, seeking entry into China's market by providing them with greater visibility and additional resources.

Small companies often do not have the means to represent their interests as strongly as big companies with large overseas offices.

Cooperation programs like the ECP provide SMEs access to important stakeholders and often give them a voice in policy decisions.

For instance, USTDA has supported several ECP members in encouraging China to adopt

U.S.-style standards so that their products can compete in the Chinese market. One of the ECP's founding members was Solatube, a small California-based company with patented daylighting devices that bring natural lighting into interior buildings.

When Solatube first arrived in China, the daylighting industry was nonexistent. Because of the absence of a market and associated standards, it was clear to Solatube that establishing reasonable standards would help them to be able to develop a market in China.

Through the ECP, Solatube participated in two USTDA reverse trade missions, during which Chinese delegations visited Oregon and California, where they saw demonstrations of the company's daylighting technologies. Following the visit, Solatube secured its first project in Henan Province for the design and installation of daylighting units in two buildings.

Solatube then won a 20,000-square meter project in Shanxi Province. They were also invited to participate in the drafting and revision of three building lighting standards that now include daylighting systems.

In response, Solatube's General Manager stated that, and I quote, "ECP gives small and medium enterprises, especially those leading a new industry, the leverage needed to work with the government and to reach out to the Chinese market and get results," end quote.

ECP members, like Solatube, help to address another important issue: the environment. In line with U.S. and Chinese government priorities, the ECP has also devoted significant resources to helping address China's environmental issues and mitigate the effects of global climate change.

Indeed, the focus on reducing environmental impacts of China's energy consumption has become increasingly important to the Chinese government, which recently announced significant emissions reduction goals.

USTDA and the ECP are currently supporting efforts to help China meet these goals. For example, the China Air Quality Management Program, developed in cooperation with the U.S. Environmental Protection Agency, will assist China in its efforts to reduce pollution by developing an air quality management plan based on U.S. best practices and technologies.

USTDA and the ECP have also supported efforts to improve electricity transmission and distribution within China's power grid. The Smart Grid Working Group, which was the first to emerge under the ECP, quickly became the largest, and it remains so in the current field of ten working groups.

It was founded by information technologies companies that offer smart grid solutions, an important priority in China, which surpassed the U.S. as the world's largest smart grid market in 2013.

Driven by industry leadership, USTDA and ECP have collaborated on nearly a dozen smart grid activities in China. For example, USTDA supported a pilot project with ECP members Honeywell and AECOM to help the China State Grid Corporation achieve its demand side management reduction goals.

The project demonstrated that U.S. technology could reduce energy loads of commercial buildings in China by 15 percent and that of industrial sites by as much as 50 percent--highly significant savings.

China is planning to expand this pilot to other cities, presenting follow-on contract opportunities for Honeywell, which won a 2013 China Low Carbon Model Award for their contributions to this project.

Another ECP working group recently requested USTDA's assistance in its efforts to address an additional source of China's emissions: mid-range and heavy duty commercial

vehicles. In response to this request from the Clean Transportation Working Group, USTDA sponsored a reverse trade mission designed to introduce Chinese delegates to the best U.S. practices in regulations for HDV fuel economy standards.

This will assist China in developing policies that improve fuel consumption and reduce greenhouse gases, while also helping to level the playing field for trade in U.S. technology.

As a result of the ECP's successes, USTDA's public-private partnerships are viewed as touchstone programs that allow government and industry partners to accomplish more together than they could separately.

The primary value of the ECP is its ability to identify tangible business opportunities for U.S. companies while contributing to China's clean energy development and emissions reduction efforts. This is also true for the agency's program in general, which has generated almost $300 million in U.S. exports for energy and environmental projects in China since 2001.

As an added benefit, we have also observed that the ECP's work can positively impact the priorities, standards, and policies of the Chinese government in the energy sector.

Through their collaboration with the ECP, our Chinese partners have begun to look to U.S. companies for technological solutions to their development challenges, and as we've seen with the Solatube example, they've begun to introduce policies and standards that can enable the implementation of U.S. technology as a response to some of those challenges.

Senator Goodwin, Commissioner Cleveland, and members of the Commission, this concludes my remarks. I look forward to your questions and I thank you again for having us here today.

PREPARED STATEMENT OF MS. LEOCADIA ZAK
DIRECTOR, U.S. TRADE AND DEVELOPMENT AGENCY

Statement by The Honorable Leocadia I. Zak
Director, U.S. Trade and Development Agency
Before the U.S.-China Economic and Security Review Commission

Hearing on "U.S.-China Clean Energy Cooperation: Status, Challenges, and Opportunities"

April 25, 2014, 9:00 a.m.

Senator Goodwin, Commissioner Cleveland and members of the Commission, thank you for the opportunity to testify about the U.S. Trade and Development Agency's cooperation on clean energy development with China. We welcome the Commission's interest in USTDA's work to foster public-private partnerships between the U.S. and Chinese energy sectors, and we look forward to describing the status, challenges and opportunities of those efforts.

USTDA's dual mandate positions our Agency to create jobs here at home, while promoting sustainable infrastructure in emerging markets around the world. USTDA was created to "promote United States private sector participation in development projects in developing and middle-income countries, with special emphasis on economic sectors with significant United States export potential."[1] USTDA is distinctive among federal agencies in that it is mandated by Congress to engage the U.S. private sector in development projects at the critical early stages when technology options and project requirements are being defined.[2] By highlighting opportunities for the use of U.S. expertise and technology when they can effectively be incorporated into project planning, the Agency increases opportunities for the use of U.S. exports in project implementation while helping to safeguard U.S. commercial interests. USTDA is a streamlined, nimble agency that takes rapid and targeted action to create meaningful project-building partnerships when the need and opportunity for them are greatest. As explained by the Center for Strategic and International Studies in its 2011 report, *USTDA: Good Value for Development Dollars*, these partnerships – in addition to the Agency's other tools – give USTDA the "unique ability to leverage its assets in a multitude of ways: to strengthen the domestic economy, continue international development priorities, and serve diplomatic interests in emerging markets around the world."[3]

USTDA's Mission

USTDA's dual Congressional mandate requires that the Agency both (a) provide foreign assistance for trade and economic development and (b) help to put Americans to work in the jobs that result from exports. In the Agency's history of linking U.S. businesses to export

[1] 22 U.S.C. § 2421(a).
[2] 22 U.S.C. § 2421(b)(2).
[3] Daniel F. Runde and Lauren Bieniek, *USTDA: Good Value for Development Dollars*, Center for Strategic and International Studies, October 21, 2011, available at https://csis.org/publication/ustda-good-value-development-dollars, last accessed April 2014.

opportunities, USTDA has generated over $45.8 billion in U.S. exports[4] and has become the leading U.S. government agency for early project development and planning activities in emerging economies. The Agency's effectiveness is demonstrated by the fact that its programs are now generating more U.S. exports per program dollar than at any other time in the Agency's history: $73 of exports for every dollar programmed, up from $41 just four years ago. In FY 2013 alone, the Agency identified $2.95 billion of new exports generated from USTDA-funded activities, which has helped support approximately 14,000 jobs in the United States.[5]

The Agency accomplishes its mission by providing grants to overseas sponsors for priority infrastructure development activities in their countries. The funding may be used to perform a feasibility study, provide technical assistance or launch a pilot project. USTDA also connects project developers with U.S. businesses through its reverse trade missions, which are specially tailored to bring foreign decision-makers to the United States to observe the design, manufacture and operation of U.S. products and services in order to inform their procurement decisions.

These activities have produced results for both U.S. industry and USTDA's partners in emerging markets: U.S. companies are provided access to the lead infrastructure project developers around the world, while foreign partners gain insight into the latest, most appropriate U.S. technologies to meet their development needs. USTDA focuses its program on sectors where U.S. firms are globally competitive, such as energy, transportation and telecommunications. As a result, the Agency is able to provide targeted foreign assistance, support U.S. trade and economic development priorities, and promote U.S. job creation.

USTDA's Collaborative Partnerships

USTDA is distinct among the U.S. government's foreign assistance agencies because, as required by its mandate, it partners with the U.S. private sector at the very early stages of project development to jointly craft solutions to developmental challenges around the world. In the course of providing these solutions, USTDA collaborates with a wide variety of U.S. government agencies and multilateral institutions in a manner that ensures success. USTDA has been recognized by its private and public sector partners for the flexibility of its program, the range of tools at its disposal and the speed with which it can deploy results-oriented assistance.

USTDA believes in the crucial importance of integrating government resources and industry innovations for win-win results. Ten years ago, this philosophy led USTDA to support the creation of a public-private partnership to promote commercial, policy and technical cooperation between the U.S. and Chinese aviation sectors. The U.S.-China Aviation Cooperation (ACP) was developed in response to requests from USTDA's partners in U.S. industry, who wanted to take advantage of opportunities in China's rapidly growing aviation market but needed the U.S. government's support in order to gain access to the key decision-makers from Chinese

[4] This historic cumulative export total includes data collected by the Agency's predecessor organization, prior to USTDA's formation as an independent agency in 1992.

[5] Martin Johnson and Chris Rasmussen, *Jobs Supported by Exports 2012: An Update*, Office of Competition and Economic Analysis, International Trade Administration, Department of Commerce, February 26, 2013, available at http://www.trade.gov/mas/ian/build/groups/public/@tg_ian/documents/webcontent/tg_ian_004021.pdf, last accessed April 2014.

government and industry. The Agency also heard from its Chinese government counterparts, who were seeking technical expertise for their infrastructure development projects. USTDA successfully convened all parties to develop a framework for the ACP, which has grown to include over 40 U.S. industry members and five public sector partners since it was founded in 2004.

U.S.-China Energy Cooperation Program

After experiencing the benefits of working closely with their Chinese counterparts in a public-private aviation partnership, several U.S. industry leaders approached USTDA to propose a similar structure for energy cooperation. Government and industry representatives from both countries collaborated to develop a plan for the U.S.-China Energy Cooperation Program (ECP), which was launched during President Obama's first visit to Beijing in November 2009.

The ECP was created, in part, to connect U.S. businesses to the enormous opportunities that exist in China's $1 trillion clean technology market, as well as the significant energy investments planned by the Chinese government. For example, the Chinese government intends to invest $530 billion by 2020 on smart grid infrastructure.[6] As the world's technical leaders in dynamic subsectors like smart grid, U.S. industry can offer Chinese decision-makers goods and services that can help them achieve their ambitious goals.

The United States and Chinese governments have committed to helping facilitate this type of collaboration. During the same state visit that launched the ECP in 2009, President Obama and President Hu Jintao committed to improving energy security and combating climate change by reducing energy waste in the U.S. and China. They announced joint efforts to promote greener buildings and communities, improve industrial energy efficiency, harmonize consumer product standards and advance energy efficiency technologies.[7] Indeed, leaders in both the United States and China – which, as the world's two largest energy consumers, together account for more than 50% of global greenhouse gas emissions – recognize the importance of mitigating the effects of climate change. China is already facing significant environmental challenges, particularly in the area of air quality. As the U.S.-China Economic and Security Review Commission has noted, Beijing's reading of airborne particulates in February 2014 was 11 times the recommended exposure limit set by the World Health Organization. And in April 2013, a British medical journal published new data indicating that 1.2 million people died premature deaths in China in 2010 due to outdoor air pollution, roughly 40% of the global total.[8]

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[6] China Greentech Initiative, *The China Greentech Report 2011: China's Emergence as a Global Greentech Market Leader*, pg. 16, available at http://cgtr.china-greentech.com/ChinaGreentechReport2011-final.pdf, last accessed April 2014.

[7] The White House, "FACT SHEET: U.S.-China Energy Efficiency Action Plan," November 17, 2009, available at http://www.whitehouse.gov/files/documents/2009/november/US-China-Fact-Sheet-on-Efficiency-Action-Plan.pdf, last accessed April 2014.

[8] Iacob Koch-Weser, USCC Economic Issue Brief No. 3, "China's Hunger for U.S. Planes and Cars: Assessing the Risks," March 27, 2014, available at http://origin.www.uscc.gov/sites/default/files/Research/USCC%20Economic%20Issue%20Brief_ChinasHunger_03

Clean energy cooperation has been a focus of USTDA's work in China since the Agency entered into a framework agreement with the Chinese Ministry of Commerce in 2001. Since that time, USTDA has partnered with China's Ministry of Environmental Protection (MEP) on over 40 environment and climate change projects. The ECP has provided a valuable forum for this collaboration by fostering creative solutions to reduce environmental impacts and increase energy efficiency. The ECP provides a platform for its 52 company members, as well as its 10 industry subsector working groups, to share information and experiences while working together to address important issues.

Additionally, the ECP often paves the way for U.S. small and medium enterprises (SMEs) seeking entry into China's market by providing them with greater visibility and additional resources. While big companies have large overseas offices complete with government relations staff, smaller companies rarely have the resources to represent their interests as strongly. Cooperation programs like the ECP provide SMEs access to important decision-makers and resources; the American Chamber of Commerce in Shanghai, for example, which has a dedicated SME Center, has supported several ECP and USTDA activities in the region.

In addition, public-private partnerships frequently give SMEs a voice in policy decisions. For instance, USTDA has supported several of the ECP's small- and medium-sized firms in encouraging China to adopt U.S.-style standards so their products could compete in the Chinese market. One of the ECP's founding members was Solatube, a small California-based company with patented daylighting devices that use advanced optics to bring natural lighting into interior building spaces. When Solatube first arrived in China, the daylighting industry was non-existent. Because of the absence of a market and associated standards, it was clear to the company's leaders that establishing reasonable standards would help them generate acceptance of – and create demand for – their high-quality systems.

Through the ECP, Solatube participated in two USTDA reverse trade missions during which Chinese delegations visited Oregon and California, where they saw demonstrations of the company's daylighting technologies. Following the first visit, Solatube secured its first government project in Henan Province for the design and installation of daylighting units in two buildings. Solatube then won a 20,000-square meter project in Shanxi Province. They were also invited to participate in the drafting and revision of three building lighting standards that now include daylighting systems. In response, Solatube's General Manager remarked that the "ECP gives small and medium enterprises, especially those leading a new industry, the leverage needed to work with the government, and to reach out to the Chinese market and get results."

The following examples illustrate the ECP's value in helping to mitigate China's short- and long- term environmental issues, and in connecting U.S. companies to the opportunities that exist in China's rapidly expanding energy market.

Air Quality and Environmental Improvement Efforts

. 27.14.pdf, last accessed April 2014.

The ECP has undertaken a number of projects to improve China's environment since its inception – building on the last decade of work by USTDA, which has invested nearly 20% of its East Asia portfolio on activities supporting clean water and the environment in China. Both before and after the launch of the ECP, USTDA has sponsored activities designed to develop environmental early warning and emergency response command systems; improve energy efficiency across the construction supply chain; and reduce emissions of sulfur dioxide, nitrogen oxide and particulate matter, as well as mercury and other heavy metals.

For example, USTDA funded a reverse trade mission in 2012 designed to introduce Chinese regulators and power providers to U.S. mercury emissions control technologies and regulatory best practices. This activity has allowed USTDA and the ECP, along with the U.S. Environmental Protection Agency (EPA) and Department of Commerce, to enter into a dialogue with the Chinese government about the social, environmental and economic benefits of setting stringent mercury emission standards for Chinese power plants. Led by ECP members, this dialogue is highlighting U.S. technologies and best practices that can be applied in China's power-plant sector.

The focus on mitigating the environmental impacts of the country's energy consumption has become increasingly important to the Chinese government, which has announced significant emissions reduction goals. China's Twelfth Five-Year Guideline, which was released in 2010, introduced for the first time an emissions target to reduce carbon intensity (CO2 per unit of GDP) to 17% below 2010 levels by 2015.[9] More recently, the Chinese government has added a new goal of reducing average levels of PM2.5 particulates in 47 cities by 5% based on 2010 levels before 2015.[10]

USTDA and the ECP are currently supporting efforts to help China meet these ambitious goals. The China Air Quality Management Program, developed in cooperation with the EPA, will assist China's MEP in meeting its efforts to reduce pollution across the country by developing an air quality management plan based on U.S. best practices. The project will include a series of workshops to educate the plan's developers on U.S. industry-leading clean air technologies. And this year, USTDA and the ECP will host a reverse trade mission to assist China's efforts to develop comprehensive regulatory frameworks, methodologies and solutions to provide clean, healthy air for its population.

Smart Solutions for Electricity Transmission and Distribution

The Smart Grid Working Group, which was the first Working Group to emerge under the ECP, quickly became the largest and remains so today. It was founded by information technologies (IT) companies that could offer solutions to improve electricity transmission and distribution within China's power grid – an important priority for the government of China, which surpassed the U.S. as the world's largest smart grid market in 2013.[11] Both the U.S. companies and the

[9] China Greentech Initiative, *China Greentech Report 2013: China at a Crossroads*, pg. 32, available at http://report.china-greentech.com/en.html, last accessed April 2014.
[10] Ibid, pg. 21.
[11] Bloomberg New Energy Finance, "China Outspends the US for the First Time in $15BN Smart Grid Market," February 20, 2014, available at http://about.bnef.com/press-releases/china-out-spends-the-us-for-first-time-in-15bn-

Chinese leadership understood that, compared to traditional electricity generation investments, smart grid investments can be realized much quicker and at much lower costs, resulting in savings that put less demand on utilities for the supply of new power generation. Equally important, smart grid investments also provide a larger pathway for utilities to receive power from renewable energy sources.

Driven by industry leadership, USTDA and the ECP have collaborated on nearly a dozen electricity transmission and distribution activities in China, including feasibility studies, pilot projects and technical workshops and trainings. For example, USTDA supported a pilot project with ECP members Honeywell (Morristown, NJ) and AECOM (Los Angeles, CA) to help the China State Grid Corporation's Electric Power Research Institute achieve its demand side management reduction goals. The recently-completed pilot demonstrated that U.S. technology could reduce energy loads of commercial buildings in China by 15% and that of industrial sites by as much as 50% – highly significant savings. China State Grid Corporation is planning to expand this pilot to other cities, presenting follow-on contract opportunities for Honeywell, which won the Chinese *Economic Observer*'s 2013 China Low Carbon Model Award for their contributions to the project.

Building on this effort, USTDA partnered with China's National Energy Administration (NEA) and the U.S. Federal Energy Regulatory Commission (FERC), as well as several ECP members, to host a successful smart grid technologies conference in Shenzhen in 2012. The conference attracted almost 300 U.S. and Chinese attendees interested in sharing best practices about grid interconnectivity and optimization.

To solidify the discussions undertaken by the participants at the event, USTDA supported follow-on projects that will advance the ECP's and China's efforts to deploy smart grid technologies, including pilot projects for fuel cell and communications applications. For example, USTDA funded a smart grid substation communication architecture pilot project. Led by Cisco (San Jose, CA) in cooperation with the China Electric Power Research Institute, the project is demonstrating U.S. technologies for smart grid communication at the substation level, which will greatly enhance the overall reliability of China's electrical grid. This project will pave the way for introduction of state-of-the-art integrated communications capability at the 8,100 Chinese substations being upgraded to smart substations over the next two years.

Standards Development for Vehicle Emissions

The ECP's Clean Transportation Working Group recently requested USTDA's assistance in its efforts to address another major source of China's emissions: mid-range and heavy duty commercial vehicles. Over the last decade, China's reliance on rail for goods transportation decreased by 30% in favor of road freight. And in 2012 alone, China sold almost 4 million commercial heavy duty vehicles (HDVs) – nearly seven times the size of U.S. sales. This upward trend in commercial HDVs is having a significant effect on both fuel consumption and air emissions in China; according to the Heavy Duty Manufacturers Association, "commercial vehicles account for only 20% of the total motor vehicles running in China but consume nearly

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smart-grid-market/, last accessed April 2014.

half of the fuel needed by all vehicles in use in the country."[12]

In response to the Working Group's request, USTDA led an effort with the U.S. Department of State to align U.S. and Chinese regulations on fuel economy standards for HDVs. This will help China develop policies that reduce greenhouse gases and improve fuel consumption, and will also help level the playing field for trade. As part of this effort, USTDA brought delegates from China's MEP, Ministry of Industry and Information Technology, Automotive Technology and Research Center, and Internal Combustion Engine Industry Association to the United States in December 2013. The reverse trade mission was designed to introduce Chinese delegates to U.S. best practices in regulations for HDV fuel economy standards, as well as to showcase advanced U.S. technologies that can assist China in meeting fuel economy and emissions requirements. U.S. firms manufacture most of the world's high-end technology for HDVs, such as engines, advanced machining, powertrain controls and fuel emissions control equipment.

While it is too early to determine U.S. exports as a result of this activity, it has already made important strides toward harmonizing fuel economy standards in China. And it demonstrates the values of public-private partnerships like the ECP, which achieve results by convening the right players to address a common issue or challenge. The outcome is dynamic engagement, mutual benefit and long-term relationship-building.

USG Interagency Collaboration

Several U.S. government technical agencies have contributed to the success of the ECP since its launch. In fact, the Departments of Energy and Commerce joined USTDA in signing the Memorandum of Understanding that officially formed the ECP in 2009. Along with other USG stakeholders like the Department of State, FERC and the EPA, these agencies continue to support the ECP's efforts to connect Chinese decision-makers to U.S. technical expertise in clean energy. This exemplary interagency collaboration has been highlighted at the U.S.-China Strategic and Economic Dialogue, the U.S.-China Joint Commission on Commerce and Trade, and other events.

Conclusion

USTDA's unique and targeted focus on engaging the U.S. private sector in early project planning for development projects places it at the forefront of an innovative, sustainable foreign assistance model. The Agency moves quickly to build mutually beneficial partnerships between the U.S. private sector and overseas project sponsors at a critical point in project planning. The Agency's public-private partnerships, particularly the U.S.-China Energy Cooperation Program, are viewed as touchstone programs that allow government and industry

[12] Heavy Duty Manufacturers Association, "China MIIT to Set Fuel-Consumption Limits for Heavy-Duty Commercial Vehicles," September 27, 2012, available at http://www.hdma.org/Main-Menu/HDMA-Publications/Diesel-Download-2013-Archive/Intl-Diesel-Download/September-27-2012/China-MIIT-to-Set-Fuel-Consumption-Limits-for-Heavy-Duty-Commercial-Vehicles.html, last accessed April 2014.

partners to accomplish more together than they could separately. In fact, when he addressed the ECP for the first time last April, Secretary Kerry called the Program "the best of international and government-to- government cooperation."[13] The primary value of the ECP – and of USTDA's program in general, which has generated almost $300 million in U.S. exports for energy and environmental projects in China since 2001 – is its ability to identify tangible business opportunities for U.S. companies while contributing to China's clean energy development and emissions reduction efforts.

As an added benefit, the ECP's stakeholders have also observed that their work can positively impact the priorities, standards and policies of the Chinese government in the energy sector. Through their collaboration with the ECP, Chinese decision-makers have begun to look to U.S. companies for affordable technological solutions to their development challenges. And, as demonstrated by the examples of Solatube and the dialogue on the reduction of mercury emissions, the Chinese have begun to introduce the policies and standards that can enable the implementation of U.S. clean energy technologies.

[13] Secretary of State John Kerry, "Remarks at Energy Cooperation Event," Beijing, China, April 13, 2013, available at http://www.state.gov/secretary/remarks/2013/04/207474.htm, last accessed April 2014.

PANEL I QUESTION AND ANSWER

HEARING CO-CHAIR GOODWIN: Thank you very much, Director Zak.

MS. ZAK: Thank you.

HEARING CO-CHAIR GOODWIN: Commissioner Slane.

COMMISSIONER SLANE: Thank you so much for taking the time to come.

MS. ZAK: Thank you.

COMMISSIONER SLANE: Can you tell me do you assist Chinese companies in coming to the United States to open up any facilities here?

MS. ZAK: No, that is not part of the USTDA mandate. USTDA focuses on exports to China, but we do not assist Chinese companies coming to the United States.

HEARING CO-CHAIR GOODWIN: Commissioner Wessel.

MS. ZAK: The Department of Commerce does.

COMMISSIONER WESSEL: Yes. I'd point out that's US and FCS, I believe, that does that.

MS. ZAK: Yes.

COMMISSIONER WESSEL: And the Select USA. So there is something.

Thank you, and thank our co-chairs for the hearing today, and thank you for being here. TDA is a fantastic resource that does not necessarily get the attention it deserves. I have worked closely with your predecessor, Thelma Askey, and many others, in the past, so I know what a great job your organization does.

Let me ask a couple of things, if I can, about how we can both address the economic challenges we face here, your efforts to help U.S. companies, as well as what is a moral question, as well, in China, in terms of the degradation of the environment and what they need to do for their people.

Let's take the wind energy sector where there are enormous opportunities, both in the U.S. and in China. We've had some concerns here, as you know, about Chinese imports, that companies like GE that had wished to enter the Chinese market have found that they have to produce there to be able to sell there.

How does TDA work with those problems? Do you coordinate with USTR and Commerce and others because gaining access for a company in terms of--and I don't know where Solatube produces its goods. I hope here.

MS. ZAK: U.S.

COMMISSIONER WESSEL: Which is great. How do we make sure that this is a two-way street; that TDA's job is to help companies spec into the economic development plans of other countries and then have the pull-through to make sure that we can participate in the growth of that market? How are we dealing with some of the market barriers? How do you work with some of your partners in the U.S. government to overcome some of the challenges that are very specific to the Chinese market?

MS. ZAK: Well, thank you very much, and thank you very much for your kind words about USTDA, and I really do appreciate your having this hearing so that people learn about the good work of USTDA.

It's a very good question, and, as a matter of fact, USTDA works very closely with USTR, and we participate side-by-side in the JCCT, which is Joint Commission on Trade, and one of the things that USTDA does is as USTR is developing policy, we work very closely with the Chinese government to show how that policy can be implemented. So it's the practical

implementation.

So where one says, oh, no, that policy is not going to work or it's too hard to do that, USTDA can come in and provide specific examples of how it can be accomplished. So we clearly focus on job creation in the United States, manufacturing in the United States. When we refer to exports, we look specifically at content from the United States, and that's our goal.

And so what we try to do is work very closely with the policymakers to say it is extremely important to have open markets, to have a fair playing field for U.S. businesses, and we can actually show you why there are benefits to that. That's exactly what we do.

COMMISSIONER WESSEL: Which is great. How much after-action review is there, if you will? Solatube sounds like a great story, and it sounds like you continue to follow them even though the handoff stage is over. You talked about the 300 million since 2001, so clearly you're doing this.

How can we better learn from some of the stories, some of the on-the-ground experiences, and make sure that our policies not only support dealing with China's moral issue but our economic challenges here?

MS. ZAK: Well, USTDA is extremely focused and data driven. So one of the things that we do is we really try to learn from our past experiences, as well as the research, and listening to industry of where to go for the future. So, as a matter of fact, we have a very robust evaluations process and evaluations department.

We actually track every single one of our projects for a ten-year period. So we keep in touch, but we also follow up to ensure, because sometimes these projects take awhile to implement, but we then learn about it. Our evaluations process--every year, we do strategic planning, and in that strategic planning process our Evaluations Department brings forward what worked well, what might not have worked well, what projects are successful.

So we keep in touch, and also the ECP is a great umbrella that allows us to keep that contact over the years to examine everyone of our activities.

COMMISSIONER WESSEL: Great. If there's another round later. Thank you.

MS. ZAK: Thank you.

HEARING CO-CHAIR GOODWIN: Commissioner Shea.

CHAIRMAN SHEA: Thank you for being here and appreciate your service.

MS. ZAK: Thank you very much.

CHAIRMAN SHEA: I am less familiar with the USTDA than maybe some of my colleagues, and I was interested in reading this one-pager you put out on USTDA in China, which is part of our briefing book. So I'm just going to ask you a question which is going to try to help me understand what you do.

You say in the China paper that the USTDA promotes economic growth in emerging economies, and you say it helps create lasting business partnerships between the U.S. and emerging market economies.

Now, China is the second-largest economy in the world, and it's probably going to overtake the U.S. economy within ten years. So that struck me as odd to consider China an emerging economy or an emerging market economy. So I was wondering if you could explain the mission and how China would fit within your mandate?

MS. ZAK: Sure. Absolutely. USTDA's mandate is to focus on developing and middle-income countries. The standard that we apply is the World Bank standard, and as a result, China, because of the fact that the economy is not spread across the people, it's still considered a middle-income country. It is not a high-income country.

The minute something becomes a high-income country--as a matter of fact, Chile just graduated this year--USTDA no longer provides its assistance there. And we like to see countries graduate.

With respect to China, it's actually really interesting because one of the things in China, we have this dual mandate focusing on economic development and developing middle-income countries but also focusing on U.S. exports and U.S. opportunities.

And China presents significant opportunities for U.S. businesses, and I think it's extremely important for us to be able to level the playing field for U.S. businesses in China. It's a significant market. It's extremely important to U.S. business. It's extremely important for job creation in the United States to be able to have exports in China.

So, as a result, USTDA is working there, focusing on areas, one, that they're going to have significant benefit--the environment is one of them that benefits all of us--and at the same time can benefit our country, and we look at areas of mutual benefit. And we see the work that we're doing in China having a significant benefit with respect to the U.S. and the markets in the United States.

CHAIRMAN SHEA: Thank you.

Let me ask you, I guess Commissioner Wessel talked about joint technology transfers. I mean there are other issues, the economic relationship obviously, intellectual property protection, and cyber espionage, and I believe clean energy. The Mandiant report, which was issued last year said that--I believe I'm correct on this--that clean energy is one of the biggest targets of Chinese cyber espionage directed at the United States.

So when you do your job, do you just look at the narrow issue of exports to China, which is a very important issue, trust me, or is there some way to take a more holistic approach that weighs these competing issues in the relationship?

MS. ZAK: We look very broadly, and, again, it's one of the great things that we have the opportunity to collaborate with our sister agencies, as well. So with respect to the work that we're doing, we are very careful to look at export controls issues, to look at some of these bigger picture issues, and what we're doing as well.

So we really look at U.S. government policy as well as focusing on exports. So we definitely keep the things in mind that you're talking about while we're trying to support U.S. technology.

CHAIRMAN SHEA: Okay. Thank you very much.

HEARING CO-CHAIR GOODWIN: Commissioner Tobin.

COMMISSIONER TOBIN: Thank you so much for your testimony.

As a citizen, actually many of our citizens, would find it valuable to know the scope of your program. So if you wouldn't mind describe the life cycle of how you gain ideas for whom you might connect with in China; how many people are apt to apply--I don't know if they apply to you; and how many of those who apply are chosen?

And then Commissioner Wessel spoke about the handoff. When and how does that handoff occur? What criteria are there for that handoff? And I realize afterwards, you must monitor things over time. So what's the scope of this for American companies?

MS. ZAK: Thank you very much.

I think Commissioner Cleveland hit the nail on the head, that one of the really important parts of USTDA, and how we're able to accomplish what we do, is the fact that we collaborate with our sister agencies.

So with respect to the project life cycle, USTDA has headquarters in Washington, D.C.,

in Virginia. But we also work very closely with the Commercial Service. So U.S. businesses can come directly to us. They could also go to the USEACs around the country, or they could go in country to the Commercial Service, to an officer who's very well versed with respect to USTDA.

So the Commercial Service and others are aware of our programs, and if they're in China, then they will refer it to us back in Washington, D.C. So it's the ability to be able to collaborate at the beginning of that cycle.

We like to make things as simple as possible and as streamlined as possible so we don't have a big application process. It starts with a phone call, call us, e-mail us, we'll discuss a project, and then we'll move it through our project cycle, which would be to look at the project, review it, have outside technical expertise, usually small businesses that help us with that, collaborate with our U.S. government agencies if we have issues with respect to any kind of export controls or other issues before we approve a project.

And then as projects are approved and they go through the rest of their life cycle, if we see a project that is viable, going to move forward, we're in very close contact with Ex-Im Bank that is operating in China. We also work with, financial institutions, private financial institutions, as well.

So part of the success, I think, is the fact that we all work together and collaborate and keep each other informed with respect to projects that are in the life cycle.

COMMISSIONER TOBIN: Two more details, if I may, on the same topic.

MS. ZAK: Sure.

COMMISSIONER TOBIN: So the grants are going to the American companies to help get them ready. Are they going to China? I know you've said you have them touring the plant facilities. Where is the investment of your grant money placed?

MS. ZAK: It's actually a very interesting operating model. Because of the nature of our agency, our grants are provided to a foreign entity. However, they have to be performed by U.S. businesses. So, as a result, the grant is given, but the services are performed by U.S. businesses. There's a contract with the U.S. businesses, and we pay directly to the U.S. business.

So that accomplishes a couple things. One, it gets a U.S. business in a relationship with the host country. Two, it ensures U.S. interests are being represented by this business, and there's a level playing field, and, three, money never leaves the United States. So it goes--we're able to pay the grant funds directly to the U.S. company.

COMMISSIONER TOBIN: And the last detail. Do you have many committing themselves with interest?Or is it the other way around?

MS. ZAK: Oh, no. We have many who are interested.

COMMISSIONER TOBIN: Okay.

MS. ZAK: And we clearly have a much higher demand than we're able to meet with our funding, and it's extremely competitive to be able to get this assistance, but we do our best to look for the projects that have the most mutual benefit, and also to ensure that we're serving not only large but small and medium-sized companies as well. So it's all trying to achieve a balance as we're trying to select the best.

COMMISSIONER TOBIN: Very helpful. Thank you.

HEARING CO-CHAIR CLEVELAND: Director Zak, what's your budget? Just to follow up on--

MS. ZAK: Our current budget for the entire agency in FY14 is 55 million.

HEARING CO-CHAIR CLEVELAND: When I left government, a long time ago, it was 47 so there's--anyway.

MS. ZAK: Thank you.

HEARING CO-CHAIR GOODWIN: Commissioner Fiedler.

COMMISSIONER FIEDLER: So what are the challenges you face in dealing with your programs in China other than the intellectual property, the normal challenges of business? And what's the geographical dispersion of the projects? Is it random or do you find that you're doing these in more urban areas or what?

MS. ZAK: I'll start with the geographic. We are very much responding to where the requests are so, as a result, a lot of it is going to be urban. So a lot happening in the major cities, seeing where there is significant issues with respect to energy, with respect to the environment, et cetera.

So they are sort of gathered around more urban areas right now. We do look for projects beyond that. But it is where they are located.

With respect to challenges, I mean one of the things is, like anything, and I think it's why the ECP has been so valuable, is it takes time. It takes time and the ability to develop relationships in China to get to the point where you're able to do business effectively, and I think that's why the ECP has been so valuable to U.S. industry members because it's provided an umbrella, and we've been able to develop some of those relationships.

The other area that is too--and I think the ECP plays a very valuable role in this--is also coaching U.S. businesses on things like intellectual property rights, on things with respect to transfer, on things with respect to what might be required of them, and what it is then as a result from the experience of other businesses, how you can say no, I'm going to do this, or, you know, wait a minute, this is our intellectual property or this is where we need to go.

So I think some of it is relationships, some of it's standards that we're trying to change, and IPR.

COMMISSIONER FIEDLER: On the IPR question, have you had projects not go fully through the system because intellectual property was stolen, technology was stolen?

MS. ZAK: The answer, no, not our projects, and some of that, again, may be because of the relationships that we've developed and also because we're kind of the umbrella. However, USTDA in working with USTR, as part of the JCCT, actually has sponsored workshops focusing on the importance of the IPR standards and practices.

So we've been working. Again, using these relationships, we've developed in this context to then try to explain why it's so important to honor IPR. But none of our projects have had these issues.

COMMISSIONER FIEDLER: What is the agency in China that you deal with as a gateway?

MS. ZAK: We deal with several. Our initial partner that we work with, and we work beyond energy, is MOFCOM. We also work with NEA. We also work with MIIT. We also work with NDRC. So depending on the type of activity, we may be working with different ministries, but our initial partner for all of our activities is MOFCOM.

COMMISSIONER FIEDLER: And the total scale of the projects dollar volume-wise, for the last five years?

MS. ZAK: It's interesting because USTDA is one of those agencies that uses a little bit of funding to go a long way--happy to do more. But right now, we're using about, annually about 18 percent of our budget for China.

COMMISSIONER FIEDLER: I'm not actually asking that question. I was asking the dollar volume of the export question or the value of the projects themselves, not your expenditures.

MS. ZAK: The value of the projects can be--

COMMISSIONER FIEDLER: Total.

MS. ZAK: Total?

COMMISSIONER FIEDLER: Total China effort in the time, in the last four or five years?

MS. ZAK: Is, I think it was approximately $230 million of U.S. exports since we've been involved.

COMMISSIONER FIEDLER: Okay. Thank you very much.

MS. ZAK: And I'm just going to confirm that. Okay. 290. They've upped it on me--290 since we've been involved.

COMMISSIONER FIEDLER: Thank you.

MS. ZAK: And I'm just going to clarify, we just look directly at exports. The projects could be bigger.

COMMISSIONER FIEDLER: No, I understand. I understand.

HEARING CO-CHAIR GOODWIN: Thank you, Commissioner Fiedler.

Commissioner Reinsch.

VICE CHAIRMAN REINSCH: Well, speaking of IP, Commissioner Fiedler stole my question so I'm going to phrase it slightly differently.

I was really interested to learn that you follow these things for ten years, which gives you, I would think, a unique perspective on what actually happens because, as I understand your work, it's really in the beginning.

MS. ZAK: Exactly.

VICE CHAIRMAN REINSCH: It's a precursor, viability studies, trying to create something that then goes on hopefully to lead to a significant amount of U.S. exports and a significant project.

In the Chinese case, is that what always happens? If you look back over ten years, how many of the things you've done have actually turned into significant successes, and I don't mean a one-time export, but significant U.S. presence, U.S. market share? And, conversely, how often do they end up failing for any number of reasons?

MS. ZAK: That's a good question. I think in our Chinese portfolio, actually we have very significant success of things moving forward, and I think part of the reason for that is it's one of the areas where there's a very strong interest, both by the Chinese government or whatever Chinese entity and the U.S. business, and the U.S. business is also willing to share some of the costs as well. So there's already a significant commitment to the projects. So in China, we have a very strong success rate. And I think it is in large part due to that commitment.

The other side of it is, I will be honest, I'm a bit of a tough taskmaster. I believe in looking at that data, and I will challenge people if we don't see success to say we're here for mutual benefit, why didn't this work? And no, we're not going to do it again if it's not something that's working.

And so the people that we work with, you know, our partners with China, as well, know that one of the things that we do is we look for our success. We share it with them, and we let them know that's what we want to achieve.

VICE CHAIRMAN REINSCH: Small digression, and then I want to come back to that. Which country do you have the most failures in, just out of curiosity?

MS. ZAK: That's an interesting question. I'm not sure we like to use the word "failure."

VICE CHAIRMAN REINSCH: Disappointments.

MS. ZAK: Disappointments. You know, I do think that there are places that it's hard to do business. I think one of the most difficult places to do business in probably sub-Saharan Africa, but there is also great return in Africa as well.

But the other thing about USTDA, and why I say there's no such thing as a failure, is because we're at the beginning of a project cycle. So it's better that people learn when they're just doing the planning that something may not go forward than to get all the way into it as an investment and learn that it's not going to go forward.

VICE CHAIRMAN REINSCH: Okay. Coming back to China, maybe you said this, in which case I missed it and I apologize, of your total amount of activity in China, roughly how much of it is devoted to clean energy and environmental projects as opposed to other things?

MS. ZAK: I think right now our proportion is about one-third of our investment is with respect to clean energy.

VICE CHAIRMAN REINSCH: Give me some examples of other sectors or other categories that you would focus on with China.

MS. ZAK: Transportation. Transportation is an area, particularly our Aviation Cooperation Program, which was the precursor to the Energy Cooperation Program. It's a little older, and as a result there's even more success with respect to transportation, and also it's very large activities as well.

VICE CHAIRMAN REINSCH: Good. Thank you.

HEARING CO-CHAIR GOODWIN: Commissioner Wortzel.

COMMISSIONER WORTZEL: Thank you very much for spending time with us.

MS. ZAK: Of course. Thank you.

COMMISSIONER WORTZEL: Very helpful. Appreciate it.

I want to clarify what I think I understood from your responses to Commissioner Tobin, and I think it was clear that you have a pretty robust, cooperative and working relationship both with Commerce and USTR here.

Do you have attachés in China?

MS. ZAK: We actually have one person who is dedicated to us from the Commercial Service.

COMMISSIONER WORTZEL: Okay. And that's what I wanted to know.

MS. ZAK: Yes.

COMMISSIONER WORTZEL: In country--

MS. ZAK: Yes.

COMMISSIONER WORTZEL: --you're actually sort of working with FCS?

MS. ZAK: Yes.

COMMISSIONER WORTZEL: Rather than having an independent office?

MS. ZAK: Yes. If we were larger, we could have more.

[Laughter.]

COMMISSIONER WORTZEL: Yeah. Then I was drawn to your Smart Grid Working Group. So if we looked at grid control software, is that jointly developed for a project or did the Chinese provide it or is it U.S. developed software?

MS. ZAK: This is U.S.

COMMISSIONER WORTZEL: So it's U.S. developed software?

MS. ZAK: Yes.

COMMISSIONER WORTZEL: That's being put into China?

MS. ZAK: Yes.

COMMISSIONER WORTZEL: Thank you.

HEARING CO-CHAIR GOODWIN: Commissioner Cleveland.

HEARING CO-CHAIR CLEVELAND: Director Zak, I am looking at promotional piece on the ECP, and one of the examples that's provided is a power plant emission retrofit feasibility study, and Shandong Power Company that's conducting a feasibility study. I'm just going to read from this thing.

MS. ZAK: Sure.

HEARING CO-CHAIR CLEVELAND: And then what I'm interested in, just to help the Commission understand how TDA operates, if you can walk us through this particular example.

They're conducting a feasibility study and pilot project demonstrating how nitric oxide and other harmful emissions from coal-fired power plants can be reduced by use of advanced technologies through the engineering, procurement and construction business model.

And it goes on to say that with support from the USTDA, LP Amina will facilitate project implementation. It was launched in May 2012, was a pilot initiative with ten coal-fired plants involved.

Are you familiar with this?

MS. ZAK: Yes.

HEARING CO-CHAIR CLEVELAND: Okay. I think it would be a great case study of how you got involved, who the initial contact was from, just to help inform us on probably how other projects work if you would walk through that?

MS. ZAK: Thank you very much.

And actually this, these particular projects are ones that we're very proud of. And LP Amina, as a matter of fact, is a member of the ECP and has been involved with the ECP, and as a result brought the projects to us where they indicated that they had an opportunity to demonstrate that in connection with coal-fired plants that they could reduce emissions of SOx and NOx.

And this is exactly one of the cases that I was talking about earlier, about the fact that by virtue of USTDA providing the funding to be able to do a feasibility study, we were able to demonstrate by using this technology with respect to these plants, they can reduce SOx and NOx emissions.

So this is a case where we saw a mutual benefit. It was an ECP member. The ECP member brought the project to us. They're a member of the working group, and we were able to fund it to provide the pilot project, which now, and it goes to one of the issues we talked about before, is looking to be replicated in other places as well.

HEARING CO-CHAIR CLEVELAND: And roughly how much was that investment by TDA, just to give us a sense of--I know staff is looking confused so we'll take that for the record.

MS. ZAK: Yeah. I was going to say I would assume it's somewhere, again, I don't want to give specifics, but I would suspect it's probably around $500,000.

HEARING CO-CHAIR CLEVELAND: Right. And would that be your sort of average, under $500,000 is the average investment for a project?

MS. ZAK: I would say at this point, it's somewhere between five and $700,000 with

respect to a feasibility or technical assistance versus a reverse trade mission.

HEARING CO-CHAIR CLEVELAND: Okay. I was noticing, I think in Ms. Forbes' testimony later, they talk about LP Amina being involved in a classifier on a coal plant and how in the United States nobody was willing to buy it so it was demonstrated in China first and now is being sold here. So it seems that it's a productive kind of dynamic.

I'm wondering if you could also give us an update, and it may have been one of your learning opportunities rather than successes. We had Peabody in--was it Peabody--two years ago to talk about the support that they were receiving for the GreenGen project. I think you all were involved? No? I'm getting shakes.

MS. ZAK: Not involved.

HEARING CO-CHAIR CLEVELAND: Well, I'm just reading. It says USTDA through the Power Engineering and Consulting Group supported a feasibility study for--this is--I'm very interested in IGCC technology--and had an agreement with Missouri-based Peabody to participate in GreenGen.

Would you like to take that for the record, too? With your staff--

MS. ZAK: We're happy to follow up on that. I'm not aware of that.

HEARING CO-CHAIR CLEVELAND: Okay. That's fine. We just had them in two years ago so I was curious as to the status of the project.

MS. ZAK: Sure. Happy to follow up.

HEARING CO-CHAIR CLEVELAND: Thanks.

HEARING CO-CHAIR GOODWIN: Commissioner Wessel.

COMMISSIONER WESSEL: Thank you.

I have a couple of questions. And again, I appreciate all that you're doing here. 55 million is the current budget?

MS. ZAK: Yes, it is.

COMMISSIONER WESSEL: Is that the same as your budget request?

MS. ZAK: No, our budget request was 63.

COMMISSIONER WESSEL: 63. And I see a pretty good payout. Of your 55 million, you said 18 percent of that was to China, and your $290 million figure would seem to be pretty--over five years, let's say, it's a six-to-one ratio. That's a pretty good budget payout for the taxpayers so thank you for that.

Your ten-year review, how much of that is open to the public? How can we learn from what you've done?

And, again, going back to wind energy or any of the other areas we've discussed like Solatube and the daylighting project,how can we look at what this is doing for U.S. exports and U.S. company profits. I assume in some cases they may decide to produce there as well, and what other activities the Chinese may be doing indigenously since indigenous innovation is one of their priorities?

How do we look at your ten-year data to learn how we can maximize the benefits for the U.S.? Again, as you've talked about coordination with other agencies, are you also looking with Commerce in terms of ITA and others at what's happening with our market, including the Chinese market?

MS. ZAK: Yes. One of the things we do is we actually share our information with the other agencies as well, and we work very closely as part of the TPCC and as part of the Export Initiative to see where we are seeing benefits and where we are seeing successes.

USTDA, one of the things it sees as very important is to share the information, and all of

our studies are available from our office. We're now going electronic. So if some--each one of these studies, they have the ability to get a copy of the study. They have the ability to get the suppliers list from the study, et cetera.

Our Evaluations Office has also been providing information on our Web site, and we also have something now that's called "Trade Leads" so as we see an opportunity that we think the public should know about, then we're providing that information to the public to say this is actually an area that you should be looking at; this is information we've learned as a result of the investigation we're doing into projects.

So we're putting out more and more of that information to the public.

COMMISSIONER WESSEL: Great. Let me follow up on an earlier question. Also, as you noted, smart grid is a priority for many here and clearly for the Chinese as well.

As I recall from the old days, one of TDA's activities was to try and spec in. So let's say a major dam was being built, trying to make sure that it was done English versus metrics, such simple things as that, which are now software standards.

Is Honeywell working with the Chinese to co-develop their smart grid technology software?

MS. ZAK: Yeah. In this case, it's a matter of looking to see, not necessarily to co-develop, but basically to provide to a specific project and to be able to provide their technology, their software to that project. So it's not a co-development.

COMMISSIONER WESSEL: And as part of this, since this goes to deeper issues, I assume the Chinese want to see through that software, if you will, to understand the issues, to ensure efficiency of their systems, et cetera. How much is shared, understanding there's an IPR issue as well? Can you tell us what the Chinese have been looking to try and understand from this before they support a project going forward?

MS. ZAK: I think in these particular cases, it's more recognizing the fact that there are significant losses, and at the same time, there is a need--

COMMISSIONER WESSEL: Significant losses?

MS. ZAK: Energy losses.

COMMISSIONER WESSEL: Okay.

MS. ZAK: So they're trying to remedy a problem that they have, and Honeywell is trying to provide them with a solution so it's more looking at sort of the practical problem--

COMMISSIONER WESSEL: Uh-huh.

MS. ZAK: --in the process. And energy losses is being recognized as being a significant problem because of how difficult it is to bring on new generation, that it's one of the things with respect to smart grid today, that people recognize the fact that if you can, it's, one, more immediate than generation, it's more cost effective than new generation, and so they're seeing the value of being able to use technology to curb losses with respect to energy and transportation.

COMMISSIONER WESSEL: Okay. Great.

And I look forward to following up with your staff, as well. The aviation sector is one that we as a Commission have looked. We would love to see the history to understand the opportunities and the challenges.

So thank you.

MS. ZAK: Absolutely. Love to. It's a terrific story.

COMMISSIONER WESSEL: Great. Thank you.

HEARING CO-CHAIR GOODWIN: Commissioner Fiedler.

COMMISSIONER FIEDLER: I think you said that of your China projects clean energy; right?

MS. ZAK: [Nods affirmatively.]

COMMISSIONER FIEDLER: Of those projects, what percentage are the U.S. companies doing with state enterprises versus private enterprises?

MS. ZAK: I'm going to have to get back to you on the specifics. As you know, many of the companies in China are state enterprises, including utilities. So to be able to implement some of the clean energy projects that we have, we do have to work with state-owned enterprises.

But I can get back to you with the specifics.

COMMISSIONER FIEDLER: I understand that on the generation side. You mentioned earlier on the building side--

MS. ZAK: Right.

COMMISSIONER FIEDLER: --that they had received some award--what was it--Solatube or--

MS. ZAK: Right.

COMMISSIONER FIEDLER: Yeah. There are state-owned real estate developers and there are private real estate developers dealing with the state.

MS. ZAK: Right.

COMMISSIONER FIEDLER: It's an amorphous kind of thing. So I would imagine that the building side of this is more private than public or state, but I would like to--

MS. ZAK: Sure. We'd be happy to provide you with that information.

COMMISSIONER FIEDLER: Yes.

MS. ZAK: I just don't have it at my fingertips.

COMMISSIONER FIEDLER: Just as an aside, I know this is a clean energy hearing, but you mentioned transportation and aviation. That, in aviation, except for part suppliers, is not a small company effort, generally speaking--you know, engines?

MS. ZAK: But actually with the ACP, we do have small business partners. Design of airports is an area where we have small businesses who are interested in part of the Aviation Cooperation Program.

Then there are sort of smaller suppliers in the airport market.

COMMISSIONER FIEDLER: So it's aviation infrastructure?

MS. ZAK: So it's aviation infrastructure generally.

COMMISSIONER FIEDLER: Okay. All right.

Thank you very much.

HEARING CO-CHAIR GOODWIN: Director, I have a very quick question in closing. As you may have seen from our agenda today, we're going to be talking with various members of research institutions that are participating in the research and development projects that are part of the clean energy collaborative efforts that were announced in 2009.

As you've described it here today, the ECPs, the private sector, commercial implementing arm of those initiatives, what's the level of organizational overlap and relationship and collaboration between the ECP in these research institutions that are participating in various consortia as part of the Clean Energy Research Center?

MS. ZAK: You described it very nicely, the fact that we are the commercial implementation arm. We work closely with DOE, who is a member of some of those organizations that are doing the research collaboration, and we're aware of that collaboration,

but we focus on the point in which something becomes commercially viable.

HEARING CO-CHAIR GOODWIN: Okay. Thank you very much, and I appreciate your time.

MS. ZAK: Thank you very much.

HEARING CO-CHAIR GOODWIN: We'll take a quick five-minute break and try to start up as soon after ten as we can. Thank you.

MS. ZAK: Thank you.

HEARING CO-CHAIR CLEVELAND: Thank you.

[Whereupon, a short recess was taken.]

PANEL II INTRODUCTION BY COMMISSIONER ROBIN CLEVELAND

HEARING CO-CHAIR CLEVELAND: Our second panel today will examine U.S.-China clean energy cooperation policy, including cooperation on shale gas and civil nuclear energy.

I'm delighted to welcome Dr. Joanna Lewis, Assistant Professor of Science, Technology and International Affairs at Georgetown. Dr. Lewis is a professor at Georgetown University School of Foreign Service and currently leading a National Science Foundation-funded project on International Partnerships and Technological Leapfrogging in China's Clean Energy Sector, and she also serves as a faculty affiliate with the China Energy Group at Lawrence Berkeley National Lab.

She also serves as an international advisor to the Energy Foundation China Sustainable Energy Program in Beijing and is a Lead Author of the IPCC's Fifth Assessment Report.

She's a member of the National Academies Committee on U.S.-China Cooperation and formerly worked at the Wilson Center--were you there when my friend Jane Harman was there or was that earlier?

DR. LEWIS: [Nods affirmatively.]

HEARING CO-CHAIR CLEVELAND: The Pew Center, the Asia Society, and the White House Council on Environmental Quality, National Wildlife Federation, and the Environmental Defense Fund.

Ms. Sarah Forbes--shall we have you read your mom's introduction? Ms. Forbes joined the World Resources Institute, a non-profit environmental think tank that works at the intersection of human and environmental needs.

She leads the Technology Consortium within the Climate and Energy Program, managing WRI initiatives on shale gas and carbon dioxide capture and storage in China. Prior to joining WRI, Ms. Forbes worked at the National Energy Technology Lab, where she led the Roadmap Development of DOE's Carbon Sequestration Research Program and conducted analyses on environmental aspects of CCS, the energy-water nexus, in which I'm particularly interested, and climate change.

Ms. Jane Nakano--welcome--is a Fellow, Energy National Security Program, Center for Strategic and International Studies. Do you work with Frank Verrastro?

MS. NAKANO: I do.

HEARING CO-CHAIR CLEVELAND: Great. A good friend. Ms. Nakano is a Fellow in the Energy and National Security Program, and her areas of research include energy security issues in Asia, global nuclear energy trends, and global natural gas market dynamics.

Prior to joining CSIS, Ms. Nakano served as the lead staff on U.S. energy engagements with China and Japan at DOE, where she was responsible for coordinating engagement in the U.S.-China Strategic Economic Dialogue and the U.S.-Japan Energy Dialogue.

Ms. Nakano's recent publications include: “New Energy, New Geopolitics”; “The U.S. and China: Making Nuclear Energy Safer”; “Prospects for Shale Gas Development in Asia”; and “China--Leader or Laggard on the Path to a Secure, Low-Carbon Energy Future?”

And then there is one final person that I really need to introduce, who is Wes Forbes, a future scientist, he says, fifth grade in Elkins, West Virginia, and he's serving as a temporary consultant.

[Laughter.]

HEARING CO-CHAIR CLEVELAND: So welcome. I think we'll begin with Dr. Lewis, if you would?

OPENING STATEMENT OF DR. JOANNA LEWIS
ASSISTANT PROFESSOR OF SCIENCE, TECHNOLOGY AND INTERNATIONAL AFFAIRS, GEORGETOWN UNIVERSITY

DR. LEWIS: Great. Senator Goodwin, Commissioner Cleveland and members of the Commission, good morning, and thank you very much for the invitation to participate in this hearing to discuss U.S.-China clean energy cooperation.

Over the past five years, clean energy has emerged as the leading topic of cooperation between China and the United States. Back in November of 2009, the United States and China signed seven new agreements on clean energy cooperation, covering energy efficiency, renewable energy, electric vehicles, advanced coal technologies and shale gas.

These agreements also launched the U.S.-China Energy Cooperation Program, the ECP, which helps U.S. companies engage in China's clean energy sector, and the U.S.-China Clean Energy Research Center, the CERC, which facilitates joint research and development on clean energy technology by teams of scientists and engineers from both countries.

While these agreements were by no means the first agreements with China to focus on clean energy, the launch of a comprehensive package of clean energy agreements at the presidential level signified a new model as well as an elevated status bilaterally for U.S.-China clean energy cooperation.

Five years later this cooperation has not waned but rather is being strengthened. In 2013, the Obama administration worked with the incoming Xi administration to sign several new agreements building on the package of bilateral cooperation that was signed back in 2009.

Key among these agreements were the establishment of a high level Climate Change Working Group, which included five new initiatives focusing on: emissions reductions from heavy duty and other vehicles; smart grids; carbon capture utilization and storage; collecting and managing greenhouse gas emissions data; and energy sufficiency in buildings and industry.

The signing of such agreements is often an accomplishment in itself. For example, many issues on which the United States now has official bilateral agreements with China long eluded U.S. policymakers, including agreements that address somewhat sensitive topics like measuring greenhouse gas emissions data or that targeted challenging technical and political topics like carbon capture and sequestration.

However, now that many of these agreements have been underway for several years, we can begin to assess what is working well and what could be improved.

Much is working well. For example, the U.S.-China Renewable Energy Partnership has hosted multiple industry forums in China and the United States to facilitate new collaborations. The U.S. Department of Energy reports a recent achievement of the partnership was the signing of an MOU between the U.S. company BrightSource Energy and several Chinese companies to deploy BrightSource's concentrating solar thermal power technology in China's Qinghai province.

And the project was structured such that key components would be manufactured in the U.S., including some of the components associated with that technology which may contain sensitive intellectual property, but the technology would be demonstrated in China, serving as China's first commercial-scale deployment of CSP technology.

Another agreement, the U.S.-China Energy Efficiency Action Plan, has helped facilitate multiple research and commercial collaborations with U.S. and Chinese partners, as well as policy development in China.

For example, with assistance from the Department of Energy, China enacted its first-ever energy code for rural residential buildings last May, and DOE estimates this could save up to 50 percent of the energy used in residences that house about 700 million people in a footprint equal to the entire U.S. residential building sector.

One bilateral initiative in particular that has moved beyond negotiated text and into the realm of real cooperation is the U.S.-China Clean Energy Research Center. The goals of the CERC are to spur innovation of clean energy technologies, diversify energy supply sources, improve energy efficiency, accelerate the transition to a low-carbon economy, and to help avoid the worst consequences of climate change.

And the focus on innovation through joint R&D and particularly the emphasis on the creation of intellectual property makes the CERC unique from previous U.S.-China clean energy cooperation agreements.

Approximately 1,100 researchers in the U.S. and China are supported by the work of the CERC, and each of the partner organizations are either contributing funds or directly performing research.

In order to address intellectual property concerns related to the CERC's activities head on, the CERC consortia has agreed upon and signed a contract that details the IP rules for participation called a Technology Management Plan. The TMP was established after months of negotiations between U.S. and Chinese lawyers and the respective government agencies involved.

All participants that are involved in the CERC's activities are subject to the provisions of this Technology Management Plan, and any new participants that join the CERC consortium must agree to its terms.

So while it's too early to comprehensively assess the efforts of the CERC, it's increasingly evident that it provides a model for collaborative clean energy research development and demonstration that's unique in the history of U.S.-China collaboration in this area.

Spanning the public and private sectors and involving top researchers from universities and national laboratories in both countries, the CERC has been credited with propelling numerous other clean energy collaborations, including some with commercial value, and by mid-2013, all of the CERC consortia had reported inventions and IP that originated from CERC activities.

The scale is extremely impressive, and it's clearly building important clean energy focused research partnerships between China and the United States.

U.S.-China clean energy bilateral initiatives provide important channels for technical cooperation and information sharing. Without sustained support and continued attention to IP concerns, it will be even harder for China and the United States to make progress towards developing true cross-national collaborations which ultimately could produce significant global benefits, particularly in the clean energy field.

Just because we have a record number of bilateral agreements on the books does not mean we can reduce our focus on the relationship. I think the significance of the U.S.-China clean energy relationship merits a sizable and sustained level of effort.

Thank you.

PREPARED STATEMENT OF DR. JOANNA LEWIS
ASSISTANT PROFESSOR OF SCIENCE, TECHNOLOGY AND INTERNATIONAL AFFAIRS, GEORGETOWN UNIVERSITY

Hearing on U.S.-China Clean Energy Cooperation:
Status, Challenges, and Opportunities

Joanna Lewis
Assistant Professor of Science, Technology and International Affairs
Edmund A. Walsh School of Foreign Service
Georgetown University

Testimony before the U.S.-China Economic and Security Review Commission
April 25, 2014[14]

Members of the Commission: good morning, and thank you for the invitation to participate in this hearing to discuss U.S.-China Clean Energy Cooperation. I am currently a professor at Georgetown University, and have been working on the issue of U.S.-China clean energy cooperation for several years in a variety of roles. My own academic research focuses on the evolving nature of U.S.-China relations on energy and climate, including models of and obstacles to clean energy cooperation and to clean energy technology transfer, as well as China's domestic energy and climate policy strategy. Currently I am the Principal Investigator on a multi-year National Science Foundation supported research project, **"**International Partnerships and Technological Leapfrogging in China's Clean Energy Sector," in which I'm conducting an international review of bilateral clean energy cooperation initiatives with China.

Previously I served as the Research Director of the Asia Society's Initiative for U.S.-China Cooperation on Energy and Climate, and led the drafting of a "Roadmap for U.S.-China Cooperation on Energy and Climate Change" in 2008 that aimed to inform the incoming Administration's clean energy cooperation priorities with China. From 2008-2010 I served on a panel of the U.S. National Academies to review "U.S.-China Cooperation on Electricity from Renewable Sources" along with the Chinese Academies of Sciences and Engineering. I have also been directly involved in many U.S.-China clean energy cooperation projects myself, including as a researcher at Lawrence Berkeley National Laboratory's China Energy Group, as an international advisor to the Energy Foundation's China Sustainable Energy Program, and as a visiting scholar at Tsinghua University.

As the largest energy consuming nation and largest greenhouse gas emitter in the world, China

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[14] This testimony draws from Lewis, Joanna I. (2013), "Engaging China on Clean Energy Cooperation," Chapter 7 in *Green Innovation in China: China's Wind Power Industry and the Global Transition to a Low-Carbon Economy.* New York: Columbia University Press; and Lewis, Joanna I. (2014), "Managing intellectual property rights in cross-border clean energy collaboration: The case of the U.S.–China Clean Energy Research Center." *Energy Policy* 69: 546–554.

plays an increasingly important role in the geopolitics of energy as well as climate change mitigation. A longtime proponent of multilateralism, China has been increasing its engagement and its seniority in various multilateral forums, including the United Nations. It has, however, been viewed by many industrialized nations as an obstructionist player in the ongoing international negotiations under the United Nations Framework Convention on Climate Change. China, for many reasons, plays a very different role in the multilateral context from the role it plays in a bilateral one.

In these negotiations, China time and again has served the role of spokesperson for the developing world, defending its right to emit in the name of economic development. In a direct bilateral discussion with a leading industrialized nation like the United States, however, China wants to be seen as an equal, and as the global superpower that it has become. For this reason direct bilateral discussions can lead to more effective platforms for cooperation on topics that become politicized in a larger negotiation.

Bilateral cooperation allows for the identification of clear technical areas of mutual interest between the countries involved. For example, while China and the United States frequently disagree over core issues in the UN climate negotiations, the technical challenges behind their mitigation options are distinctly similar. Both countries have abundant domestic coal resources that provide energy security benefits but are a significant source of emissions.
While both China and the United States also have excellent renewable resources, including wind and solar, the best resources and locations for renewable power development tend to be located far from population centers and electricity demand and therefore will require expanded and modernized transmission infrastructures. Both countries have realized the potential energy efficiency gains they can achieve but still lag behind Europe, Japan, and others in developing a more efficient energy system.

China and the United States have a somewhat unique positioning in the international community on energy and climate change issues, as the two largest economies, the two largest energy consumers, and the two largest greenhouse gas emitters on the planet.
Owing to the similarities in energy systems shared by the two countries, there are many areas where both the United States and China could benefit from cooperation on climate change and clean-energy development.

The United States and China have a long history of bilateral clean energy cooperation, both through official governmental channels and between universities and nongovernmental organizations. For this testimony I am focusing specifically on official bilateral cooperation activities facilitated by the governments of the Untied States and China.

The U.S.–China Agreement on Cooperation in Science and Technology (S&T Agreement) was signed in 1979, soon after the normalization of diplomatic relations between the two countries. This agreement established a framework for many of the subsequent agreements on energy-related cooperation between the United States and China signed over the next thirty years. Many of the agreements signed during the 1970s and 1980s focused on promoting collaboration and understanding in basic research related to many core energy technologies of this period, including the 1970 Agreement on High Energy Physics, the 1983 Protocol on

Nuclear Physics and Magnetic Fusion, and the 1985 Protocol on Cooperation in the Field of Fossil Energy Research and Development.

Cooperation on basic research topics continued during the 1990s, but a new set of cooperation agreements were signed focusing more on energy policy discussions. These included policy discussions on fossil and nuclear energy, energy efficiency, and renewable energy. In 1995 U.S. Secretary of Energy Hazel O'Leary signed several bilateral agreements with China on high-level energy policy consultations, nuclear energy, renewable energy, energy efficiency, coal-bed methane, and climate research. That year the initial Protocol for Cooperation in the Fields of Energy Efficiency and Renewable Energy Technology Development and Utilization was signed; it was subsequently amended with new programs of cooperation (through annexes to the agreement) in the years following.

The agreements signed from 2000 to 2010 built upon the agreements of the previous two decades, which allowed for a further broadening of the energy topics being discussed bilaterally, as well as further linkages to other bilateral discussions taking place between the United States and China on economic and security issues. In 2006 the U.S.–China Strategic Economic Dialogue (SED) was founded by Vice Premier Wu Yi and U.S. Treasury Secretary Henry Paulson. The biannual, cabinet-level dialogue involved several agencies, including the U.S. Department of Energy and Environmental Protection Agency, and China National Development Reform Commission and Ministry of Science and Technology, and included a specific track for energy and environment discussion. In 2008 the fourth SED led to the establishment of the U.S.–China Ten-Year Framework for Cooperation on Energy and Environment. The Framework involves multiple U.S. and Chinese government agencies that work on environment and energy. It initially established five joint task forces on the five functional areas of the framework: (1) clean, efficient, and secure electricity production and transmission; (2) clean water; (3) clean air; (4) clean and efficient transportation; and (5) conservation of forest and wetland ecosystems. These five areas were further elaborated in seven specific action plans for implementation and were later expanded on in the July 2009 Memorandum of Understanding to Enhance Cooperation on Climate Change, Energy, and Environment, and meetings and negotiations under this agreement continue today.

Over the past 5 years, clean energy has emerged as a leading topic of cooperation between China and the United States. In November 2009, the United States and China signed 7 new agreements on clean energy cooperation, covering energy efficiency, renewable energy, electric vehicles, advanced coal technologies, and shale gas. These agreements also launched the U.S. China Energy Cooperation Program (ECP), which helps U.S. companies engage in China's clean energy sector, and the U.S.-China Clean Energy Research Center (CERC), which facilitates joint research and development on clean energy technology by teams of scientists and engineers from both countries. While these agreements were by no means the first agreements with China to focus on clean energy, the launch of a comprehensive package of clean energy agreements at the Presidential level signified a new model, as well as an elevated status bilaterally, for U.S.-China Clean Energy Cooperation.

Five years later, this cooperation has not waned, but rather is being strengthened. In 2013, the Obama Administration worked with the incoming Xi Administration to sign several new

agreements building on the package of bilateral cooperation signed back in 2009. Key among these agreements were the establishment of a high level Climate Change Working Group, which included five new initiatives: (1) Emission Reductions from Heavy Duty and Other Vehicles, (2) Smart Grids, (3) Carbon Capture Utilization and Storage, (4) Collecting and Managing Greenhouse Gas Emissions Data, and (5) Energy Efficiency in Buildings and Industry.

The signing of such agreements is often an accomplishment in itself. For example, many issues on which the United States now has official bilateral agreements with China long eluded U.S. policymakers, including agreements that addressed somewhat sensitive topics like measuring greenhouse gas emissions data, or that targeted challenging technical and political topics like carbon capture and sequestration. However, now that many of these agreements have been underway for several years, we can begin to assess what is working well, and what could be improved.

Much is working well. For example, the U.S.-China Renewable Energy Partnership has hosted multiple industry forums in China and the United States to facilitate new collaborations. The U.S. Department of Energy reports that a recent achievement of the partnership is the signing of a MOU between the U.S. company BrightSource Energy and several Chinese entities to deploy BrightSource's concentrating solar thermal power (CSP) technology in Qinghai province. This project, valued at $350 million, is structured such that key components would be manufactured in the United States, including some which may contain sensitive intellectual property, and the technology would be demonstrated in China, serving as China's first commercial-scale deployment of CSP technology.

Another agreement, The U.S.-China Energy Efficiency Action Plan has helped facilitate multiple research and commercial collaborations between U.S. and Chinese partners, as well as policy development in China. For example, with assistance from the U.S. Department of Energy, China enacted its first-ever energy code for rural residential buildings in May 2013. DOE estimates this could save up to 50 percent of the energy used in residences that house 700 million people, in a footprint equal to the entire U.S. residential building sector.

One bilateral initiative in particular that has moved beyond negotiated text and into the realm of real cooperation is the U.S.-China Clean Energy Research Center (CERC). The goals of the CERC are to spur innovation of clean energy technologies, diversify energy supply sources, improve energy efficiency, accelerate the transition to a low-carbon economy, and help to avoid the worst consequences of climate change. The focus on innovation through joint R&D and particularly the emphasis on the creation of intellectual property makes the CERC is unique from previous U.S.-China clean energy cooperation agreements. Approximately 1100 researchers in the U.S. and China are supported by the work of the CERC, and each of the partner organizations are either contributing funds or directly performing research.

The CERC is governed by a steering committee that includes ministerial- or secretary-level oversight from the relevant government agencies. From the United States, the lead agency is the Department of Energy (DOE). In contrast, China has 3 different government ministries all playing a leadership role in the CERC, including the Ministry of Science and Technology

(MOST), the National Energy Administration (NEA), and the Ministry of Housing and Urban and Rural Development (MOHURD).

The CERC has three technology areas that were targeted for initial cooperation activities: advanced coal technologies, efficient building technologies and clean vehicle technologies. The CERC currently consists of 88 individual projects within these three tracks, and almost all of these projects are joint collaborations between U.S. and Chinese researchers. The types of projects that are included in the CERC are varied along the technology research, development, demonstration and deployment (RDD&D) continuum, ranging from basic science research to technology demonstration. In addition, several projects foc us on policy analysis to support the technologies being developed.

In order to address intellectual property concerns related to the CERC's R&D activities head-on, each CERC consortia has agreed upon and signed a contract that details the IP rules for participation called a Technology Management Plan (TMP). The TMP was established after months of negotiations between U.S. and Chinese lawyers and the respective government agencies involved. All participants involved in the CERC's activities are subject to the provisions of the TMP, and any new participants that join the CERC consortia must agree to its terms.

The TMP was specifically designed to clarify the joint ownership of IP resulting from joint research activities, and invented jointly by signatories to the CERC protocol from both the U.S. and China. If project IP is invented by signatories from one territory only, then the TMP requires that participants agree to negotiate in good faith terms of a nonexclusive license to the participants from the other territory. There are also provisions in the TMP that encourage the sharing of data and information related to the project work with the public, except when there is a need to preserve confidentiality. If any disputes over IP arise in the context of CERC activities, there are provisions in the TMP for how they are to be resolved.

CERC participants with IP-related disputes are first supposed to try to work out a mutually agreeable resolution. If such a resolution cannot be reached, then an arbitral tribunal in accordance with the applicable rules of international law as set by the United Nations Commission on International Trade Law (UNCITRAL) is to be utilized. The inclusion of such a provision for dispute resolution is rare among collaborative research efforts, which typically leave any disputes to the individual laws of the relevant countries to resolve.

The CERC begins to shed some light on the question of how IP can be better managed to promote cross-national technology cooperation in the clean energy sector. While the CERC is still in its early stages, my own analysis of the CERC's IP framework highlights some of the unique characteristics of the model for collaborative clean energy research that it has established, as well as a range of expectations about what the CERC can and will achieve. Many CERC participants reported that they had initially joined the initiative because they believed the IP framework could be beneficial to their continued work in China, although they did not expect that the TMP would solve all of their IP challenges. Several private companies involved in the CERC mentioned tangible results from their participation, including new business ventures, and new IP. By mid-2013, all of the CERC consortia had reported

inventions and IP that originated from CERC R&D initiatives.

Almost all of the U.S. commercial participants across the three consortia mentioned that one of the biggest advantages of participating in the CERC was to gain leverage for technology demonstration projects. Many have invested their own money in the collaborations taking place under the CERC far in excess of government support because government involvement provided leverage for project approvals, and many CERC collaborations were perceived to have current or future commercial value.

While it is too early to comprehensively assess the efforts of the CERC, it is increasingly evident that the CERC provides a model for collaborative clean energy research, development and demonstration (RD&D) that is unique in the history of U.S.-China collaborations in this area. Spanning the public and private sectors and involving top researchers from universities and national laboratories in both countries, the CERC has also been credited with propelling numerous other clean energy collaborations, including some with commercial value. The scale of the CERC is extremely impressive, and it is clearly building important clean energy-focused research partnerships between China and the United States.

The CERC experience provides some useful insight about improvements that are still needed in order to effectively navigate IP concerns specific to U.S.–China collaborations. There is still clearly a need to better alleviate the concerns of the participants related to IP protections, as well as to better educate researchers about how to use legal tools like the TMP to better facilitate collaborative research endeavors. Rather than attempt to navigate complicated IP issues, researchers not trained in IP law are more likely to avoid IP negotiations, even at the expense of potentially valuable cross- border collaborations, unless they are confident that they have institutional support. As the first U.S.–China program targeting clean energy R&D, the CERC may ultimately play an important role in building trust among the consortia participants, which could lead to even more constructive collaborations in the future.

U.S.-China clean energy bilateral initiatives provide important channels for technical cooperation and information. Without sustained support, and continued attention to IP concerns, it will be even harder for China and the United States to make progress towards developing true cross-national collaborations which ultimately could produce considerable global benefits, particularly in the clean energy field. Just because we have a record number of bilateral agreements on the books, does not mean we can reduce our focus on the relationship. The significance of the U.S.-China clean energy relationship merits a sizable and sustained level of effort.

OPENING STATEMENT OF MS. SARAH FORBES
SENIOR ASSOCIATE, WORLD RESOURCES INSTITUTE

MS. FORBES: Thank you for the opportunity to contribute to the deliberations of this Commission, and thank you especially for welcoming my son so warmly.

My name is Sarah Forbes. I'm a Senior Associate at the World Resources Institute, or WRI. WRI is a non-profit, non-partisan think tank that focuses on the intersection of the environment and socioeconomic development. We go beyond research to put ideas into action working globally with governments, businesses, and civil society.

I'm delighted to speak with you today about clean energy cooperation between the United States and China, and I'd like to open my testimony with that concrete example of how collaboration under the U.S.-China Clean Energy Research Center's Advanced Coal Technology Consortium--hereafter I'll call it the CERC ACTC--as well as the ECP, has resulted in deployment of new technology and created manufacturing jobs here in the United States.

LP Amina, a North Carolina-based company, developed and patented a new coal classifier to sort pulverized coal. A classifier to prevent larger coal particles from entering the boiler. LP Amina's classifier was easy to add to an existing plant and such a retrofit lead to a resulting reduction in coal consumption as well as emissions, increasing efficiency and decreasing emissions.

Despite the benefits, customers in the United States would not buy the new classifier because it had not yet been demonstrated. After engagement in the joint R&D and workshops convened by the CERC ACTC, as well as involvement of the ECP, LP Amina installed one of its new classifiers at the Fengtai Power Station in Anhui Province in eastern China.

After successful demonstration in China, LP Amina is now marketing this technology to global companies, including plants in the United States. So the technology was developed here in the United States, demonstrated in China, and is now being deployed globally, and the innovation is creating American manufacturing jobs. Each classifier keeps ten to 20 manufacturing workers busy for a month and manufacturers in Michigan, Ohio, and West Virginia have already been put to work building them.

As the recently released IPCC Working Group III report highlighted, large-scale clean energy deployment must be accelerated now if we are to avoid the worst impacts associated with climate change.

As the report highlights, this means tripling or quadrupling energy from renewables, nuclear and fossil energy with CCS by 2050. Both the U.S. and China are critical to this clean energy transformation. By working together through substantive, well-designed collaborative efforts, we can do remarkable things.

As my written testimony emphasizes, the building blocks for such collaboration are already in place. Both the U.S. and China have taken the collaboration seriously, have made significant progress, and have ultimately created a solid foundation for further action.

But the collaboration and the resulting development in deployment and deployment of clean energy technologies in both the U.S. and China must be taken to the next level. We need to increase the pace and scale of collaboration, avoiding duplication and investing in joint clean energy demonstrations.

In a world where companies and products are globally integrated, the benefits of U.S.-China cooperation on clean energy innovation extend beyond either the U.S. or China. A visit to an industrial facility anywhere in the world might reveal parts and technologies purchased

from dozens of countries.

By leveraging and combining the collective ingenuity of engineers and scientists in both the U.S. and China, we can help unlock a clean energy revolution by developing smarter approaches to producing and using energy. These new developments can and will be used globally.

I will end my testimony with five specific actions that can be taken to improve U.S.-China cooperation on clean energy. Congress can play an important role in these recommendations by supporting the collaborative efforts undertaken by the administration through the agencies and ensuring that the building blocks I describe do serve as a foundation for future action.

First, we must create collaborative networks that include supporting innovators' needs and building capacity in the workforce.

The framework for such sustained capacity- building and innovation-fostering collaborations spans government-to-government, researcher-to- researcher and business-to-business collaboration. We need more clean energy public-private partnerships.

One example of such collaboration is already in place through the CERC as well as through ECP, as we heard previously. Currently, the CERC focuses on three clean energy areas: advanced coal; electric vehicles; and energy efficiency in buildings.

My second recommendation: we need to continue high-level strategic engagement between the U.S. federal government and China's central government on clean energy collaboration.

The influence of formal high-level government-to-government collaborations can't be underestimated. Such platforms are needed to integrate current efforts and promote information sharing among complementary efforts, ultimately eliminating redundancies.

The recently established Climate Change Working Group may serve a coordinating function among various clean energy cooperation between the two countries. Right now, the Climate Change Working Group is focusing on scaling up collaboration in five issue areas: smart grid; CCS; EE; vehicle emissions; and greenhouse gas data.

My third recommendation: undertake substantive work on developing and implementing environmental regulations for air, water and climate impacts.

Too often collaboration focuses only on technology and not on the important interaction between the technology and policy. This includes addressing holistic environmental impacts associated with technology deployment.

One way to accomplish this would be for the U.S. and China to initiate a platform of multi-agency ministry dialogue between the countries, one that is focused specifically on environmental policies, spanning from environmental standards and recommendations to policies that provide incentives for clean energy infrastructure and deployment.

My fourth recommendation: foster private sector engagement and investment, personnel training and greater transparency. Business-to-business collaboration will continue to be important, but there are barriers that must be addressed for it to be more effective.

To understand and address these barriers, Congress could request a report on U.S.-China business-to-business collaboration that includes input from industry, from government, and academic stakeholders who are already involved in the cooperative efforts.

My final recommendation: facilitate opportunities for joint research development and demonstration. While existing technical collaboration is happening and we're seeing some early successes, it must evolve into deeper efforts that include more extended exchanges of

researchers and collaborative large-scale demonstrations. The level of effort and pace of such collaborations should be accelerated.

I'd like to end my remarks with a quote from the April 2013 Joint U.S.-China Statement on Climate Change.

Secretary Kerry said: "Action by the U.S. and China, including large-scale cooperative action, is more critical than ever. Such action is crucial both to contain climate change and to set the kind of powerful example that can inspire the world."

I do believe that by working together, the U.S. and China can inspire the world and foster a faster transition to a clean energy economy.

Thank you.

HEARING CO-CHAIR CLEVELAND: Thank you.

Ms. Nakano.

PREPARED STATEMENT OF MS. SARAH FORBES
SENIOR ASSOCIATE, WORLD RESOURCES INSTITUTE
TESTIMONY OF SARAH M. FORBES

SENIOR ASSOCIATE, CLIMATE AND ENERGY PROGRAM
WORLD RESOURCES INSTITUTE

HEARING BEFORE THE US-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION "US-CHINA CLEAN ENERGY COOPERATION: STATUS, CHALLENGES, AND OPPORTUNITIES"

April 25, 2014

Thank you for the opportunity to contribute to the deliberations of this commission. My name is Sarah Forbes, and I am a Senior Associate in the Climate and Energy Program at the World Resources Institute (WRI). WRI is a non-profit, non-partisan think tank that focuses on the intersection of the environment and socio-economic development. We go beyond research to put ideas into action, working globally with governments, business, and civil society to build transformative solutions that protect the earth and improve people's lives. We operate globally because today's problems know no boundaries. We provide innovative paths to a sustainable planet through work that is accurate, fair and independent.

I am delighted to speak with you today about clean energy cooperation between the United States and China. I would like to open my testimony with a quote from the April 2013 Joint US-China statement on Climate Change:

> *"[F]orceful, nationally appropriate action by the United States and China – including large scale cooperative action – is more critical than ever. Such action is crucial both to contain climate change and to set the kind of powerful example that can inspire the world"*

In my testimony I will describe the context for US-China collaboration on clean energy, outline the need for policies that encourage innovation throughout the value chain, describe how collaboration with China can advance US energy goals, and, perhaps most importantly, give recommendations for how US-China collaboration on clean energy could be improved so that we can inspire the world and speed the transition towards a clean energy future. My testimony will discuss not only clean energy collaboration, but will also touch on the issues you raised in inviting me around the state of cooperation on shale gas.

I will expand on the following five recommendations throughout my testimony. Future US-China collaboration on clean energy and shale gas should include:

1. Creation of collaborative networks that include supporting innovators' needs and building capacity in the workforce;

2. Continued high-level strategic engagement between the US federal government and China's central government on clean energy collaboration;
3. Substantive work on developing and implementing environmental regulations for air, water, and climate impacts;
4. Private sector engagement and investment, personnel training, and more transparency; and
5. Facilitation of opportunities for joint R&D.

Context for Clean Energy Cooperation between the US and China

Many parallels exist in the US and Chinese energy profiles. Both are continent-sized countries with geographically dispersed energy resources and with energy demand centers (cities) that are often far from energy supplies. Both countries currently rely heavily on fossil fuels to power their economies, primarily drawing on coal, natural gas, and imported oil (the US and China have similar levels of crude import dependence). Both countries seek to increase energy independence by diversifying the energy mix and ramping up domestic energy production, particularly unconventional fossil fuels such as shale gas as well as renewable energy technologies.

Collaboration on clean energy – energy efficiency, renewable energy and carbon capture and storage (CCS) – and shale gas falls into these broad categories:

- Business-to-Business
- Government-to-Government
- Researcher-to-Researcher

The following provides a brief overview of the scope of existing collaboration on clean energy and shale gas, with the shale gas discussion adapted from a paper I recently drafted for the Brookings Institution[15].

Business-to-Business (B2B)

The following are examples of key B2B collaborations[16]:

- Duke Energy and Huaneng have been cooperating on clean energy technology since 2009. The two companies have been sharing information, especially on carbon capture, utilization and storage (CCUS). In 2012, the original agreement was expanded to examine the feasibility of brining carbon capture and storage technology that had been pilot tested in China to US power plants.
- GE and State Grid Corp have formally agreed to cooperate to jointly develop standards for smart grids in China. GE has formed an equally-owned joint venture in China to offer leasing services to the energy industry and an equally-owned joint venture to market and manufacture grid monitoring and diagnostic products.
- A consortium of US and Chinese companies including Boeing, Honeywell, PetroChina,

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http://www.brookings.edu/~/media/Events/2014/2/06%20china%20clean%20energy/USChina%20Moving%20Toward%20Responsible%20Shale%20Gas%20Development_SForbes.pdf

16 These examples are excerpted from WRI China FAQS factsheet "US-China Collaboration: Can they "inspire the world"? (http://www.chinafaqs.org/library/chinafaqs-us-china-collaboration-can-they-inspire-world)

and Air China has been collaborating to develop biofuels for passenger jets. In 2011, this effort led to a successful Chinese test flight of a Boeing 747 using a 50% blend of traditional jet fuel and the new biofuel. This collaboration benefits from being a part of the US-China Energy Cooperation Program.

In terms of shale gas, Chinese companies currently possess the ability to drill wells horizontally and have some experience with hydraulic fracturing but are in the nascent stages of acquiring experience and applying these techniques to shale gas extraction. Operators and service providers in the United States currently have substantial experience with drilling and fracking shales, having mastered these techniques effectively to maximize output. Given this level of technical and experiential asymmetry, China has made it possible for US entities to strike up partnerships with Chinese companies, primarily the National Oil Companies (NOCs). But China has prohibited foreign companies from fully entering the onshore energy production sector on their own, forcing them to form partnerships with Chinese entities. As a result, several foreign companies have already begun participating in shale gas development in China, through joint ventures (JVs) such as PetroChina-Shell and China National Offshore Oil Company-British Petroleum (CNOOC-BP).[17] Leading US service providers like Schlumberger, Baker Hughes, and Halliburton also have well-established offices and/or research institutes in Beijing and provide services to Chinese companies, including the NOCs and other smaller new entrants.

China has also invested in shale gas development in the United States, with NOCs establishing JVs with US companies. These generally take the form of acquiring stakes in company assets—investments in specific shale gas plays—and not as investments in the US companies themselves. It is a model that the global oil and gas industry has long used to sustain growth and hedge against financial risk. The rationale for these Chinese investments varies. In some cases, Chinese petroleum engineers are able to spend time onsite learning about shale gas development first hand. However, limits on "access to technology" remain an oft-cited constraint on China's future shale gas developments. What is meant by "access to technology" may be best described as "know how." That is, the technology for horizontal drilling or fracking may not be the key barrier for China *per se*—instead, it is the lack of experience in applying these tools to different geological formations to maximize the flow of the gas.

Government-to-Government (G2G)

In 2009, the following key forums for G2G collaboration on clean energy were established:

- The Clean Energy Research Center, or CERC (electric vehicles, building efficiency, and advanced coal technology), is a unique bilateral platform to allow both countries' researchers to work closely on the same tasks and is operated as a public-private partnership on both sides.
- US-China Energy Cooperation Program is a government-led collaboration that includes private-sector partners on both sides, supporting projects in the areas of smart grid, green buildings, combined heat and power and renewable energy.

[17] Forbes, Sarah, 2012. "China's Prospects for Shale Gas and Implications for the United States" Congressional Testimony. http://pdf.wri.org/testimony/forbes_testimony_china_shale_gas_2012-01-26.pdf

- US-China Renewable Energy Partnership includes road mapping renewable energy deployments in each country, an annual US-China renewable energy forum and sharing best practices.
- US-China Electric Vehicles Initiative supports joint standards development and demonstrations in a dozen cities.
- US-China Energy Efficiency Action Plan supports officials in both countries to develop codes and rating systems and benchmark industrial energy efficiency as well as a training program for inspectors and an annual US-China Energy Efficiency forum.

In 2013, the Climate Change Working Group (CCWG) for the Strategic and Economic dialogue completed a report that took stock of the existing collaboration. The CCWG was established in April 2013 to deepen and extend existing collaboration that spurs large-scale cooperative efforts. The report resulted in a July 2013 commitment to new action initiatives for collaboration on five issues, which will draw on the relevant agencies in each country:

1. Emissions reductions from heavy-duty and other vehicles
2. Smart grid
3. Carbon capture utilization and storage
4. Collecting and managing GHG emissions data
5. Energy efficiency in buildings and industry

With respect to shale gas specifically, in 2009, President Obama and then-President Hu Jintao announced the launch of the US-China Shale Gas Resource Initiative, with the goal of sharing information about shale gas exploration and technology to reduce greenhouse gas emissions, promote energy security, and create commercial opportunities. Activities conducted under the initiative include forums, workshops, and a Chinese delegation's visit to a US shale gas development operation. The governments' collaboration includes the following activities, led by key agencies:

- The US Geological Survey and the Department of Energy (DoE) have worked with Chinese counterparts to develop estimates for China's shale gas resource. Although the collaboration resulted in sharing information on methodology, Chinese geological data is considered a state secret and cannot be shared with foreigners.
- DoE manages the US-China oil and gas industry forum, which sponsors an annual meeting designed to bring industry players together to share information via technical presentations.[18] In September 2012, the forum sponsored a meeting focused on shale gas. DoE also has relevant work underway that focuses on issues under Annex III of the bilateral Fossil Energy Protocol.[19]
- In April 2013, the US Trade and Development Administration partnered with the National Energy Administration on a training program. The program included four short courses led by the Gas Technologies Institute and targeted attendees from the Chinese government and industry.[20]

[18] http://www.uschinaogf.org/

[19] http://www.fossil.energy.gov/international/International_Partners/China.html

[20] http://www.rpsea.org/attachments/calendarevents/452/US-China%20Shale%20Gas%20Resource%20Characterization%20and%20Assessment%20Workshop-%20US%20V%204_3_2013)USE.pdf

Researcher-to-Researcher (R2R)

Regardless of the G2G or B2B framework for collaboration, the effectiveness of collaboration on clean energy technology development ultimately depends on the relationships established between researchers. G2G frameworks like the CERC are designed to foster such R2R relationships, however the depth and extent of collaboration ultimately depends on a collection of individual relationships among researchers who share the same interests and vision.

It is increasing common for effective G2G, B2B and R2R collaborations to result in bilateral public/private partnerships:

- CERC participants from Yanchang Petroleum, University of Wyoming, and the China Academy of Sciences are partnering on a CCUS/Enhanced Oil Recovery project in Shaanxi province.
- CERC participants from Huaneng Energy, Lawrence Livermore National Laboratory, and Duke Energy have conducted carbon capture cost modeling on Duke's Gibson Power Plant and Huaneng's Shidonku plant.

Future Environmental Challenges Require Innovation

Transforming the global energy picture requires innovation. Such innovation will not happen without investment from the public and private sector, commitment from governments and industry, support from local communities, and out-of-the box ideas that push the envelope of what seems possible. All of these must be sustained over time.

R&D spending alone is not effective in deploying new energy technologies, and the innovations created in U.S. national laboratories and universities often do not get manufactured or deployed into the marketplace. For instance, a recent WRI report comparing clean energy industries across major countries highlighted that the United States had the highest public investments in wind energy R&D. Yet, it was the only wind energy market among the five countries analyzed that maintained a long-term trade deficit in wind equipment, importing more than it exports, due largely to the uncertainty surrounding the longevity of policies that support deployment of wind energy technologies.[21]

WRI's work on innovation concluded the following:[22]

"Innovation is a powerful, cumulative process but it does not happen automatically in a highly regulated sector like electricity. It is critical that policymakers support innovators by building a robust, dynamic innovation ecosystem. This goes beyond investing in public research and development and creating markets through subsidies. It also includes building collaborative networks, creating stable regulatory environments, providing infrastructure, supporting innovators' needs for finance, and building capacity in the workforce."

[21] http://www.wri.org/publication/delivering-on-the-clean-energy-economy
[22] http://pdf.wri.org/factsheets/factsheet_power_of_innovation.pdf and http://www.wri.org/publication/two-degrees-of-innovation

International collaboration, and US-China collaboration specifically, is one way to create collaborative networks and build global capacity among researchers and ultimately in the workforce. In the area of CCUS, bi- and multi-lateral mechanisms for collaboration, such as the US-China Clean Energy Research Center's Advanced Coal Technology Consortium and the Carbon Sequestration Leadership Forum, have already been established. These efforts together create a globally integrated collaborative network. However, US-China collaboration stands out among international efforts on CCUS because of the sustained nature of the collaboration and the level of commitment among the businesses and researchers engaged.

US Benefits from US-China Clean Energy Cooperation

There was a time when US-China collaboration on clean energy was geared primarily towards "capacity building" or "technology transfer." That view of the world is increasingly outdated. China is a global leader in clean energy investment and in clean energy technology development and the benefits from US-China collaboration on clean energy can and will be realized by both countries. China is now a center of global clean energy collaboration, working with Australia, Canada, and European Union on a range of clean technologies.

U.S. businesses, universities and think tanks are already leveraging the benefits of international collaboration to advance clean energy technology and reduce the environmental impacts associated with continued fossil fuel use.

In a world where companies and products are globally integrated, the benefits of US-China cooperation on clean energy technology innovation extends beyond either the US or China. A visit to an industrial facility anywhere the world might reveal parts and technologies purchased from dozens of countries. By leveraging and combining the collective ingenuity of engineers and scientists in both the US and China, we can help unlock a clean energy revolution by developing smarter approaches to producing and using energy. These new developments can and will be used globally.

An intangible benefit of cooperation is the benefit of the cooperation itself. And the benefits of this cooperation are not merely bilateral. The frameworks under which cooperation occurs provide opportunities for businesses, government agencies, and academics within each country to engage in discussions and work jointly in ways would not be possible otherwise. Such cross-fertilization directly benefits the US entities involved in the collaboration.

Before I turn to my recommendations, I would like to end my testimony with a concrete example of how collaboration under Clean Energy Research Center-Advanced Coal Technology Consortium and the US-China Energy Cooperation Partnerships has resulted in deployment of new coal technology and created manufacturing jobs in the United States.[23]

LP Amina, a North Carolina-based company, developed and patented a new coal classifier to sort pulverized coal. The classifier was easy to add to existing plants and such a retrofit would lead to a reduction in coal consumption and emissions. The classifier prevents larger coal particles from

[23]WRI published a more comprehensive version of this story as a ChinaFAQs factsheet; see http://www.chinafaqs.org/files/chinainfo/China%20FAQs_Road_Testing_Tech_v1_6.pdf.

entering the boiler, reducing nitrogen oxide emissions by up to approximately 15 percent and with slight efficiency improvements. Despite the benefits, customers in the United States would not buy the new classifier because it had not yet been demonstrated. After engagement in joint R&D and workshops convened by the CERC-ACTC, LP Amina installed one of its new classifiers at the Fengtai Power Station in the Anhui Province in eastern China. After the successful demonstration in China, LP Amina is now marketing this technology to global companies, including plants in the United States. The technology was developed here in the United States, demonstrated in China, and is now being deployed globally. And the innovation is creating American manufacturing jobs. Each classifier keeps 10-20 manufacturing workers busy for a month and manufacturers in Michigan, Ohio, and West Virginia have already been put to work building them.

Recommendations for Improving US-China Cooperation on Clean Energy

Note: the final three recommendations are an adapted and expanded version of the recommendations made for US-China collaboration on shale gas in "The United States and China: Moving towards Responsible Shale Gas Development"[24].

1. *Creation of collaborative networks that include supporting innovators' needs and building capacity in the workforce.*

   While deployment of clean energy technologies depends on national regulatory changes and infrastructure investments, innovation also can be accelerated by collaborative networks. US-China collaboration that fosters true innovation and is sustained over time can play an important role in clean energy innovation. Such collaboration should extend beyond R&D and also build capacity in the workforce. The framework for such sustained, capacity-building collaboration is already in place through the US-China Clean Energy Research Centers, the Energy Cooperation Partnership Program and the US-China Renewable Energy Partnership—however, the budgets for these efforts are continually at risk of inadequate resources as they are subject to annual Congressional appropriations. In addition to ensuring collaborative efforts are adequately funded, Congress can also play a role in tracking the progress of various collaborative efforts through a periodic assessment or report to congress. Such a report could include recommendations for improving and reshaping existing collaborations.

2. *Continued high-level strategic engagement between the US federal government and China's central government on clean energy collaboration.*

   High-level communication and engagement is very important. China's top-down innovation system requires government leadership and guidance. An institutional collaborative mechanism between China and the US could be beneficial. Such a platform should integrate current platforms and promote information sharing-among complimentary efforts. For example, although some of the same businesses and researchers are engaged in the shale gas initiatives led by different governmental agencies, there does not seem to be a formal

[24] http://www.brookings.edu/~/media/events/2014/2/06%20china%20clean%20energy/uschina%20moving%20toward%20responsible%20shale%20gas%20development_sforbes.pdf

integration or assessment of efforts. Ideally such an integration would look across clean energy cooperation, including energy efficiency, renewable energy, CCUS and shale gas. The Climate Change Working Group (CCWG) is designed explicitly to bring the relevant agencies and ministries together in such a manner. However, its scope is currently limited to collaboration on the five issue areas described. Congress could request a report that analyzes the gaps and progress in current collaboration and evaluates whether the CCWG could effectively serve a coordinating function among clean energy cooperation between the two countries.

3. *Substantive work on developing and implementing environmental regulations for air, water, and climate impacts.*

   Too often collaboration focuses only on technology and not on the important interaction between technology and policy, including addressing the environmental impacts of technology deployment. Comprehensive, life cycle environmental concerns regarding clean energy development must be addressed as part of future collaboration. This collaboration should involve both technical and policy aspects of clean energy deployment. One way to accomplish this would be for the US and China to initiate a platform for multi-agency/ministry dialogue between the countries that is focused specifically on environmental policies needed for clean energy deployment in China and the US. Such a platform could be led by two agencies, or perhaps occur under the auspices of the CCWG, but would include all relevant agencies/ministries in the discussions and would focus on policies and regulations rather than technologies and demonstrations. Congress could encourage such collaboration through supporting international collaboration efforts undertaken by Environmental Protection Agency.

4. *Private sector engagement and investment, personnel training, and more transparency.*

   Business-to-business collaboration will continue to be important, but there are barriers that must be addressed for it to be effective. They include inadequate involvement of companies on both sides, and sensitivities surrounding information protection and technology sharing.

   To remedy these issues, the two governments could initiate a joint industry forum focused on the interests and needs of companies that cross-cuts clean energy issues. A new workforce training program could provide opportunities for young professionals from both countries to have an extended stay in the respective country. This would help to cultivate a group of engineers and scientists, ready to support clean energy development anywhere in the world. Leaders in both governments should jointly discuss the barriers to cooperation including intellectual property and data availability. Such an effort could begin by Congress requesting a special report on US-China business-to-business collaboration that includes input from industry, government, and academic stakeholders engaged in cooperative efforts and assessing the opportunities and barriers for private sector engagement in collaboration.

5. *Facilitation of opportunities for joint R&D.*

   While existing technical collaboration is important, it should evolve into deeper efforts that

include exchanges of researchers and dialogues aimed at solving the unique challenges of various clean energy approaches. Both governments should create platforms for cooperation and fund researchers in academia and industry to partner bilaterally and co-develop novel clean energy solutions.

Taking this recommendation seriously means prioritizing extended exchange programs over short workshops and meetings as part of existing and new collaborative efforts. It also means expanding beyond the questions around technology and including joint research on the economic and policy aspects of clean development. A collaborative clean energy demonstration program, modeled on existing international collaborations such as the CERC, could be one way to effectively encourage joint green technology development and demonstration.

OPENING STATEMENT OF MS. JANE NAKANO
FELLOW, ENERGY AND NATIONAL SECURITY PROGRAM, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES

MS. NAKANO: Good morning, Commissioner Goodwin and Commissioner Cleveland and other esteemed members of the Commission.

I'd like to thank the Commission for the opportunity to testify about the U.S.-China nuclear energy cooperation today. It is an honor to be here this morning.

The United States has a wealth of expertise in nuclear regulatory matters, as well as strong capability in reactor design and technical innovation, yet the U.S. nuclear industry has lost the robustness it once had in manufacturing and deploying nuclear reactors.

In contrast, China has a growing nuclear energy sector with the national drive to become a global nuclear supplier, yet is short of regulatory expertise and technological capacity. These complementary abilities provide a unique synergy and basis for growing bilateral cooperation.

My remarks today will address key elements of bilateral engagement between the two nuclear sectors, as well as between the two regulatory bodies, and challenges and opportunities associated with such engagement that has been transforming from one of coexistence to one of mutual dependence.

Please note that my scope does not include bilateral cooperation in the area of nuclear security or nonproliferation.

China is becoming a major player in civilian nuclear energy. Today, the country has only 20 reactor units online accounting for about two percent of its total generation capacity. But it has 29 units under construction representing roughly 40 percent of reactor construction around the world.

To the Chinese leadership, the expansion of nuclear power generation is a politically practical and economically viable means of moving the country away from its heavy coal dependence and attendant air pollution. Indeed, China's commitment to growing its nuclear power generation is independent of U.S. action.

Nonetheless, cooperation with various U.S. nuclear energy stakeholders has significantly helped China narrow the gap between its pace of nuclear energy expansion and its technological and institutional capacity deficit.

Specifically, Chinese frustration at striking a balance between its stated desire for self-reliance and its relatively limited technological capabilities led to their decision in 2007 to purchase four units of advanced pressurized water reactors called AP-1000 from Westinghouse.

The Unit 1 at Sanmen is slated to be the first operational AP-1000 in China and in the world when it comes online as early as next year. The successful deployment of AP-1000 is expected to significantly help the safety of China's commercial nuclear fleet, which has been dominated by older design reactors.

The enhanced nuclear safety in China is a concrete benefit to the U.S. public, the safety of U.S. nationals residing in and traveling to China, as well as U.S. economic interests there. Also, Chinese success in diversifying its power supply mix and burning less coal would be a clear benefit for the climate.

Furthermore, the AP-1000 sale ushered in a new era for bilateral regulatory engagement, the engagement that dates back to the early 1980s. China's decision to begin constructing the U.S. designed AP-1000 reactors ahead of the design certification by the U.S. Nuclear

Regulatory Commission provides the NRC with an opportunity to learn from the Chinese experiences.

These lessons improve U.S. regulatory expertise concerning future AP-1000 reactor units in the United States.

Notwithstanding the clear benefits and opportunities, bilateral cooperation is not free of challenges, both real and potential. China's industrial structure and lower manufacturing costs will likely turn the country into a fierce competitor to the U.S. nuclear industry when the Chinese successfully adopt advanced reactor technology.

In fact, the Chinese nuclear sector is accelerating efforts to develop and deploy large advanced pressurized water reactors that are based on the AP-1000 reactor. The initiative has led to the development of CAP-1400, which is now slated for construction later this year and targeted to come online by 2018. More significantly, the Chinese plan on exporting these reactors.

Key questions that may arise from this development include whether there is an intellectual property rights concern, and if a dispute arose in the future, how it would affect the future scope of bilateral commercial engagement.

Westinghouse is believed to have decided that there was more to be gained than lost by establishing a presence in China's nascent, yet growing, market--even at the price of extensive technology transfer that would bolster the competitiveness of Chinese vendors.

Reportedly, China has eight new AP-1000 reactor units planned and several dozen additional AP-1000 units proposed for construction. U.S. vendors, including Westinghouse, are expected to be involved in these future projects in China. Moreover, the AP-1000 sale has accorded the U.S. nuclear industry some valuable insights in the capability of Chinese nuclear sector that may otherwise be inaccessible.

Whether the commercial cooperation on nuclear energy could yield greater challenges than advantages to the U.S. economy in the long-term is a question that has no simple answer. The supply chain for nuclear power projects has become increasingly globalized, and this renders the task of quantifying the scope of economic benefit to the United States remarkably challenging.

However, the increasingly globalized supply chain does not negate the need for U.S. regulatory expertise or undermine the value of bilateral cooperation. In fact, such globalization could heighten the stake of U.S. nuclear regulators and industry in the qualitative aspects of the Chinese nuclear industry development.

Nuclear energy technology cooperation between U.S. and Chinese nuclear sectors goes hand-in-hand with the robust cooperation between the nuclear regulators from the two countries. Both are indispensable if bilateral nuclear energy cooperation is to be sustainable, as much as if nuclear energy is to remain part of the national energy mix for the United States and for China.

Thank you very much.

HEARING CO-CHAIR CLEVELAND: Thank you.

Commissioner Wessel.

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PREPARED STATEMENT OF MS. JANE NAKANO
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Statement before the U.S.-China Economic and Security Review Commission

"U.S.-CHINA CLEAN ENERGY COOPERATION"

A Statement by

Jane Nakano

Fellow, Energy and National Security Program
Center for Strategic and International Studies (CSIS)

April 25, 2014

608 Dirksen Senate Office Building

Testimony before the U.S.-China Economic & Security Review Commission

Hearing on U.S.-China Clean Energy Cooperation

Jane Nakano

Fellow
Energy and National Security Program
The Center for Strategic and International Studies

April 25, 2014

Good morning Commissioner Goodwin and Commissioner Cleveland, and other esteemed members of the Committee. I would like to thank the Commission for the opportunity to testify about U.S.-China nuclear energy cooperation. It is an honor to participate in this hearing.

My remarks today will address the scope and status of civilian nuclear energy cooperation between the United States and China. The United States has a wealth of expertise in nuclear regulatory matters as well as strong capability in reactor design and technical innovation, yet the U.S. nuclear industry has lost the robustness it once had in manufacturing and deploying nuclear reactors. In contrast, China has a growing nuclear energy sector with a national drive to become a global reactor supplier yet is short of regulatory expertise and technological capacity. These complementary abilities provide a unique synergy and basis for growing bilateral cooperation. Today I will touch on key elements of China's nuclear energy policy and program, bilateral engagement between the two nuclear sectors as well as between the two regulatory bodies, and challenges and opportunities associated with such engagement that has been transforming from one of *co-existence* to one of *mutual dependence*. Please note that my scope does not include nuclear security or nonproliferation.

China's Nuclear Sector and Chinese Nuclear Energy Policy

China is becoming a major player in civilian nuclear energy. While the country has only 20 reactors online (accounting for about 2 percent of total generation capacity),[25] it has 29 reactors under construction, representing roughly 40 percent of reactor construction around the world.[26] Even more staggering, the World Nuclear Association has stated that an additional 58 reactors are being planned (including 24 inland units whose construction is deferred to until after 2015).[27]

The enormous growth in China's energy demand over the last decade has made nuclear energy

[25] China Nuclear Energy Association, *Nuclear Power Operation Status for the First Quarter of 2013*, June 2013, p. 1. (2013 *nian di yi ji du he dian yun xing qing kuang*)
[26] World Nuclear Association, *Nuclear Power in China*, updated April 2014.
[27] Ibid. The construction delay for planned inland reactors stems from the public concern over how to dispel polluted water in case of a major incident.

expansion a practical way to address the country's growing dependence on energy imports as well as to help reduce the country's severe air pollution. Coal has been an important part of that strategy (coal accounts for nearly 70 percent of China's primary energy consumption and its electricity demand[28]), but air pollution in China has led the leadership to seek low-carbon alternatives. As a technologically proven and no-carbon source of electricity, nuclear energy has come to play a central role in China's plan to diversify its fuel mix away from coal. Consequently, the civilian nuclear sector's remarkable expansion is attributable to the strong political and policy support it enjoys.

The Chinese government approved the country's first nuclear power plant in 1982,[29] but nuclear energy was not integrated into China's overall strategic energy plan until the 10th Five-Year Plan (FYP, 2001-2005). With this strategic push, nuclear energy began expanding with the construction of four reactors during the 10FYP.[30] This was followed by the Medium- and Long-Term Nuclear Power Development Plan of 2007, which called for 40 GW of installed capacity by 2020, or about 5 percent of the total energy mix.[31] In 2008, in recognition of the rising prominence of nuclear energy, nuclear energy policymaking was moved out of the State Administration of Science Technology and Industry for National Defense[32] and became part of the National Development and Reform Commission, the powerful economic planning agency in China.

The role of nuclear energy was further elevated under the 11FYP (2006-2010). The mandatory 20 percent energy intensity reduction under the 11FYP provided momentum for developing clean energy sources such as nuclear power. Government-backed investment into heavy industry followed the heightened government commitment to encourage the development of nuclear manufacturing.[33] By 2009, government investment totaling about $49.2 billion (RMB 300 billion) is said to have gone into four key Chinese nuclear manufactures of reactor components like pressure vessels, steam generators, and steam turbine generators.[34]

The national efforts to raise non-fossil energy to 11.4 percent of total primary energy use and to reduce carbon intensity by 17 percent—both under the 12th FYP (2011-2015)—continue to drive nuclear energy expansion. Before the Fukushima nuclear accident in March 2011, the Chinese government had indicated that up to 86 GW by 2020 and as much as 500 GW by 2050 could be installed in the country.[35]

Post-Fukushima Development in China

The multiple reactor meltdown accident at the Fukushima Dai-ichi Nuclear Power Station led to

[28] U.S. Energy Information Administration, *Country Analysis Brief—China*, last updated: September 4, 2012.
[29] Bo Kong, "Civil Nuclear Energy Development in China and U.S.-China Nuclear Cooperation," presentation at Brookings Institution seminar, Washington, D.C., Sept. 17, 2010.
[30] World Nuclear Association, *Nuclear Power in China*, updated April 30, 2013.
[31] World Nuclear Association, *Nuclear Power in China*, updated September 2011.
[32] Zhou, Y., et al., *Is China Ready for its Nuclear Expansion*? *Energy Policy* (2010), doi: 10.1016/j.enpol.2010.10.051, p.2.
[33] Ibid., p.6.
[34] Ibid.
[35] World Nuclear Association, *Nuclear Power in China*, updated September 2011.

a pause in Chinese nuclear development, but unlike in neighboring countries, the accident did not lead to a fundamental reassessment of China's nuclear energy policy. Nonetheless, the Chinese government took the matter seriously, immediately halting approval of all reactor construction. This moratorium also affected the four approved units that were scheduled to start construction in 2011.[36] Within a week of Fukushima, the government had also ordered safety inspections of the country's 11 operational reactors and the 26 reactors that were already under construction.[37]

These safety inspections illuminated shortfalls in 16 areas that mainly concern emergency backup systems, flooding prevention, and earthquake-related safety issues.[38] Many of these safety concerns found their way into the 12th FYP (2011-2015), approved around the same time as the reactor inspection report in 2012. The plan recognized that while most Chinese nuclear plants meet existing domestic safety regulations and International Atomic Energy Agency safety standards and requirements,[39] investment of nearly RMB 80 billion ($13 billion) would be needed by 2015 to improve safety at both operating reactors and reactors under construction.[40]

Another notable development post-Fukushima was the introduction of a new government nuclear safety plan in October 2012. Unequivocally stressing the paramount importance of safety, the new plan called for domestic safety regulations to fully incorporate the internationally accepted level of safety standards by 2020, and for levels of nuclear safety-related research and development to be enhanced.[41] More significantly, the plan also recommended that older reactors be phased out in a timely manner.[42] The much stricter standards for new nuclear construction under the new nuclear safety plan—particularly the elimination of large radiation releases in units built beyond 2016—will likely accelerate the country's fleet switch away from Gen II reactors,[43] which accounted for roughly half of the units under construction and many on order in China right before the Fukushima accident. Again, despite considerable government attention on nuclear safety issues, Fukushima did not alter the Chinese commitment to nuclear power. Although the post-Fukushima safety inspections temporarily slowed the pace of new builds, the October 2012 safety plan lifted the moratorium on new reactor construction and the Chinese government left its 2015 target for installed capacity unchanged at 40 GW.[44] The government also revised a 2020 target at 58 GW. Moreover, the country's White Paper on Energy Policy in October 2012 reaffirmed the central

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[36] World Nuclear Association, *Nuclear Power in China*, updated March 2013.
[37] At the time of Fukushima accident, 34 reactors had construction approval, including the 26 units already being built. See World Nuclear Association, *Nuclear Power in China*, updated March 2013
[38] Report on the Status of Safety Inspections on Civilian Nuclear Facilities across the Country (*Guan yu quan guo min yong he she shi zong he an quan jian cha qing kuang de bao gao*), National Nuclear Safety Administration, National Energy Administration, and China Earthquake Administration, p. 8-9.
[39] Ibid., p. 4-5.
[40] 12th FYP for Nuclear Safety and Radioactive Pollution Prevention and Vision for 2020, Ministry of Environmental Protection, National Nuclear Safety Administration, National Development and Reform Commission, Ministry of Finance, National Energy Administration, and National Defense Science and Technology Industrial Development Bureau, p. 19, http://haq.mep.gov.cn/gzdt/201210/W020121016305772730116.pdf.
[41] Fayen Wong, China issues nuclear safety blueprint, eyes $13 billion investment, Reuters, October 16, 2012.
[42] Ibid.
[43] Yun Zhou, "China Responds to Fukushima," *Bulletin of the Atomic Scientists*, June 28, 2012.
[44] The Information Office of the State Council, *China's Energy Policy 2012*, www.gov.cn/english/official/2012-10/24/content_2250497_5.htm

role for nuclear energy in raising the share of non-fossil fuels in the primary energy mix. The White Paper also included plans to "invest more in nuclear power technological innovations, promote application of advanced technology, improve the equipment level, and attach great importance to personnel training."[45]

Growing Commercial Engagement

With notable levels of state assistance, China is fast becoming a formidable force in the global nuclear energy industry. However, the country has struggled to achieve a balance between its stated desire for self-reliance and domestic production and its relatively limited technological capabilities. This has led to a strategy of engaging western vendors in order to accelerate its ability to strengthen its reactor design capability and to improve the safety standards of its commercial reactor fleet.

China's nuclear energy development vision has placed a strong emphasis on self-reliance. Their notion of self-reliance entails building capabilities to establish a fully integrated domestic supply chain, including self-reliance for reactor design, with the long-term objective of exporting nuclear reactors to a global marketplace. However, technology development has been a major challenge for the Chinese nuclear sector, where a select number of state-owned nuclear companies long struggled to develop advanced reactor technology based on older reactor imports—mainly from France, but also from Russia and Canada. The lack of an authoritative research and development (R&D) institution, combined with the inability of China National Nuclear Corporation to effectively coordinate nuclear research across the sector, impeded China's technology adoption.[46]

In fact, China's tendency to build older-design reactors has become a particular concern in light of its aspiration for robust fleet expansion. These older "Generation II" design reactors were originally developed in the 1960s, and do not include many advances (for example in areas such as safety, fuel technology and thermal efficiency) that now come with newer generation reactors—the so-called Generation III or III+—that were developed in the 1990s and are being built around the world today.

It was this Chinese frustration that led the State Council to establish the State Nuclear Power Technology Corp. (SNPTC) in May 2004 as the major contractor for foreign suppliers and to approve to source Generation III nuclear technology from overseas through an open bidding process.[47] After a year-long evaluation, SNPTC selected AP-1000 reactors.[48] Among the key reasons was that AP-1000's small-modular construction may allow for rapid construction and better cost control as well as a greater degree of localization.[49]

Construction of the Gen III+ pressurized water reactor (PWR) began in 2009 at the Sanmen site in Zhejiang province and at the Haiyang site in Shandong province. The sale of AP-1000 reactors included a technology transfer agreement that has allowed SNPTC to acquire over 75,000 technology transfer documents from Westinghouse since 2010.[50] The Sanmen Unit 1 is slated to be the first operational AP-1000 reactor in China and in the world when it comes

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[45] Ibid.
[46] Zhou, Y., et al., *Is China Ready for its Nuclear Expansion*? *Energy Policy* (2010), doi: 10.1016/j.enpol.2010.10.051, p.2.
[47] World Nuclear Association, *Nuclear Power in China*, updated April 2014.
[48] World Nuclear Association, *Nuclear Power in China*, updated March 21, 2013.
[49] World Nuclear Association, *Nuclear Power in China*, updated March 21, 2013.
[50] Westinghouse Electric gives reactor documents to China, E&E Wire, November 24, 2010.

online later this decade.[51]
The AP-1000 sale was also a milestone for the U.S. nuclear industry, which gained a significant foothold in China's growing nuclear power sector. According to the Westinghouse documents, each Westinghouse project in China creates or sustains as many as 5,000 jobs in the United States. The prospect for further commercial cooperation remains strong for U.S. nuclear industry stakeholders, at least for the short to medium term, as the Chinese strive to improve their learning curve for advanced reactor manufacturing and deployment. Reportedly, China has eight new AP-1000 reactor units planned at the Sanmen and Haiyang sites[52] and several dozen additional AP-1000 units proposed for construction.[53] U.S. vendors, including Westinghouse, are expected to be involved in the future AP-1000 projects in China.

Deepening Safety and Regulatory Cooperation

According to a nuclear safety aphorism, "A nuclear accident anywhere is an accident everywhere." Fukushima has rightly heightened the need for higher safety standards around the world, including in China. There has been concern both within China and internationally about the growing gap between the rapid pace of Chinese nuclear expansion and the country's institutional capacity, both in terms of regulatory framework and human resources. Specifically, China's nuclear regulators are regarded as lacking sufficient authority and independence to effectively regulate the growing nuclear fleet. The regulatory body is also woefully understaffed and under-experienced. In this light, bilateral cooperation in the area of nuclear safety and regulations has become an important area of civilian nuclear energy cooperation between the two countries.
The Protocol between the U.S. Nuclear Regulatory Commission and China's National Nuclear Safety Administration on Cooperation in Nuclear Safety Matters, signed in 1981, governs cooperation on regulatory matters concerning civilian nuclear power plants such as assessment and inspection of construction, operation and decommissioning, emergency preparedness and radiation protection through the exchange of information and specialists, as well as collaborative research and joint seminars.[54] Personnel training by the U.S. Nuclear Regulatory Commission (NRC) has been a significant part of this engagement. Chinese regulators are allowed to accompany U.S. inspectors on operating reactor and reactor construction inspections in the United States, as well as participate in NRC staff training at the NRC's facility in Tennessee.[55] For example, under the auspices of the NRC Assignee Program, which provides foreign regulators with hands-on training in the United States for six to twelve months, the NRC has trained several Chinese regulators.[56]

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[51] Sanmen Unit 1 was originally schedule enter operation by the end of 2014. But, according to a Chinese presentation at the International Atomic Energy Agency technical meeting, the construction is said to be at least 24 months behind and 20 percent over budget. (Shan Sun, "Challenges during construction of new NPPS," at the IAEA Technical Meeting, February 4-7, 2014. http://www.iaea.org/NuclearPower/Downloadable/Meetings/2014/2014-02-04-02-07-TM-INIG/Presentations/37_S7_China_Sun.pdf)
[52] Matthew Miller, "China seen buying Westinghouse reactors for $24 billion nuclear energy projects," Reuters, April 21, 2014. http://www.reuters.com/article/2014/04/21/china-nuclear-idUSL3N0ND1GS20140421
[53] World Nuclear Association, *Nuclear Power in China*, updated April 2014.
[54] *Protocol between the Nuclear Regulatory Commission of the United States of America and the National Nuclear Safety Administration of the People's Republic of China on Cooperation in Nuclear Safety Matters*, signed in 2008. This protocol was amended and extended in 1986, 1993, and 1998 and renewed in 2004.
[55] Ibid.
[56] *Multinational Design Evaluation Programme Annual Report March 2011 – March 2012*, June 2012, Nuclear

Furthermore, with the Chinese approval of the AP-1000 reactor, nuclear regulatory cooperation has become a two-way street. The sale of Westinghouse AP-1000 reactors to China in 2007 ushered in a new era for regulatory engagement between the United States and China. China's decision to begin constructing the U.S.-designed advanced reactors ahead of the NRC design certification[57] provides U.S. regulators with an opportunity to learn from the Chinese experiences, which could improve their regulatory expertise concerning future AP-1000 reactor units in the United States, including the four units that received NRC approval for construction and operation in 2012. For example, during 2011-2012, two NRC resident inspectors visited China for three months and another inspector visited China as a technical reviewer for one month to engage about lessons learned from ongoing AP-1000 construction at the Sanmen and Haiyang sites.[58] During the U.S.-China Strategic and Economic Dialogue meeting in July 2013, the two governments formally reaffirmed their mutual interest in deepening personnel exchange and sharing expertise on AP-1000 construction and licensing.[59]

U.S. and Chinese regulators also cooperate through the AP-1000 Workshop Group under the Multinational Design Evaluation Programme (MDEP)[60] that is designed to facilitate safety reviews of the AP-1000 design, including sharing of design information, application documents, and preliminary findings, as well as identifying significant review issues.[61] Additionally, the participating regulators have shared information on their construction experience and how lessons from the Fukushima accident could be applied and affect their review of the AP-1000 design.[62]

Continued Government Cooperation over Nuclear Energy Technology

The U.S. and Chinese governments also cooperate on nuclear energy technology. The research and development (R&D) cooperation in this area allows for multiplier effects in funding and human resources that may otherwise be limited or are often too vulnerable to fluctuations in public support, as well as to advance the state of nuclear energy technology through synergizing one another's expertise or comparative advantage.

For example, under the "U.S.-China Peaceful Uses of Nuclear Technology Agreement," signed in 1998, the United States and China are currently focusing on technology matters related to the current fleet of operational reactors. Since the Fukushima nuclear accident, cooperation has been renewed on probabilistic safety assessment (PSA),[63] which in fact is one of the areas

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Energy Agency, p. 19.

[57] The NRC certified the AP-1000 design at the end of 2011.

[58] *Multinational Design Evaluation Programme Annual Report March 2011 – March 2012*, June 2012, Nuclear Energy Agency, p. 19.

[59] U.S.-China S&ED Outcomes of the Strategic Track, July 13, 2013. http://www.china.org.cn/business/2013-07/13/content_29412960_5.htm

[60] Spearheaded by the Nuclear Energy Agency, this program was established in 2006 to leverage the resources and knowledge of the national regulatory authorities that are or will be tasked with reviewing new reactor designs.

[61] *Multinational Design Evaluation Programme Annual Report March 2011 – March 2012*, June 2012, Nuclear Energy Agency, p. 19.

[62] Ibid.

[63] Suzhou Nuclear Power Research Institute, *The Fourth Conference on U.S.-China Peaceful Use of Nuclear Technology and Cooperation in Probabilistic Safety Assessment Cooperation as Held Successfully (zhong mei he ping li yong he ji shu he zuo he dian gai lv an quan fen xi di si ci yan tao hui shun li zhao kai)*, October 29, 2012,

identified by the Chinese government for improvement after the nation-wide reactor safety inspection. Specifically, this cooperation has yielded several PSA workshops under the technical leadership of the Argonne National Laboratory that helped the Chinese engineers to improve their understanding of risk that is informed by decision-making methodologies.[64]

More advanced and longer term cooperative R&D in nuclear energy technology is carried out under the auspices of the U.S.-China Bilateral Civil Nuclear Energy Cooperative Action Plan, signed in 2007. Designed to "explore advanced nuclear fuel cycle approaches in a safe, secure and proliferation-resistant manner,"[65] the two countries cooperate in the areas of advanced fuel cycle technology, fast reactor technology, and small and medium reactors.[66] Also, the two countries undertake R&D cooperation under the auspices of the bilateral memorandum of understanding on "Nuclear Energy Sciences and Technology Cooperation."

Additionally, the two governments are engaged in several multi-lateral nuclear energy cooperation fora, such as the GEN IV International Forum and the International Forum for Nuclear Energy Cooperation.

Implications for the United States: Benefits and Challenges of Cooperation

To the Chinese leadership, the expansion of nuclear power generation is a politically practical and economically viable means of moving the country away from its heavy coal dependence and attendant air pollution. China's commitment to growing its nuclear power generation is independent of U.S. action—for example the level of U.S. government support for nuclear energy or the degree to which the U.S. nuclear industry is interested in working with China. Nonetheless, cooperation with U.S. regulators and the U.S. civilian nuclear science and technology community and industry has significantly helped China narrow the gap between its robust expansion of nuclear power and its institutional and technological capacity deficit.

In turn, the enhanced nuclear regulatory capacity in China through cooperation with and assistance from U.S. regulators is in a concrete benefit to the U.S. public—i.e., the safety of U.S. nationals residing in and traveling to China as well as U.S. economic interests there. Also, Chinese success in diversifying its electricity supply mix and burning less coal would be a clear benefit for the climate. Additionally, nuclear energy technology cooperation is one valuable way for the United States to foster and preserve its domestic expertise through the access to financial resources and S&T expertise of its cooperation partner in exchange for contributing its resources and expertise. Furthermore, the active reactor build-out involving U.S.-based design provides U.S. regulators and engineers with first-hand observations and exposures that may otherwise be limited in the United States.

Bilateral cooperation is not free of challenges, both real and potential. China's industrial structure and lower manufacturing costs will likely turn the country into a fierce competitor to the U.S. nuclear industry when—rather than if—the Chinese successfully "indigenize" Gen

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http://www.360doc.com/content/12/1105/08/4609583_245795800.shtml

[64] "The Fourth Conference on U.S.-China Peaceful Use of Nuclear Technology and Cooperation in Probabilistic Safety Assessment Cooperation as Held Successfully" *(zhong mei he ping li yong he ji shu he zuo he dian gai lv an quan fen xi di si ci yan tao hui shun li zhao kai)*, Suzhou Nuclear Power Research Institute, October 29, 2012, http://www.360doc.com/content/12/1105/08/4609583_245795800.shtml.

[65] United States-China: Bilateral Civil Nuclear Energy Cooperative Action Plan, p. 3. http://www.nti.org/media/pdfs/1a_1_1.pdf?_=1317157933

[66] Ibid., p. 5.

III/III-plus technology. In fact, the Chinese nuclear sector is accelerating efforts to develop and deploy large advanced PWRs based on the AP-1000 reactor. This initiative, identified as one of the 16 "national projects" under China's Medium- and Long-Term National Science and Technology Development Plan (covering 2006-2020),[67] led to the development of advanced PWR named CAP-1400 by SNPTC and Shanghai Nuclear Engineering Research and Design Institute (SNERDI).

With its basic design approved by the Chinese government in early 2014, at least one CAP-1400 reactor unit is slated for construction later this year and targeted to come online in the 2017-2018 timeframe. More significantly, the Chinese do not intend to keep these reactors at home. According to various Chinese statements and media reports, CAP-1400 intellectual property rights reside with the Chinese entities, referring to their agreement with Westinghouse half a decade ago that reportedly gave the Chinese domestic rights to much of the core AP-1000 derivatives over 1,350 MWe. Some questions that may arise from this development include whether there is an intellectual property rights concern and, if a dispute arose in the future, how it would affect the future scope of bilateral commercial engagement.

The Chinese nuclear market was too attractive for Westinghouse not to market its most advanced reactors, even at the price of extensive technology transfer that would bolster the technological competitiveness of Chinese vendors. Moreover, U.S. industry participants knew that even if the U.S. vendor stayed away, China would have acquired Gen III reactors from other suppliers. The sale of EPRs by Areva of France to China is a case in point: in 2007, Areva won a contract to supply two units of EPRs to be built at Taishan in Guangdong province.

Westinghouse is believed to have decided that there was more to be gained than lost by establishing a presence in China's nascent yet growing market. In fact, the AP-1000 sale has accorded the U.S. nuclear industry not only financial gains but also valuable insights into the capacity of Chinese nuclear sector, such as the maturity level of its supply-chain and various non-hardware capabilities, that may otherwise be inaccessible.

Whether nuclear energy cooperation in the commercial sphere could yield greater long-term challenges than advantages to the U.S. economy is a question that has no simple answer. The globalization of civilian nuclear capabilities renders the task of quantifying the exact scope of economic benefit to the U.S. nuclear sector remarkably challenging regardless of the pace of successful "indigenization" by the Chinese nuclear sector. In fact, the supply chain for nuclear projects in China had globalized since before the May 2013 announcement by Westinghouse to launch a joint venture with SNPTC to develop a global supply chain for the AP-1000 reactors. For example, the equipment and components for the initial four AP-1000 units in China include pressure vessels from Doosan of South Korea, steam turbine generators from Mitsubishi Heavy Industries of Japan, steam generators from ENSA of Spain, as well as reactor coolant pumps by Curtiss-Wright of the United States. Also, under a $35 million contract, signed in 2011, Westinghouse will begin technology transfer to China Baotou Nuclear Fuel whereby the company will "design, manufacture and install fuel fabrication equipment that will enable China to manufacture nuclear fuel" for AP1000 units being built in China.[68] While the

[67] Ministry of Science and Technology, "Zhuanxiang Jieshao". http://www.nmp.gov.cn/zxjs/ [accessed April 15, 2014] This plan aimed at enhancing economic productivity and national security using science and technology.
[68] "Westinghouse in Contract to Provide Fuel Fabrication Equipment to China," PRNews, January 18, 2011.

Westinghouse announcement strongly indicates that China Baotou's facility will supply only to AP-1000 units in China, it remains unclear whether the Chinese would be explicitly barred from supplying fuels to future AP-1000 reactor units in the United States or elsewhere outside China.

The increasingly globalized supply-chain, however, does not negate the need for U.S. regulatory expertise or undermine the value of bilateral cooperation. In fact, such globalization could heighten the stake of U.S. nuclear regulators and industry in the qualitative aspects of the Chinese nuclear industry development. According to the World Nuclear Association, the number of Chinese manufacturers of nuclear-grade components that are accredited by the globally recognized American Society of Mechanical Engineers grew from only six at the end of 2009 to 26 by the end of 2011.[69] Moreover, globalization could accelerate to expand a range of Chinese supplies for nuclear power plants in the United States. For example, if the aforementioned fuel fabrication technology transfer to China leads to Chinese supplying nuclear fuels to future AP-1000 in the United States, U.S. nuclear regulators would have a vested interest in ensuring that fuels meet its technical perimeters as fuel integrity is the first line of defense for safe operation of nuclear power plants.

The modernization of Chinese nuclear reactor fleet—facilitated by growing U.S.-China cooperation—is improving nuclear safety and in turn affirming the viability of nuclear energy as a fossil alternative in China. Moreover, engagement with China's growing nuclear sector gives the United States valuable opportunities to further its regulatory and nuclear engineering expertise. Nuclear energy technology cooperation between the U.S. and Chinese nuclear sectors goes hand-in-hand with robust cooperation between nuclear regulators from the two countries. Both are indispensable if bilateral nuclear energy cooperation is to be sustainable as much as if nuclear energy is to remain part of the national energy mix for the United States and China, respectively.

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http://www.prnewswire.com/news-releases/westinghouse-in-contract-to-provide-fuel-fabrication-equipment-to-china-114162809.html. Note that Westinghouse is to supply the initial fuel load and some re-loads of the initial four AP-1000 units in Sanmen and Haiyang.

[69] World Nuclear Association, *Heavy Manufacturing of Power Plants*, updated January 2014.

PANEL II QUESTION AND ANSWER

COMMISSIONER WESSEL: Thank you, all, for being here, and thank you for loaning a staffer for the day, Ms. Forbes. The government can use all the help we can get so thank you.

President Obama in one of his early State of the Unions talked about the promise of green jobs. And earlier I talked about the moral issue that exists in China. We have a duty to help them in terms of ensuring cleanliness, energy efficiency, and utilization of renewable and other alternative energy sources.

So we have to separate the two issues, but they should also be connected. When I look at a number of the clean energy areas and the development of China, we are certainly helping them on their path, but we're also in some ways putting U.S. jobs at risk. I'd like you to challenge me if you would like.

For example, in the nuclear sector, Ms. Nakano, you talked about Westinghouse design, but, in fact, much of the production of those facilities is taking place in China. As I understand it, the containment facilities are, in fact, I believe, Japanese produced, also because we haven't produced a containment facility here in so long that we have few N-class certified producers. As part of the cooperative efforts, we are going to help China become N-class certified, which one would want for the safety and security of those facilities.

We've helped in the development of solar energy, and, as you know, there have been trade cases on the solar chips and panels here. We have helped, as we should, in the development of wind energy, and now we see the importation, not only of blades, nacelles, full turbines, but wind towers, which one would see as a totally uneconomic sale, as it's a huge effort -- you can probably do two or three of them on a major containment container vessel.

How can we square the desire to address China's moral concerns, world concerns, and understanding that we do want to help China in terms of its development level, while also wanting to make sure we share more in the job manufacturing renaissance that should be happening?

How do we make sure that the promise of green jobs is actually achieved here, and what are we doing right or what should we be doing better with China?

I'll take you down the road. Ms. Nakano, do you want to start?

MS. NAKANO: Sure. Thank you so much for the very important question.

As you mentioned, there are many nuclear components and equipment that are going into the current four units that are being built in China that came from places other than the United States.

But it's not just all Chinese. There are some Japanese and Korean components and equipment. Also, Curtis- Wright of United States provides the coolant pumps. According to some of the earlier presentations by Westinghouse that I was able to get a hold of, the project in China creates about 5,000 U.S. jobs.

I'm not sure what the status is as of today, but I understand that companies like Chicago Bridge and Iron, which has the engineering expertise, has roughly a hundred people at each of the sites, sharing expertise and ensuring that the construction goes smoothly.

Again, it really is difficult to measure its progress or success, but I do share your concern that it has been one of the challenges for the U.S. nuclear industry to revitalize its supply chain.

Some of the data that I was able to find suggest that the number of N-stamped manufacturers, the manufacturers of nuclear components and equipment that are certified by the American Society of Mechanical Engineers, at one point went down substantially. —I am sorry

that I don't remember the precise number. But, the number of N-stamped manufacturers has bounced back notably since around 2008.
But what matters obviously is how the U.S. industry is performing relative to how the Chinese industry is performing. Meanwhile, the Chinese respect what the NRC does and the U.S. regulatory standards, and they have been engaging the ASME and the number of ASME accredited Chinese nuclear manufacturers has increased from about six in 2009 to 26 by the end of 2011.

Therefore, while the U.S. supply chain is becoming revitalized, when viewed in comparison to the Chinese supply chain maturity pace, it's not happening fast enough. So, I do share your concern, and I'm not sure exactly what will be the silver bullet.

However, I think having continued involvement in Chinese projects through the AP-1000 will keep creating more jobs in the U.S. The question then is what is next once the Chinese successfully indigenize advanced reactor technologies and start building. What would be the share for the U.S. industry? We will have to see how it goes.

Thank you.

COMMISSIONER WESSEL: Ms. Forbes? Dr. Lewis?

MS. FORBES: I'll keep my comments very brief. In my written testimony, I referenced a report some of my WRI colleagues wrote that was called "Delivering on the Clean Energy Economy," and they looked specifically in that report at the wind energy industry across a series of economies and what were the factors that led to the deployment that you saw. Of the five countries they looked at, the U.S. was the only one that's maintained a long-term trade deficit.

And what that research found was that that was largely a result of uncertainty in the longevity of policies that support wind energy in the U.S.

COMMISSIONER WESSEL: PTC, RES.

MS. FORBES: Exactly.

COMMISSIONER WESSEL: Right.

MS. FORBES: And the other countries also did a little bit more on providing policies, too, throughout the full cycle of wind energy, whereas the U.S. is, you know, more just the PTC.

COMMISSIONER WESSEL: Right.

MS. FORBES: And I'll be happy to send a copy of that report--

COMMISSIONER WESSEL: I'd love to see it.

DR. LEWIS: I think this is a great question, and I don't see a direct conflict between U.S. jobs and clean energy and helping China promote clean energy there, and I think we need both.

As an example of this, China has used more wind power than any other country in the world at this point, but they're having some real problems making sure that the wind farms they've actually built are actually generating electricity, working efficiently, that electricity is going into the grid.

COMMISSIONER WESSEL: Right.

DR. LEWIS: China has less than ten years of experience building wind farms. The U.S. has 30, 40 years--right--so in fact, there's a lot of jobs for U.S. companies that can help China with the operation, maintenance, and a lot of the things that go into actually designing and developing these wind farms.

In the solar industry, for example, you know, the U.S. has really pioneered the solar installation business model. If you look at the solar value chain, a lot of the money in putting in

place solar systems in homes and commercial buildings is really in the installation side. You need local people to get up on the roofs to install these things, and that's where there are many, many jobs.

So I think that when we look at aspects of the supply chain, we really need to look at this globally. These are global supply chains. No one technology is being made in any one country, whether it's a blade or a tower; and the same goes for the jobs.

There's all these different pieces, and even a U.S. company has a global supply chain, like a GE, so I think we need to look comprehensively at where the U.S. can really have an advantage.

And I think that I would end by just actually echoing what Ms. Forbes just said about the U.S. policy environment. I think one of the most detrimental things to the U.S. clean energy industry and technology companies has been the volatility of U.S. support for clean energy.

COMMISSIONER WESSEL: Agree.

DR. LEWIS: As opposed to competition for elsewhere.

COMMISSIONER WESSEL: Okay. If there's another round, please. Thank you.

HEARING CO-CHAIR CLEVELAND: Commissioner Wortzel.

COMMISSIONER WORTZEL: Thank you all for your testimony here today.

I'm going to ask a question really directed to all three of you, and the answer may be a negative.

I'm trying to gauge the political support inside China for some of the programs you've discussed. So when there is serious political or diplomatic turbulence between China and the United States, such as over China's actions against Japan in the Senkaku Islands or against the Philippines, has the Chinese State Council slowed or disrupted any of the programs you've discussed?

DR. LEWIS: You're asking whether there is a direct link between these types of security issues and the clean energy programs?

COMMISSIONER WORTZEL: Right. You've discussed a range of programs that are important to China and the United States, and in other areas when there is serious diplomatic and political turbulence, the State Council tends to intervene.

So I'm asking whether that has occurred in the programs you've discussed?

DR. LEWIS: To my knowledge, the clean energy space is happening somewhat independently of these other decisions. I think one of the things that the Chinese leadership has done well in this sector is that it has kept a pretty stable clear policy signal in the clean energy space, driven by not just national laws and policies, but mandates that go from the center all the way down to the local level.

MS. NAKANO: I do echo Dr. Lewis' observations. Westinghouse is majority owned by Toshiba of Japan, but clean energy, including the development of nuclear energy, is so essential for the regime stability in China as an enabling tool for the current leadership to address the air pollution problem that the current bilateral tension between China and Japan has not disrupted the AP-1000 cooperation. I think that the Chinese are greatly committed to the nuclear expansion.

Thank you.

HEARING CO-CHAIR CLEVELAND: Commissioner Shea.

CHAIRMAN SHEA: Thank you. Thank you, all, for being here.

I just want to get on the record first that we need more Chinese buying more Kentucky and West Virginia coal so let's get that--

HEARING CO-CHAIR CLEVELAND: Clean coal technology.

CHAIRMAN SHEA: Clean coal technology, too. Thank you.

So let's talk about solar. China started out, as I understand it, wanting to dominate the solar manufacturing market, the manufacturing of solar products. That was their initial focus. Now, they're seeking to deploy more solar. What is the percentage of solar power to overall power in China?

How would you assess the seriousness of deploying solar, solar technologies and solar power, in China?

DR. LEWIS: I'm happy to take that. In terms of overall percentage, solar power is still contributing less than one percent of China's electricity generation, but China installed more solar last year than any other country has ever installed in one year anywhere in the world.

So I think we've seen a real shift in what the Chinese government is doing to promote solar domestically. You're absolutely right that up until a couple years ago, almost all of the solar that was produced in China was for export.

CHAIRMAN SHEA: Right.

DR. LEWIS: But there's been a real shift in that and a really serious scale-up domestically, I think, for a variety of reasons.

CHAIRMAN SHEA: Okay. Let me ask you--thank you. Let me ask Ms. Nakano about nuclear facilities. You know, when I first read about that Toshiba-Westinghouse deal when they turned over--what--75,000 records and handed over the technology, I said what are these guys doing here? This is crazy. But you're suggesting it's much more nuanced and unclear what the prospects will be from a competitive standpoint going forward.

Do the Chinese export nuclear reactors, nuclear technology? Do they have a branding issue, branding problem?

MS. NAKANO: Thank you for the question. Chinese have exported reactors to Pakistan.

CHAIRMAN SHEA: Right.

MS. NAKANO: That has been the extent of their global marketing or global export activities. However, very recently, within the last three to six months, I think that the Chinese agreed to export one or two additional units to Pakistan.

I think this step is part of their long-term nuclear energy vision of developing a full supply chain, including the ability to export. I think that the Chinese are counting on their ability to successfully indigenize the Western technologies to significantly improve their branding, not just image-wise, but the quality of reactors.

But so far what they are exporting, to my knowledge, are not as advanced as what were developed in the 1990s by internationally competitive and established vendors, like Westinghouse or a French vendor.

For that reason, it will be interesting to see how some of the markets or the governments from the less-developed economies may undertake the cost/benefit calculation--

CHAIRMAN SHEA: Right.

MS. NAKANO: relative to an option to buy reactors that are not technologically advanced but could be cheaper than the reactors by more established suppliers.

CHAIRMAN SHEA: Okay. Thank you.

Now, China has this official policy to move more to renewable energy, increase nuclear, increase natural gas, less dependence on coal. Coal is about 70 percent of the energy consumption in China, and the rest make up the difference--renewables, about 15 percent;

nuclear, two percent; natural gas, somewhere in there.

But as the Chinese economy continues to expand, you know, it's still expanding at seven percent, 7.4 percent a year, even though there's been a downturn, and as it continues to expand, the energy needs will be significant, and so I see this sort of expanding pie. While you can have 70 percent coal now or fossil fuels today, but if the pie becomes larger, and you have 50 percent, it's still more than the 70 percent, you know, six years ago.

So to me, if your goal is to move from fossil fuels, it seems almost impossible to reduce the aggregate level of greenhouse gas emissions if you are trying to continue to grow your economy. Am I off the mark there?

DR. LEWIS: I think this is a really important question, but I think the one piece of this that you didn't mention is energy efficiency.

CHAIRMAN SHEA: Right.

DR. LEWIS: You know, China, between 1980 and 2000, they were able to quadruple their GDP and only double their energy use, which is actually--that meant that their energy intensity, the ratio of energy to GDP, declined more rapidly than any other country did over that timeframe.

If China's energy intensity had remained frozen where it was back in 1978-1979 before opening, they would be using more than four times the energy they're using today. So I think that they need to do all the things that you mentioned to continue to use low carbon sources of energy, but I think until you can actually bring down and slow demand, and make, as you said, the total pie smaller, it makes it hard to even, as you scale up all of these things in a really big way, it's hard for them to represent a large share. But the good news is that they are trying to do that as well.

MS. FORBES: I would just like to add that most of the projections that the International Energy Agency and others put do show a role continuing for fossil energy in China for the future.

However, there's also an active discussion ongoing right now about, within China as well as within academics and the international community, about when will coal use peak in China and when will emissions peak? And that's a very active and a very real discussion happening right now, and something that is being actively discussed, not just by think tanks but by energy leaders and academics in China as well.

CHAIRMAN SHEA: Okay. Thank you.

HEARING CO-CHAIR CLEVELAND: Commissioner Fiedler.

COMMISSIONER FIEDLER: A quick question on--I think it was you, Dr. Lewis, or maybe it was you, Ms. Forbes, talking about the coal classifier, and how the U.S. didn't adopt it, and the Chinese did, and it actually--which I'm willing to accept that power companies in the United States are less than fully intelligent, which is the implication. But I think the real reason might be that they operate more efficiently, currently, and the Chinese inefficiency, the impact and gain by the classifier use in China was higher and therefore more cost efficient.

But now, by saying the U.S. companies then used it gets to the point of it that it was, in fact, more than marginally useful for them to reduce emissions in the United States. Is that fair?

MS. FORBES: So--

COMMISSIONER FIEDLER: Rather than the Chinese were smarter?

MS. FORBES: I did not mean to imply that Chinese were smarter than the U.S. companies. In the U.S., often the power sector is relatively risk averse, and the technology

that's not been demonstrated on a power plant is often not that attractive. The classifier was installed as part of a research effort, and so it was demonstrated in research, and now it's being marketed to companies and plants in the United States.

I'm not sure if it's been installed yet so--

COMMISSIONER FIEDLER: Oh.

MS. FORBES: So the devil is always in the details, and it's important to be careful, but I think it's a tremendous example of how bilateral collaboration between the U.S. and China on a range of technical issues can result in direct benefits here in the United States.

COMMISSIONER FIEDLER: If I caught you correctly, someone correctly, on the AP-1000 Westinghouse., The Chinese approved it, bought it, prior to NRC approval in the United States, which was, I suppose, a modest risk of sorts for them; right?

And then how long after before the NRC approved it?

MS. NAKANO: It was in 2007 that the Chinese purchased Westinghouse AP-1000, and I believe it was December of 2011 that the NRC issued the design certification to the AP-1000.

COMMISSIONER FIEDLER: And because I don't understand and because I think it's important, the Fukushima experience is having what effect on either--you then had the CAP-1400, I think it was, and, you know, you're going to build 29 of these things. You got a bit of a risk problem if there was something you weren't thinking about, and it's not as if Japan is an unsophisticated country.

So there were some serious mistakes made in that planning, and it must have impact worldwide on the nuclear market. I think it is having an impact in the United States on development.

MS. NAKANO: Yes. China took the Fukushima lessons quite seriously. Immediately after the Fukushima nuclear accident, the Chinese government stopped the approval of the new construction, and undertook the inspection of operational reactors nationwide. There were only about 11 units online at the time, but nonetheless the Chinese inspected them all.

China also did update its nuclear safety plan. One of the highlights of the new nuclear safety plan, I believe, is the government call for the faster phase-out of older design reactors within China.

In essence, the Chinese are still committed to the very robust build-out of the civilian nuclear reactor fleet, but they started considering qualitative issues more seriously. For example, the Chinese government expanded the size of regulatory staffs at the Chinese nuclear regulatory authority called National Nuclear Safety Administration.

On the technology front, , I am not aware of any pause to R&D activities for initiatives such as CAP-1400 reactors. I believe that the Chinese kept CAP-1400 development on course throughout the safety review period. CAP-1400 design is based on AP-1000 design, which has advanced passive safety reactor design features—minimal reliance on human intervention to cool down the reactor—that can address or mitigate many of the issues that contributed to the Fukushima nuclear accident.

So the Chinese learned lessons from the Fukushima. While China is still committed to nuclear expansion, there have been qualitative improvements to the Chinese nuclear power program since Fukushima.

Thank you.

COMMISSIONER FIEDLER: Thank you.

HEARING CO-CHAIR CLEVELAND: Commissioner Tobin.

COMMISSIONER TOBIN: Thank you.

I wanted to explore that topic, too, the post-Fukushima situation. I think you've handled that question well but perhaps you could, give us your critical assessment of the strengths and weaknesses today of the Chinese regulatory system.

We, the U.S., have been regulating for a long time in other arenas and locations. We know that China's regulatory system is not as robust, and Japan, too has regulated their industry for a long time. So I'd like you to comment on that, and then I'll come back with one other question for the other two witnesses.

MS. NAKANO: Thank you so much.

I think that the challenges associated with China's regulatory framework or apparatus can be put into two different categories. One is more of an institutional challenge in that China is yet to have an atomic energy law that clearly stipulates what their vision is and how they carry out R&D, for example.

Also, China lacks a nuclear liability law. Liability issues are currently addressed through a decree, and some of the international vendors that are interested in marketing their reactors to China do wonder whether a decree would provide them protection as similarly effective as a liability law. This issue can affect a vendor's determination as to whether or not to supply a reactor to China.

Also, the second category is--

COMMISSIONER TOBIN: Can you say more on that?

MS. NAKANO: Sure.

COMMISSIONER TOBIN: They do not have--

MS. NAKANO: Law.

COMMISSIONER TOBIN: Liability law.

MS. NAKANO: Yes. So it's a decree. A law would have to be legislated by the Chinese parliament and, in our thinking, would have standing in a court. But, a decree is something that will be issued by the State Council. I think that some companies do view this liability decree as something that has sufficient standing in the Chinese system, but the validity of such an assumption hasn't been tested because there hasn't been a nuclear accident in China. Knock on wood. So this is a risk that some companies think are too big.

COMMISSIONER TOBIN: And it's a risk for the company, but a risk for the people.

MS. NAKANO: Right. Yes, risk for the people. But, for a company that may supply reactors, whether the financial responsibility resides with the operator versus reactor vendor is determined under the decree now as opposed to law is a major issue.

COMMISSIONER TOBIN: Do you think that will change?

MS. NAKANO: I'm not sure if they have immediate interest in changing because many international vendors except probably the U.S. vendors, like Westinghouse and GE, have such strong state support. Basically nuclear is sovereign business in the case of French or Korea, so suppliers from these countries go in with political backing from their home government. They might perceive liabilities differently from fully commercial and market-based operators--I'm sorry--vendors or providers would.

COMMISSIONER TOBIN: Thank you.

MS. NAKANO: Yes.

COMMISSIONER TOBIN: Should I wait till the next round?

HEARING CO-CHAIR CLEVELAND: Can I just add on that? This is a problem in terms of the liability issue. It's not unique to China. The same issue pertains in other countries where we are competing against the French and others to go into the market. I mean I recall it

was true in Russia that there's a lack of liability law virtually everywhere in terms of this differentiation between operator versus vendor responsibility.

Is that accurate?

MS. NAKANO: I'm actually not as familiar with how the Russians deal with the liability issue. What distinguishes the Chinese case is that in the case of say France or Russia, they produce and they market their reactors domestically. So it becomes a concern only when they want to go into a third country.

In case of China, they have this aspiration to become a civil nuclear power, and once they start exporting, their policy or their approach may look more similar to that of a French vendor or a Russian vendor than to that of the U.S.

I don't know if I answered the question.

HEARING CO-CHAIR CLEVELAND: Commissioner Tobin, go ahead. I'm sorry. I didn't mean to interrupt. I was just--

COMMISSIONER TOBIN: Okay. Collectively, we will be reading your testimony again, thinking about the implications of what you've said here today, you and the other witnesses, and in doing that,we need to think about what this mean? What recommendations do we need to make so, Dr. Lewis, as a scientist, Ms. Forbes, and if you wish to add, Ms. Nakano?You've painted a picture on our bilateral relationship,and talked about strengthening things and making things better.

What do you think we should be pushing Congress to think about going forward? And I do realize, Ms. Forbes, you outlined five actions. So why don't we put this to Dr. Lewis in the interest of time.

DR. LEWIS: Thank you.

I think it's an important question, and I think that at this point, we have some excellent programs on the books. We have all these agreements so I think that it's not just that we need new agreements. We need to make sure that the ones that we have are really sustained, they have firm commitments, whether that's financial, whether that's programmatic, because I think a lot of the challenges we've seen with cooperation historically has come from sort of political backing of these things waning and becoming stronger and fading.

And I think from the Chinese side, where they tend to have a bit more sort of consistency in terms of who's involved in these programs, it can be hard for them to really understand how serious we are on this side.

So I think that now that we have some programs that are working really well, we do want to make sure that we're continuing building upon them. As Ms. Forbes said, strengthening and deepening, I think are the right sorts of adjectives, and we have a good foundation of just scientific exchanges, researchers back and forth of information, but actually moving towards demonstration projects that can involve more U.S. companies, U.S. companies working in China and actually Chinese companies also working in the U.S. I think there are some real obstacles to both of these things that remain.

COMMISSIONER TOBIN: Are there particular audiences that you think have been more up and down in terms of understanding what you've just said within Congress?

DR. LEWIS: I don't know if I could speak to specific audiences, but I think that on the whole I know that the U.S.-China relationship, it's one much bigger than clean energy and climate change, but I think that this is actually one area where our two countries actually have much more in common than not, and there aren't that many topics where that may be the case between the U.S. and China.

So in terms of having a topic and a platform where we can really build trust, strengthen the relationship, and work on projects of mutual benefit, I think clean energy, climate change is really the big ticket item.

COMMISSIONER TOBIN: Okay. Thank you very much.

HEARING CO-CHAIR CLEVELAND: Senator Talent.

COMMISSIONER TALENT: I think one of you testified that China's, 15 percent of their energy supply is renewable. So what is that made up of? What forms of renewable energy make up that 15 percent?

DR. LEWIS: Actually, I believe 15 percent is their target for the year 2020.

COMMISSIONER TALENT: Oh.

DR. LEWIS: So they're not quite there yet, but right now if you look at, they have a non-fossil energy target which is 15 percent by 2020. That will be predominantly hydroelectricity--

COMMISSIONER TALENT: Yeah, I was going to say--

DR. LEWIS: --and then nuclear and then wind, solar and the other renewable--

COMMISSIONER TALENT: Probably mostly hydro because they already have that. And they're not going to be able to expand that.

DR. LEWIS: That's the largest non-fossil energy sphere right now. Yes.

COMMISSIONER TALENT: Yeah. So that does suggest, doesn't it, that they're going to go pretty heavy into nuclear because it deals with their pollution problem. They think they can produce it cheaply. Maybe just address this issue. If they go to the extent they go with solar or wind, they confront higher costs.

I think one of you mentioned regime stability is a huge issue for them. And they're concerned about the slowing economic growth anyway. So doesn't it suggest that they really will push the nuclear side in the belief that they can get both the environmental goals that's so important and then also the economic growth?

MS. NAKANO: Yes, I do think what you just described are some of the key drivers behind Chinese leadership push for nuclear.

According to the U.S. Energy Information Administration's latest or 2013 International Energy Outlook, by year 2040, the share, the nuclear share in their installed power generation would probably go up to seven percent from current share that is between one percent and two percent.

So that's the area. To add to the strengths of nuclear you just mentioned, I think nuclear is also a stable baseload compared to some of the renewables.

And I think there is also a job creation benefit. I actually am not an expert on the number of jobs created by nuclear versus alternative sources, but nuclear expansion also addresses heavy industry manufacturing that the Chinese have been emphasizing.

Having said that, the carbon reduction effect of nuclear will still be a really minuscule share of the total CO2 emissions by the Chinese power sector. So I do not think that nuclear will ever be the silver bullet. However, it does diversify electricity sources. It's not a fossil energy. It addresses the import dependence as well, although uranium import or uranium supply security is something that the Chinese companies are closely watching. They're starting to go abroad.,

I think that the Chinese are pursuing all of the above strategies when it comes to energy. So nuclear is definitely an important component although it's not the silver bullet.

DR. LEWIS: I would just maybe briefly add that in 2012, China actually got more electricity from wind than from nuclear. So nuclear is starting at a very small base.

COMMISSIONER TALENT: Right.

DR. LEWIS: And wind and solar are also growing quite rapidly. I think from a cost issue, it's actually a little bit harder to compare because there's obviously a lot of their costs that go into nuclear power which are not necessarily expressed in the actual tariff itself.

So I think if China can actually address some of the grid integration challenges, and they are building out a much stronger power grid and smart grid technology, this could actually increase the potential of renewables, and so I think even though there's very aggressive targets for all the low carbon technologies on the books, it's maybe not so clear which will win out.

There have been some pretty aggressive studies that have come out that have showed how renewables could reach, for example, 80 percent of China's electricity by 2050. These are obviously optimistic high-end scenarios but technically feasible should they decide to go that route.

COMMISSIONER TALENT: One more question because I think they view the importance of reducing pollution as a huge issue for them in terms of their reputation with the public, and the kind of pollution that they're concerned about I think most is the kind that affects the average person day-to-day, obviously the smog and that sort of thing.

How likely is it that they might continue to produce the coal-producing plants but try and do it in a way that reduces the visible pollution and pollutants? I mean there are cleaner ways of running coal-fired plants. So they might put some money and effort into that rather than going in a non-fossil fuel direction. That's all I have.

MS. FORBES: So I think one of the important things is the local air quality problems. The coal plants contribute to them, but so do vehicle emissions, and a variety of other things. Local air quality is something at the forefront of everybody's mind. If you've been to Beijing recently, it's difficult for our staff in our office there.

I would say we've seen in the shale gas space some of the gas targets have been tied to local air quality, and I think we'll continue to see policies that are designed to improve local air quality and certainly critical.

HEARING CO-CHAIR CLEVELAND: Senator Goodwin.

HEARING CO-CHAIR GOODWIN: Thank you.

Dr. Lewis, a question on the CERC and the Technology Management Plan as it pertains to the intellectual property rights and maybe generated as part of the R&D projects and the clean coal and clean vehicle and building efficiency consortia.

In an article provided as part of our briefing materials that you wrote, you indicated you felt that where CERC has fallen short is in providing a model for true R&D collaboration that generates truly collaborative inventions.

And I note that there have been, to date, no joint patent applications filed between the participants in the various consortia. So my question is where does the Management Plan fall short? Why has it not done enough to change the attitudes and concerns, very justifiable concerns about sharing and collaborating on joint IP and joint patent applications, and why is that important to further the R&D efforts?

DR. LEWIS: Thank you for the question, and you know I can only speak to this as someone who studies this model because I'm very interested in understanding what role something like the TMP can play in facilitating cross-border R&D, and I think that, you know, what the TMP has done very well is really put on paper all of the assurances that you would need to do collaborative research and development, and that was no easy feat. So I think it's an extremely important agreement.

I think that when you have these consortiums with many, many researchers, companies, and others involved, ultimately they're going to make choices that they feel comfortable with, and so I think we're in an environment where this can begin to really build up the trust that is necessary for doing collaborative R&D.

And so even if you have these assurances on paper, it doesn't necessarily mean, you know, a company is going to bring their most sensitive IP into something like the CERC. They're going to have to make that choice based on their own business plan.

So I think that we do see, though, are signs of intellectual property being created through collaborative work, and this is really a new model for doing this. So I think it actually could eventually lead to the types of efforts you mentioned.

HEARING CO-CHAIR GOODWIN: Sure. But you're certainly saying that the lack of sufficient intellectual property protection in China, in your estimation, certainly inhibits full collaboration in these research and development efforts; correct?

DR. LEWIS: Well, I think it's perceived, right.

HEARING CO-CHAIR GOODWIN: Right.

DR. LEWIS: I mean I think actually China's legal protections for intellectual property are getting much better, and part of this has to do with the fact that you now have many Chinese companies that have IP that they want protected, and so this really changes the incentives on the ground, but this will take time, yes.

And so I think that the groups that are part of the CERC are also part of many other activities in China, and so they have to look at this somewhat holistically as just part of their strategy.

MS. FORBES: So WRI is a member of the coal CERC, and I would just like to add that joint patent applications are not the only metric by which to measure how effective this is, and I've had a chance to see firsthand the researchers sit down on an annual, sometimes more often, basis and agree to the annual work plans and see them working together in very real ways on research that may be more basic science, more fundamental in nature, but is ultimately moving towards a common set of goals.

And the information exchange and collaboration exchange is actually quite significant.

HEARING CO-CHAIR GOODWIN: Thank you.

Ms. Forbes, I actually had another quick question for you. In your testimony or perhaps in an article that was also shared with us, you were discussing the deep shale revolution here in the United States.

And as you observed, although it might seem like an overnight success to so many Americans, the reality is that it never could have happened without years, if not decades, of government commitment and government dollars going to support critical research and development, along with subsequent regulatory changes, tax policy initiatives, and so forth.

At the same time, however, you cautioned that the natural gas market itself was structured in such a way that truly facilitated the rapid increase in development once these policy changes were put in place.

So my question for you is participating in CERC, obviously with a keen interest being from West Virginia and the clean coal technology and the advanced coal consortia part of the CERC, what government initiatives, tax changes, regulatory modifications can we make to see a similar and robust development of clean coal technology? And what sort of market obstacles or differences exist between coal and clean coal technology and natural gas and deep shale development that could create challenges in that regard?

MS. FORBES: That's a great question.

HEARING CO-CHAIR GOODWIN: And I just ran over my time.

[Laughter.]

MS. FORBES: I'll get back to you. I'll put some thought to it. I think that, in general, the types of policies, so if we look to the future, and especially tied to the climate scenarios, we're really thinking about carbon capture, utilization, and storage, and we've done a bit of work on CCS, and it probably needs all three types of policies. Both policies that provide incentives that offset the incremental costs, enabling policies like the environmental regulatory frameworks that make it happen, government funding for demonstration, and then ultimately probably policies that go a bit further and facilitate require action, and from a global perspective, that's what we're seeing as effective for CCS.

Regarding the comparison between natural gas and coal, I actually haven't thought about that as much as I should, and I will put some thought to it and hopefully come back to you with a better answer.

HEARING CO-CHAIR GOODWIN: All right. Thank you.

HEARING CO-CHAIR CLEVELAND: This may actually repeat a little bit of what Senator Goodwin mentioned, but in your, I don't think it was your testimony, I think it was the article that was just mentioned, you said that neither country, neither China or the U.S. has invested nearly enough in CCS research and development, nor managed to greatly reduce the cost of its deployment, and neither has done adequate demonstration of CCS nor deployed these technologies at a scale that would meaningfully serve as a solution to mitigate the effects of climate change.

Why not?

MS. FORBES: I'm not sure those are my words, but I will--CCS is--

HEARING CO-CHAIR CLEVELAND: You're right. They're not.

MS. FORBES: Okay. That's okay. That's good that I noticed that. So components of the CCS process are commercially mature, been used since the early 1900s, but really applying it and scaling it up to power plant scale is something that from an international perspective, we have very little experience doing.

If you look at the CCS landscape globally in terms of numbers of projects, the U.S. and China actually stand out as places that there is quite a lot happening, and I think if you look at that in terms of projects that are planned, there is always some uncertainty that some of those projects may not go forward, but we have seen in both countries significant investment, significant research exchange, and a move toward at-scale demonstration.

HEARING CO-CHAIR CLEVELAND: Okay. It was actually--I don't know what the source of it is, but it's something written by Kelly Gallagher, "Moving Forward on Coal and Climate Change."

And in the same article there is mention of the cost of constructing an IGCC plant in China is almost half the cost of constructing in the United States.

What is the sort of state of interest? When I left the World Bank, we were pushing fairly hard for IGCC technology to be introduced, partly because over the long run, it was less expensive. Front-end costs were higher, but over the long run, it was better than the disposable coal plants that we were seeing driven into the ground. So what's the state of play on IGCC, and what's the cost/benefit analysis now?

MS. FORBES: So the GreenGen project in China in Tianjin has been operating. The plans are to look at utilization in the next phase, about 2015. I haven't had a chance to visit that

plant, but I understand it's gone through the tests and has been operating.

In Kemper County in Mississippi, Southern Company, this year, their plant will be running, and I think we're seeing these operational plants that aren't just IGCC, that are actually tying IGCC in with CCS.

HEARING CO-CHAIR CLEVELAND: Right.

MS. FORBES: And there's quite a bit of progress. One thing I think that with respect to costs, first of all, a lot of the costs that we have for IGCC are still based on paper studies which we know are wrong.

Second, the first demonstrations, we know that those costs are also going to be wrong, and I think the real challenge is going to be finding out if Southern Company were to build the Kemper County plant again, what would the costs be?

And from what I understand, the cost would be significantly less so I think we're marching through, and we don't yet know what that nth plant cost is going to be.

HEARING CO-CHAIR CLEVELAND: One final comment. I just want to compliment you on raising a really nice young son because I've asked him whether or not he needs an increase in allowance, and he said, no, and I asked him whether or not he'd like to go on your next trip to China, and he said, no, school won't be out. So I think he's quite a young man so I'm delighted you brought him.

MS. FORBES: Thank you.

HEARING CO-CHAIR CLEVELAND: Anything you want to add?

MR. FORBES: No.

HEARING CO-CHAIR CLEVELAND: Commissioner Wessel.

COMMISSIONER WESSEL: Thank you.

I'd like to go back to a comment or discussion we had a little earlier and also call on the three of you for some help here.

You talked about political support potentially waning in terms of cooperation, et cetera, and earlier we talked about important domestic policies here in the U.S. that if sustained can help in terms of deployment, those being PTC, the Production Tax Credit, RES for the Renewable Electricity Standard, et cetera.

Dr. Lewis, you talked, as many do, and I appreciate that, about how many jobs may be created from taking Chinese produced solar chips and then installing them on U.S. houses or buildings.

When one looks at wind turbines, and certainly there are production, maintenance jobs, installation and maintenance jobs. One of the reasons that support for some of those policies wanes on one side, is because of the question of whether we should be having credits that support business? On the other hand, are we actually getting a bang for the buck?

Many Americans are not as interested in installing chips that, when they turn them over, say "made in China" or putting a wind tower up when it also has the same thing stamped on all of its components.

So I just urge each of you as important policymakers and participants in these that you understand, and to the extent appropriate, argue for or point out the tension in these policies and the question of where the benefits are. That goes throughout.

Ms. Nakano, I point out for Kentucky, which I believe up until last year, was one of the great producers of enriched uranium for a lot of reasons at Paducah for gaseous diffusion. I think more of that--

HEARING CO-CHAIR CLEVELAND: Enriching it. Not producing it.

COMMISSIONER WESSEL: I'm sorry--enriching.

HEARING CO-CHAIR CLEVELAND: Enriching.

COMMISSIONER WESSEL: I'm sorry. Enriching. That's what I meant. As well as in Ohio. You know, what are we going to be able to do to help not only build the facilities in China but also provide the power sources, highly enriched uranium, et cetera?

And all of that is a part of a fabric that hopefully will expand cooperation. So I urge each of you in your policymaking roles, your participation roles, and these international efforts, that you both recognize and share the point of view that, as Tip O'Neill used to say, all politics is local, and that's how many politicians look at it. So I just urge you there, that's one.

Number two, I want to understand from you the limitations from the water side of the equation. China, not only in terms of the amount of water, but also the quality of water, has enormous challenges, and if I look at fracking, I look at nuclear, coal slurry--I'm not sure they do any coal slurry-- that water can be a real limiting part of expanding energy production and utilization in those areas.

Can you tell me whether as part of any of your international work or your review, you see water as a limiting factor? If so, how is China challenging or addressing it? Any of the participants, please.

MS. FORBES: So the World Resource Institute through our China Office, we have a water team, and they've published a report recently on the energy-water nexus and continue to do increasing work.

We also have a program called Aqueduct, and they look at global water risk, and they're finishing up a project that they're looking at the global water risk associated with future shale gas development. And one of the things that we found with respect to shale gas is that of course you have the areas that are water stressed where water availability for fracking will be a problem.

But even in those areas that you might not expect it, the seasonal variabilities can also pose significant challenges if you're really thinking about a real world oil and gas operation.

So the answer to your question, from my perspective, is, yes, I think water is a critically important resource and something that China is really grappling with, especially in the context of growing energy demands.

COMMISSIONER WESSEL: Can you supply those materials to our staff? What is the limiting factor? You can't increase the water supply that much. So what might the limits be on fracking? What might it be on nuclear, et cetera, in terms of their great aspirations, which again we want them to be a cleaner, more efficient energy environment? Are their aspirations going to be limited by water?

MS. FORBES: That's a good question. My work on shale gas is that water is probably a limiting factor for shale gas. I haven't looked at nuclear, and yes, I can follow up with those materials.

COMMISSIONER WESSEL: Great. Thank you.

Ms. Nakano.

MS. NAKANO: On the nuclear side, China, prior to Fukushima, had quite robust build-out plans for plants to be built inland.

COMMISSIONER WESSEL: Right.

MS. NAKANO: But there has been active discussions between the government and the local population about water in that if a plant is not sited along the coast, how would some of the radioactive or polluted water from the reactor be dispersed? They're looking at some of the

U.S. examples as there are a lot of reactors that are built inland in the United States. It seems that they have concluded that water shouldn't be the concern for now, and they will be resuming the construction or the plans to construct them during the next Five Year Plan period, which starts 2016.

If I may quickly address the shale question because CSIS energy program has studied the prospects for shale gas development in Asia, as well. Technology could be a key. From what I understand, within the United States, the amount of water that companies can now recycle is as high as 80 percent up to 90 percent. Obviously, each shale is unique so it's difficult to generalize, and the national average might be a lot lower.

But there are a lot of companies, service companies based in the United States, that are trying to engineer better ways of water usage. If China opens up the market more to really welcome U.S. and Western technology holders to come in, whether in the form of joint venture or not, and work with the Chinese counterparts, I think there's quite a bit that the Chinese can learn from the U.S. experiences.

They will likely have to tweak it to meet their needs, but should be able to see to what extent that the water issue could be solved from some of the existing or the advanced application of the U.S. technologies.

COMMISSIONER WESSEL: Thank you.

Any comment, Dr. Lewis?

DR. LEWIS: Sure. I'll just briefly add, I mean as you may know, China is spending a huge amount of money as well as energy to move water around the country the South-North water transfer project as well as others.

So it's not necessarily that China is water scarce, but there is not water in all the places where it's needed. The question is: is it the right cost/benefit calculation to use all the extra energy to be able to move it to where they need it?

And just briefly, on your first point, I absolutely agree with what you said, but I wanted to clarify, I didn't mean to say that I don't think we should be manufacturing--

COMMISSIONER WESSEL: No, no, I understand. I'm just--

DR. LEWIS: --these technologies here.

COMMISSIONER WESSEL: --saying that there is a tension here.

DR. LEWIS: I absolutely--

COMMISSIONER WESSEL: Right.

DR. LEWIS: --I'm very, very familiar with it, and--

COMMISSIONER WESSEL: Right.

DR. LEWIS: --I appreciate that, and I also think that because these are global supply chains, it's actually really increasingly difficult to even pick up a solar panel that says "made in China" and not know where that technology was invented, where the polysilicon came from, where the cells came from. Often there are many, many countries and companies involved.

Thank you.

COMMISSIONER WESSEL: Understand. Thank you.

HEARING CO-CHAIR CLEVELAND: I now am quoting you, Ms. Forbes, when I'm reading an article that I think you circulated for research that talks about hydraulic fracking and says that although water use for fracturing is modest when compared to total industrial water usage, the incremental increase in water consumption can be locally significant, and you talk about cutting off the water supply in Shaanxi Province during a shale drilling test, but you also note that about 90 percent of the water used for fracking stays underground and is not

recoverable.

So I think that whole paragraph ought to be included in the record in this section.

Ms. Nakano, can I follow up on one point you made? You said the NRC had accredited manufacturers for six of 26 plants in China. Did I get that wrong? And I'm curious--26 of how many?

MS. NAKANO: Thank you.

No, what I meant to say was that there had been six nuclear component manufacturers in China that were accredited by the American Society of Mechanical Engineers. The ASME issue what's called N-stamp. They examine and basically certify that both the design and also the fabrication of these components meet their standards. So it's not an NRC certification. The number of the N-stamp manufacturers in China increased from six to 26 in two years.

There are certainly many, many manufacturers in China, but certainly it's quite different to manufacture nuclear quality components. There are an increasing number of companies, to my knowledge, that had been producing components for conventional power plants that are starting to enter the nuclear sector, and for those I think they do look to see how the NRC and how the U.S. industry standards should be applied. So maybe I wasn't clear, but that's the context that I raised that example.

HEARING CO-CHAIR CLEVELAND: And when you say "they," you mean the companies or the Chinese government?

MS. NAKANO: It's the Chinese regulators. So they do look to the U.S. regulatory practices, and then they use the ASME standards, as well as something comparable in France. They look to both the U.S. and French nuclear component manufacturing certification standards, and then they apply those standards to them.

HEARING CO-CHAIR CLEVELAND: And what's the state of play in terms of NRC collaboration with whoever their counterparts may be, and I'm sure there's more than one? How would you characterize the nature of the relationship and the desire for the Chinese counterpart organizations to improve their own regulation relying on NRC expertise?

MS. NAKANO: I think that the collaboration is deepening. It, again, goes back to the early 1980s, and back then it was, I'd say, very much a one-way street. The NRC would provide extensive personnel training, would welcome Chinese inspectors, regulators come to the U.S. and let them shadow NRC inspectors and go out to the actual plants, look at how they observed the actual construction site, and attend some of the NRC discussion, staff discussions, to learn how the standards are communicated with counterparts.

This engagement also demonstrated how transparent the NRC system is. It's both a workplace culture as well as the actual standards that I think NRC and the Chinese collaboration has been improving in China.

But most recently, since the Westinghouse sale of the AP-1000, collaboration has become truly mutually beneficial from the U.S. perspective, too. The NRC has sent several inspectors, technical staff, to China to actually spend one to three months visiting the sites, the AP-1000 construction sites in China, talking to staff there, both the regulators but then also Chinese engineers and such. So it's becoming quite a two-way street actually.

And I should also note that the Nuclear Energy Association, that's part of OECD, does have some multilateral mechanism where regulators from countries that either are currently or will have to be certifying the same reactor design get together and do extensive information exchange. Under that umbrella, both the NRC and the Chinese regulators are collaborating, including lessons learned from Fukushima.

HEARING CO-CHAIR CLEVELAND: Thank you.

Anybody else? Yes.

CHAIRMAN SHEA: Just a little bit of a curve ball. China's President Xi is engaged in a corruption, anti-corruption campaign, and one of the targets is the CNPC group, the oil company group, and the leader of that group used to be on the Politburo Standing Committee and also the leader of that oil company.

And I was wondering if you see--there's a lot of money flowing into the clean energy sector, into the nuclear sector, from 20 nuclear reactors to 49, in a short period of time, and that's a particular place where corruption could have deadly consequences, and I was wondering if you have any thoughts in both the clean tech and in renewables and nuclear, whether corruption is a concern?

MS. NAKANO: I constantly actually ask my work associated friends based in China, especially journalists, if they are hearing anything along the line of whether this anti-corruption campaign may, especially in the energy sector, may spill into the nuclear arena. I am not aware of such news, but that doesn't mean it's not likely.

I simply do not know. But, I think that even if the anti-corruption campaign spills into the nuclear, the Chinese leadership would not slow down the nuclear expansion because of the importance of nuclear expansion to the government. But, I think this is a very timely question.

CHAIRMAN SHEA: Thank you.

DR. LEWIS: I mean I think it's an interesting question. It's obviously one that is difficult to get really solid data and information on.

CHAIRMAN SHEA: Right.

DR. LEWIS: But I think anytime there's an industry where there's a lot of money being poured in, there are opportunities [for corruption], and there are anecdotal reports of a solar project here or there that's built in a location that doesn't make sense that wouldn't have necessarily been built on economic grounds. But I think that all the information that I've seen points to the fact that this is a pretty small percentage of the total amount of money that's being invested in a small share of projects.

CHAIRMAN SHEA: Thank you.

HEARING CO-CHAIR CLEVELAND: Thank you, all, for coming. We really appreciate your testimony. I feel like I've learned a tremendous amount, but it will take some time to digest, and, Wesley, thank you for your supporting role. We appreciate your being here.

[Laughter.]

HEARING CO-CHAIR CLEVELAND: Would you like to come up and take a picture of him sitting here? Would you like to gavel the hearing down? Come over here. Senator Goodwin will show you how for your future job. So what do you say?

HEARING CO-CHAIR GOODWIN: Say we're going to take a 15-minute break.

MR. FORBES: We're going to take a 15-minute break.

[Applause.]

[Whereupon, a short recess was taken.]

PANEL III INTRODUCTION BY COMMISSIONER CARTE P. GOODWIN

HEARING CO-CHAIR GOODWIN: We're going to go ahead and get started. Give the witnesses a moment to sit down.

For our third and final panel of case studies in U.S.-China clean energy cooperation, we are very happy to welcome Dr. Jerald Fletcher, Director of Advanced Coal Technology Consortium of the U.S.-China Clean Energy Research Center.

Dr. Fletcher is a Professor of Energy, Environmental and Natural Resource Economics at West Virginia University, where he also serves as Director of the Natural Resource Analysis Center, a multidisciplinary research center that applies GIS and spatial analysis to energy, environmental, natural resource and economic development problems.

Much of his current research relates to the management options and economic implications of coal utilization, carbon management, and public policies that affect decisions related to energy and natural environments.

Welcome, Dr. Fletcher.

Next we have Dr. Valerie Karplus, a senior lecturer in the Global Economics and Management Group at the MIT Sloan School of Management and Director of the China Energy and Climate Project in the MIT Joint Program on the Science and Policy of Global Change, a collaborative team of researchers from the U.S. and China, focusing on China's role in global energy markets and climate change mitigation.

Dr. Karplus is an expert on China's energy system, including technology trends, energy system governance, and the sustainability impact of various business decisions.

She has previously worked in the Development Policy Section of the German Federal Foreign Office in Berlin as a Bosch Foundation Fellow, and in the biotech industry in Beijing as a Luce Scholar.

Welcome, Dr. Karplus.

Finally, we're happy to welcome Dr. Huei Peng, Professor, Mechanical Engineering at the University of Michigan, where he also serves as the U.S. Director of the Department of Energy's sponsored Clean Energy Research Center's Clean Vehicle Consortium, which supports more than 30 research projects related to the development of clean vehicles in the United States and China.

His current research focuses include design and control of electrified vehicles, connected/automated vehicle, and he's been involved in the design of several military and civilian concept vehicles over the last ten years.

He also serves as the Associate Director of Michigan's Mobility Transformation Center, which studies connected and autonomous vehicle technologies and promotes their deployment.

Welcome, Dr. Peng. We'll begin with you, Dr. Fletcher.

OPENING STATEMENT OF DR. JERALD J. FLETCHER
DIRECTOR, ADVANCED COAL TECHNOLOGY CONSORTIUM, U.S.-CHINA CLEAN ENERGY RESEARCH CENTER
PROFESSOR, ENERGY, ENVIRONMENTAL AND NATURAL RESOURCE ECONOMICS, WEST VIRGINIA UNIVERSITY

DR. FLETCHER: Thank you. Thank you for the opportunity to provide information to the U.S.-China Commission today. I do direct the U.S.-China Energy Center at West Virginia as well as the Advanced Coal Technology Consortium of the U.S.-China CERC.

My remarks today are really limited to programs related to collaboration between the U.S. and China in the energy area since 2002. WVU has a long history in working with China.

It is my opinion that the U.S. and China collaborations are of utmost importance as we consider the growing demand for energy worldwide and the implications of increased fossil energy use on the levels of carbon dioxide in the atmosphere.

WVU's current role in U.S.-China collaborations with DOE started with meetings in 2002, when we met with Zhang Yuzhuo, and now the President of the Shenhua Group. China was seeking at that time alternatives to imported oil that could be derived from domestic resources.

These meetings led to discussions with DOE on opportunities for collaboration under the Fossil Energy Protocol. China's interest in coal conversion lined up well with prior work in the U.S. and provided an avenue for mutual cooperation. The U.S. DOE has provided financial assistance for WVU's support of Annex II activities since that time.

Concentrated carbon dioxide stream is one of the byproducts of energy conversion plants. In 2007, our work with Shenhua expanded to include a prefeasibility study of options for capturing and storing a portion of the carbon dioxide produced by the liquefaction plant. This resulted in one of the first successful demonstrations of carbon capture and storage in China.

Annex II support activities also include a series of workshops that alternate between the U.S. and China. We had a workshop in Birmingham, Alabama in April of last year, 2013, with 143 participants, 62 from China, 81 from the U.S., representing 25 Chinese and 35 American companies as well as universities and government agencies.

The next round of workshops will be hosted by China and held in Taiyuan in September of this year.

WVU has also organized and managed a U.S. DOE technical exchange program under the Annex II umbrella to increase communication and understanding among energy professionals from the two countries. The first round of technical exchanges occurred last year with the second round now being planned for 2014.

The WVU U.S.-China Center is also supported by the West Virginia Development Office, a state agency and a state activity designed to help develop relationships between businesses in the U.S. and China.

I will now turn my discussion to CERC, which is an innovative approach to cooperation between the U.S. and China in areas dominated by technology. The protocol establishing the CERC takes a direct approach to addressing not only technology but the intellectual property issues that play such an important role in today's industrial society.

The CERC includes programs in building energy efficiency, clean vehicles and clean coal, including carbon capture and storage. The U.S. Advanced Coal Technology Consortium represents U.S. participation in the coal area and includes academic institutions, National Labs,

NGOs, and industrial partners.

The China Consortium also includes academic, industrial and research center partners in China.

The first meeting between the U.S. and China research teams under the CERC took place in Beijing in October of 2010. In addition to research discussions, which were of interest to most of us, an immediate concern was how to implement the requirements written into the protocol, namely, how to deal with the intellectual property issues and how to develop the technology management plans required by the protocol in conjunction with the overall research plan.

The CERC protocol as established and approved by the two governments fundamentally required the communication gaps between the U.S. and China participants related to intellectual property and technology managements be overcome and appropriate communications channels developed prior to initializing joint collaborative research.

Thus, under the leadership of the U.S.-China Clean Energy Forum, discussions related to intellectual property became one of the primary activities of the first year of the CERC.

Joint workplans for each area were completed and approved by January 2011--relatively quickly. The discussions on IP and the development of technology management plans took much longer. With the benefit of joint workshops on IP, the technology management plan for the ACTC was finally approved by the two directors of the U.S. and China ACTC in August of 2011 with final government approval September 23, 2011, almost a year after the start of the research program.

Breakthroughs in intellectual property discussions and understandings are significant for this and other U.S.-China cooperative activities. While the initial impetus for IP was due to the requirements of the protocol, there is a clear understanding that this is an area where additional advancement is in the mutual interest of both countries. Additional IP workshops have continued.

Joint research workshops of the ACTC have alternated between the U.S. and China. The latest was held in Jackson, Wyoming in October of '13, and the next is planned for Hangzhou, China in September of 2014.

The federal commitment to the U.S. ACTC is $2.5 million per year and is matched by resources provided by the universities and private sector partners. While we believe that the China contribution has matched that of the U.S., the actual mechanisms for support in China are unclear. There are no financial issues between the two U.S. and Chinese organizations. All U.S. funds are U.S. specific and the funding for the Chinese participations are provided in and used by China.

We do know that our China counterparts have had the resources necessary to fully engage in the activities of the ACTC.

In terms of the overall impacts of the program, there are few, if any, concerns related to national security or economic damage. Experience to date indicates that the overall economic impact will be positive, strengthening trade and the related economic factors, while increasing overall energy efficiency.

Both countries benefit from initiatives such as the CERC. In the longer term, it would be difficult to assess which country gains the most. The U.S. and China are in very different points on the development scale and must assess the benefits from their own perspective.

The research efforts can be loosely categorized into three general areas: those in carbon capture, utilization and storage; those in power generation; and those in coal conversion and

other uses of coal.

While both countries are engaged in all aspects of the research, it has been clear from the beginning that the U.S. perceived the carbon management issues to be of the highest interest, while China was most interested in the increasing efficiency and technical advances in power generation and coal utilization.

In summary, I would like to close with a personal thought. I believe that it is important to keep certain facts in mind in understanding relationships between the U.S. and China. With roughly four times the population and an economy half the size of the U.S., China is at a very different place on the overall economic development scale. Per capita income is about one-eighth that of the U.S. and two-thirds that of the world average. From an environmental perspective, the issues we see in China today are reminiscent of those we saw in the U.S. when the U.S. EPA was founded--air and water quality problems abound.

As we engage in China on long-term carbon management issues, it is important to remember that China is facing a broad array of environmental issues of immediate importance. Including issues with immediate impact in China will no doubt encourage cooperation on the longer-term issues of worldwide importance.

Thank you. I appreciate the opportunity to talk with you today.

HEARING CO-CHAIR GOODWIN: Thank you.

Dr. Karplus.

PREPARED STATEMENT OF DR. JERALD J. FLETCHER
DIRECTOR, ADVANCED COAL TECHNOLOGY CONSORTIUM, U.S.-CHINA CLEAN ENERGY RESEARCH CENTER
PROFESSOR, ENERGY, ENVIRONMENTAL AND NATURAL RESOURCE ECONOMICS, WEST VIRGINIA UNIVERSITY
TESTIMONY OF JERALD J. FLETCHER

PROFESSOR AND DIRECTOR, US-CHINA ENERGY CENTER
WEST VIRGINIA UNIVERSITY

U.S. DIRECTOR, US-CHINA CLEAN ENERGY RESEARCH CENTER – ADVANCED COAL TECHNOLOGY CONSORTIUM

TESTIMONY BEFORE THE U.S.-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION: "U.S.-CHINA CLEAN ENERGY COOPERATION: STATUS, CHALLENGES AND OPPORTUNITIES"

April 25, 2014

Thank you for the opportunity to provide information to the US-China Commission today. My name is Jerry Fletcher and I am a professor at West Virginia University specializing in natural resource, energy and environmental economics. I also direct the US-China Energy Center at WVU and serve as the US Director for the Advanced Coal Technology Consortium of the US-China Clean Energy Research Center (CERC). The CERC is the implementation of a joint protocol agreement between the US and China that was signed by President Obama in 2009 and initiated in 2010 as part of the overall bilateral cooperation on clean energy innovation.

I am pleased to have the opportunity to provide information about programs at West Virginia University that relate to collaborations between the United States and the People's Republic of China in the energy area. I will first describe activities in which West Virginia University has been involved over the past several years including support for Annex II - Clean Fuels (Transportation & Chemicals) to the Protocol for Cooperation in the Field of Fossil Energy Technology Development and Utilization between the US and China signed in 2000. The opportunity to work with universities and businesses in China led to other cooperative activities and, ultimately, to the creation of the US-China Energy Center at WVU. I will then provide an overview of activities under the US-China Clean Energy Research Center (CERC), a program announced in November 2009 by President Obama and then President HU Jintao. President Obama and China's President XI Jinping have indicated continuing support for future activities under the CERC. It is my opinion that the US and China collaborations are of the upmost importance as we consider the growing demand for energy worldwide and the implications of increased fossil energy usage on the levels of carbon dioxide in the atmosphere.

Background

The initial impetus for WVU's current role in US-China energy collaborations with USDOE came from meetings in 2002 with ZHANG Yuzhuo, then President of the China Shenhua Coal to Liquid and Chemical Co., Ltd. and now the President of the Shenhua Group, the world's largest coal company. Throughout the rest of my remarks, I will use Shenhua to indicate cooperation with the overall Shenhua Group or specific subsidiaries.

Dr. ZHANG was tasked with developing the first coal conversion plant to use direct coal liquefaction (DCL) technologies in the post-World War II era. Germany successfully used DCL technologies to produce liquid fuels from coal when access to petroleum resources was restricted during the war. Like Germany, China was searching for alternatives to imported oil that could be derived from domestic resources. Qingyun SUN, now the Associate Director of the US-China Energy Center at WVU, was asked to help locate potential technology partners that could assist in the development of the DCL plant. I was first introduced to Dr. ZHANG in July of 2002. During our initial discussions, he also expressed interest in developing a better understanding of the economic and environmental impacts of such a plant.

Annex II to the Fossil Energy Protocol

As further background, the US - China Protocol for Cooperation in the Field of Fossil Energy Technology Development and Utilization in the US Department of Energy is composed of a number of annexes on specific topics including Annex II – Clean Fuels (Transportation & Chemicals). Although Annex II had not yet been implemented in 2002 since appropriate joint activities and participants for this aspect of the protocol had not been identified, China's interest in the direct liquefaction technology lined up well with prior work in the US and provided an avenue for mutual cooperation. Joint work related to the development of the DCL plant became the basis for the initial agreements under Annex II that included a focus on the assessment of the economic and environmental impacts of the DCL plant. The US Department of Energy has provided financial assistance for WVU's support of Annex II activities since 2003.

I should also note that the direct conversion of coal to fuels and chemicals produces a relatively highly concentrated carbon dioxide stream as one of the byproducts of the overall process. In 2007, our cooperation with Shenhua under Annex II expanded to include a prefeasibility study of options for capturing and storing a portion of the carbon dioxide produced by the direct coal liquefaction plant in deep geological formations. This work resulted in one of the first successful demonstrations of carbon capture and storage (CCS) in China.

WVU has also been engaged with China on other studies of carbon storage and utilization options designed to reduce releases of carbon into the atmosphere. These activities have included technical exchanges between the two countries and hosting visitors from China interested in developing collaborations and better understanding.

Annex II support activities include a series of workshops that alternate between the US and China. The latest workshop organized by WVU was a technical workshop held in Birmingham, Alabama in April 2013 that attracted industrial and research participants from both the US and China. There were 143 participants registered – 62 from China and 81 from the US –

representing 25 Chinese and 34 American companies as well as universities and government agencies from both countries. Additional support for the workshop was provided through corporate sponsorship by Southern Company and Peabody Energy. The next round of these workshops will be hosted by China and held in Taiyuan in September 2014 with support from the USDOE, the China National Energy Administration and Chinese business sponsorships. WVU has also organized and managed a USDOE technical exchange program under the Annex II umbrella designed to increase communication and understanding among energy professionals from the two countries. The first round of technical exchanges occurred in 2013 with a second round planned for 2014.

US-China Energy Center at West Virginia University

The US-China Energy Center (USCEC) was initially conceived as an umbrella to house the energy related activities between the US and China located at West Virginia University. The USCEC activities at WVU have also been supported by the West Virginia Development Office, a state activity designed to help develop relationships between businesses in the US and China. For example, Petitto Mine Equipment Co. of Morgantown, WV developed an agreement with the Datong Coal Group to develop and provide advanced mining equipment for use in China. Facilitating communications and relationship development between the US and China continues to be a primary focus of activities of the USCEC. For additional information, see http://uscec.wvu.edu/ - a site maintained in both English and Chinese.

US-China Clean Energy Research Center (CERC) – Initial Implementation

The US-China Clean Energy Research Center represents an innovative approach to supporting cooperation between the US and China in areas dominated by technology. The protocol establishing the CERC takes a direct approach to addressing not only technology, but the intellectual property issues that play such an important role in today's industrial society. See http://www.us-china-cerc.org/pdfs/protocol.pdf for a copy of the protocol including Annex I – Intellectual Property) Additional background on the CERC including participants and progress, can be found on the primary CERC web site. Please see http://www.us-china-cerc.org for further information.

As initially conceived and implemented, the CERC includes programs in three major areas: building energy efficiency, clean vehicles and clean coal including carbon capture and storage. The US participants in the three areas were selected through an open competition based on proposals submitted in answer to a funding opportunity announcement (FOA) issued in March of 2009 by the USDOE. Proposals were due in May, 2010, with projects to begin October 1, 2010.

WVU is the lead institution of the US Advanced Coal Technology Consortium, a group selected to provide the US participation in the coal area. Other members include academic participants (University of Wyoming, University of Kentucky, Indiana Geological Survey at the University of Indiana, Washington University in St. Louis), National Laboratories (Lawrence Livermore National Laboratory, Los Alamos National Laboratory, National Energy Technology Laboratory), non-governmental organizations (World Resources Institute, US-China Clean Energy Forum) and private sector partners (Duke Energy, LP Amina, Babcock and Wilcox). As planned, the project was initiated October 1, 2010.

The China coal consortium is led by Prof. ZHENG Chuguang of the Huazhong University of Science and Technology (Wuhan), the lead institution for the China consortium. Other participants are the China Huaneng Group Clean Energy Research Institute (Beijing), China Huaneng Group Power International, Inc. (Beijing), China Power Engineering Consulting Group Corporation (CPECC) (Beijing), China Power Investment Corporation (Beijing), ENN (XinAo Group) (Langfang), Harbin Institute of Technology (Harbin), Institute for Rock & Soil Mechanics, Chinese Academy of Science (Wuhan), Northwest University (Xi'an), Research Center for Energy & Power, Chinese Academy of Sciences (Beijing and Lianyungang, Jiangsu), Shaanxi Yanchang Petroleum Group Co., Ltd. (Xi'an), Shanghai JiaoTong University (Shanghai), Shenhua Group (Beijing), Tsinghua University (Beijing), and Zhejiang University (Hangzhou). While both the Ministry of Science and Technology (MOST) and the National Energy Administration (NEA) in China are listed as responsible government agencies, in practice most of the communications have been through MOST. In my opinion, more commitment from NEA would enhance the ability of the larger state-owned enterprises in China to fully engage in the CERC.

The first meetings between the US and China research teams under the CERC took place in Beijing, October 26-30, 2010. As the two research teams in the area of clean coal including carbon capture and storage had not communicated previously and had no prior knowledge of the specific goals and objectives of the other side, there were significant and wide ranging discussions in a number of areas. These discussions covered the broad areas of technical interest of highest priority to both the American and Chinese research teams. The teams agreed to use the Advanced Coal Technology Consortia (ACTC) to refer collectively to the US and China research teams. One of the overarching issues of immediate concern was how to implement the requirements written into the protocol – namely how to deal with the intellectual property issues and how to develop the technology management plans required by the protocol, in conjunction with the overall research plan.

The CERC protocol as established and approved by the two governments thus fundamentally required that the communication gaps between the US and China participants related to intellectual property and technology management plans be overcome and appropriate communication channels developed prior to initializing joint, collaborative research. Approval of the research plans and the technology management plans by both governments was needed prior to initiating research. This applied to all participants in the CERC. Thus, under the leadership of the US-China Clean Energy Forum, one of the US ACTC members, discussions related to intellectual property became one of the primary activities of the first year of the CERC.

Joint work plans for each area were completed and approved by both governments on January 18, 2011, as part of a signing ceremony held in Washington, DC. The discussions on IP and the development of technology management plans took longer. The first joint workshop on IP was held in conjunction with the ceremony to approve the work plans. A second workshop for ACTC participants was held in Wuhan, China, in May of 2011. The technology management plan for the ACTC was finally approved by the directors of the US and China ACTC at a signing ceremony held at West Virginia University on August 19, 2011 (http://www.us-china-cerc.org/pdfs/CERC-ACTC_TMP_19_Aug_2011.pdf). Final government approval was obtained as part of a joint meeting in Beijing on September 23, 2011. (http://www.us-china-cerc.org/pdfs/US/CERC-ACTC_TMP_Endorsement_English_23_Sep_2011.pdf)

Thus the first year of the CERC was devoted to developing communication links, identifying and planning longer term research efforts of joint interest and technology management plans that reflected appropriate intellectual property provisions. While this was a time consuming process, the breakthroughs in intellectual property discussions and understanding are significant for this and other US-China cooperative activities.

US-China Clean Energy Research Center (CERC) – Progress and Potential

Advancements in intellectual property management have continued. While the initial impetus was due to the requirements of the protocol, there is a clear understanding that this is an area where additional advancement is in the mutual interest of both countries. Joint workshops were held in Haikou, China March 5-6, 2012 and in Stanford, CA February 26-27, 2013. (http://www.us-china-cerc.org/Intellectual_Property.html)

The cooperative research efforts within the ACTC have also continued. Joint workshops on the separate research areas have alternated between the US and China. Annual project meetings have provided the opportunity to both review research progress and plan future work. The latest was held in Jackson, Wyoming October 2-4, 2013. The next is planned for Hangzhou, China September 18-20, 2014.

The federal commitment to the US ACTC is $2.5 million per year. This has been matched by resources provided by the universities and private sector partners. Through the first three years of the project, about 36% of the cost share has been provided by our industrial partners and the balance by the universities. While we believe that the China contribution has matched that of the US, the actual mechanisms for support in China are unclear. There are no financial issues between the two US and Chinese organizations; all US funds are US specific and the funding for the Chinese participation are provided in and used by China. We do know that our Chinese counterparts have had the resources necessary to fully engage in the activities of the ACTC.

The research effort is divided into seven themes to match the research interests and efforts of both the US and China. These can be loosely categorized into three general areas: carbon capture, utilization and storage; power generation; and coal conversion. While both countries are engaged in all aspects of the research, it has been clear from the beginning that the US perceived the carbon management issues to be of the highest interest while China was most interested in the increasing efficiency and technical advances in power generation and coal utilization.

In terms of the overall impacts of the program, there seem to be few, if any, concerns related to national security or economic damage. The experiences acquired to date indicate that the overall economic impact will be positive – strengthening trade and the related economic factors while increasing overall energy efficiency. Both countries will benefit from initiatives such as the CERC. In the longer term, it would be difficult to assess which country gains the most – the US and China are in very different points on the development scale and must assess the benefits from their own perspective.

Summary

In summary, I would like to close with a personal thought. I believe that it is important to keep certain facts in mind in understanding relations between the US and China. With roughly four

times the population and an economy half the size of the US, China is at a very different place on the overall economic development scale. Per capita income is about 1/8 that of the US and 2/3 that of the world average. From an environmental perspective, the issues we see in China today are reminiscent of those in the US when the USEPA was founded. Air and water quality problems abound. As we engage China on long-term carbon management issues, it is important to remember that China is facing a broad array of environmental issues of immediate importance. Including issues with immediate impact in China will no doubt encourage cooperation on the longer term issues of worldwide importance.

OPENING STATEMENT OF DR. VALERIE KARPLUS, PROJECT DIRECTOR, CHINA ENERGY AND CLIMATE PROJECT, MIT JOINT PROGRAM ON THE SCIENCE AND POLICY OF GLOBAL CHANGE

DR. KARPLUS: Thank you.

I serve as project director of the China Energy and Climate Project at the Massachusetts Institute of Technology. The China Energy and Climate Project, or CECP, is part of the MIT Joint Program on the Science and Policy of Global Change and is also closely associated with the MIT Energy Initiative.

It was launched in October of 2011 with the support of four founding sponsors for an initial period of five years. MIT researchers involved in the CECP are actually closely involved on a day-to-day basis in collaboration with researchers at Tsinghua University based in the Institute of Energy, Environment and Economy.

Our collaborative team studies energy and environmental management and policy decisions in China, in many cases by employing new energy economic modeling tools that are jointly developed by our team.

At any given time, we have about five different studies in progress. They are led by one of several team members. They fall into about roughly four thematic areas including: integrated assessment of the impacts of climate and energy policy proposals in China on China's economy and energy system; and then more focused studies in the areas of transportation energy, low carbon electricity and heat, and industrial energy use and trade.

Again, the focus is on policy. Ms. Sarah Forbes this morning highlighted the importance of initiatives that focus on research at the intersection of policy and energy system development. So we do sit right at that intersection.

Let's see. So our project is not focused on energy technology development so it therefore avoids many of the common economic or national security concerns associated with U.S.-China cooperation on clean energy technology development.

The type of work that we do in our project actually has the potential to mitigate economic and national security concerns to the extent that it creates a stronger shared basis for policy and dialogue on related issues, specifically around energy and climate change.

A specific goal of our project is actually developing analysis, both tools and publishing research results that reflect the latest data available on China's energy system and careful study of the economics of energy and associated technologies in the Chinese context.

So having a body of research and a research community spanning the U.S. and China that is proficient in the same set of energy data and energy system analysis tools creates an obvious starting point for bilateral dialogue and decision-making.

The benefit to China and the U.S. of this project is approximately equal. In the U.S., the project allows MIT researchers--senior personnel, post-docs and students--to broaden understanding of China's energy system and policy. Many of these students go on to take roles in the policy community or in U.S. companies, helping them to better understand and navigate in the Chinese context.

This understanding is the result of frequent interaction and joint work between the U.S. and Chinese researchers based on a strong mutual interest in formulating research and co-authoring manuscripts based on, again, the latest data available and the latest policy developments in China.

On the Chinese side, our collaborators benefit from the opportunity to send students to

MIT for training, which over the long-term raises the caliber of research at their home institute. Our collaborators also benefit from the association with a leading U.S. research institution which gives additional weight to their proposals within the policy community in China and helps the group to secure funding on the Chinese side.

The connection, of course, with MIT has also resulted in some internal changes within the group in China in terms of standards and practices resulting from the interaction. It enables our collaborators to adopt more international standards in terms of research practices, ethics. We've actually--through working in the process of producing joint work, we do have to confront a number of challenges, and we resolve them together, and that's a very constructive process.

Again, human, technological and financial resources are organized separately at the two partner institutions. I'm happy to answer any questions on how that is done in the course of my remarks today and the Q&A as well.

None of the founding sponsors of our project is part of the U.S. government. The only U.S. government actor on our side is the Energy Information Administration at the U.S. Department of Energy, which engages our project or has engaged us for about a year now in a cooperative agreement related to some internal activities on their end developing projections of transportation energy use within large international modeling effort.

Let's see. So our founding sponsors are all corporate, not solely U.S. We have Eni, an energy company, Shell, also an energy company, and ICF International, a U.S.-based consultancy, as well as the French Development Agency, as founding sponsors of this project.

The research efforts in the U.S. and in China are funded separately. Sponsorship of the MIT component involves an annual contribution and a multi-year commitment. We also occasionally apply for grants to support specific research, including grants, again, from the DOE as well as the Energy Foundation. Those are our two current grants in progress at the moment. Energy Foundation is a private foundation.

We are not involved in the allocation of funding at our partner institution, Tsinghua University.

In terms of steps that the U.S. side has taken to ensure protection of U.S. intellectual property, I'd just like to emphasize that our project has developed models. The main intellectual property within the project that are either open source or made available by parent groups, they're based on templates that are either open source or made available by the parent groups.

As part of the project, the MIT researchers have shared models developed at MIT for the purpose of helping students who are in residence at MIT develop new models that have specific detail included for the Chinese context. For example, provincial level detail in the energy system. And this means that both sides are working with the same tools, and that has value long-term as I've outlined previously in my remarks.

Both the MIT and Tsinghua sides have agreed that the models developed in this collaboration are exclusively for use in our ongoing research activities, although our plan is to ultimately place versions of both models into the public domain in the U.S. and China along with all of the other outputs of our research effort.

ThisThis is a much smaller effort in many ways than CERC or some of the other efforts. It's very policy focused. I think there is latitude to potentially engage more U.S. government support, but again that should not come at the expense of the tight connection and collaboration in a mutual sort of organic shared interest that has evolved in the course of the project so far.

I think it's been tremendously valuable. It's built a lot of personal and sort of direct working connections with researchers in China that I think long-term have the ability to provide a very solid foundation for bilateral dialogue going forward.

Thank you.

HEARING CO-CHAIR GOODWIN: Thank you, Doctor.

Dr. Peng.

PREPARED STATEMENT OF DR. VALERIE KARPLUS, PROJECT DIRECTOR, CHINA ENERGY AND CLIMATE PROJECT, MIT JOINT PROGRAM ON THE SCIENCE AND POLICY OF GLOBAL CHANGE
Hearing on U.S.-China Clean Energy Cooperation
April 25, 2014
Dr. Valerie J. Karplus, Senior Lecturer, MIT Sloan School of Management
Project Director, MIT-Tsinghua China Energy and Climate Project

1. Describe the current and future projects you are working on.

I serve as the project director of the China Energy and Climate Project (hereafter CECP) at the Massachusetts Institute of Technology. The CECP is part of the MIT Joint Program on the Science and Policy of Global Change and associates closely with the MIT Energy Initiative. The CECP at MIT was launched in October of 2011 with the support of four founding sponsors for an initial period of five years. MIT researchers involved in the CECP collaborate closely with researchers at Tsinghua University in the Institute of Energy, Environment, and Economy. Our collaborative team studies energy and environmental management and policy decisions in China, in many cases by employing new energy-economic modeling tools developed by the team. We have around five studies in progress at any given time, led by one or several team members. Studies fall into four broad thematic areas: 1) integrated assessment of the impacts of climate and energy policy proposals on China's economy and energy system, 2) transportation energy, 3) low carbon electricity and heat, and 4) industrial energy use and trade. To conduct studies, we employ modeling tools developed by the research group as well as a range of empirical social science research techniques. Studies result in published, peer-reviewed academic papers along with press coverage and, in some cases, policy briefs. More information can be found on the project's web site (globalchange.mit.edu/cecp).

2. Are there economic or national security concerns associated with U.S.-China cooperation on clean energy? What about Chinese investment in U.S. clean energy/clean technology?

Our project is not focused on energy technology development. Therefore, it avoids many of the common economic or national security concerns associated with U.S.-China cooperation on clean energy. The type of work our project conducts has the potential to mitigate economic and national security concerns to the extent that it creates a stronger shared basis for policy dialogue on related issues, specifically around energy and climate change. Creating this basis is an explicit goal of our research effort. Specifically, the project is focused on developing analysis tools and publishing research that reflects the latest available data on China's energy system and careful study of the economics of energy and associated technologies in the Chinese context. Having a body of research and a research community spanning the U.S. and China proficient in the same set of energy data and energy system analysis tools creates an obvious starting point for bilateral dialogue and decision-making.

3. To what extent is each country benefiting from the joint initiatives? Is the United States accruing benefits to the same extent as China? How has clean energy cooperation with China advanced U.S. energy policy goals, enhanced U.S. energy security, or benefitted U.S. companies or citizens?

The benefit to China and to the U.S. is approximately equal. In the U.S., the project

allows MIT researchers—senior personnel, postdocs, and students—to broaden understanding of China's energy system and policy. This understanding is the result of frequent interaction between U.S. and Chinese researchers, who have a strong mutual interest in formulating research and co-authoring manuscripts based on the latest available data and policy proposals from China. These learnings have been incorporated into modeling systems and analysis conducted in parallel on the U.S. side by the project's parent organization, the MIT Joint Program. For instance, CECP inputs have helped to shape assumptions for China as part of ongoing analysis within the MIT Joint Program to simulate future energy and climate policy initiatives by individual countries and regions. CECP studies also investigate ways in which the U.S. and Chinese economies and energy systems are connected, for instance, by understanding the carbon emissions associated with the production of goods imported from China into the United States. Since October of 2013, cooperative agreement between the MIT Joint Program/CECP and the Energy Information Administration at the U.S. Department of Energy has engaged our team to support ongoing model development efforts within the agency, leveraging our capabilities of modeling future energy demand in China's transportation system. We are also actively conducting research on the trans-boundary impacts of air pollution in China on the United States, and the possible benefits that would result in both the U.S. and China from stronger policies to cut carbon and air pollution emissions. The CECP also helps to increase the presence of MIT as well as our project sponsors in China.

Meanwhile, our collaborators in China benefit from the opportunity to send students to MIT for training, which over the long term raises the caliber of research at our partner institute. Our collaborators also benefit from the association with a leading U.S. research institution, which gives additional weight to their proposals within the policy community in China and helps the group to secure funding. Exposure to more demanding international research standards and practices in the course of conducting joint studies has raised awareness and led to the adoption of similar practices at our partner institute at Tsinghua University. The connection with MIT and internal changes in standards and practices resulting from the interaction enables our collaborators to further improve their weight and visibility in global research circles. Finally, our project is producing improved tools and new analysis that are being used to support China's domestic energy management, pollution reduction, and climate change mitigation efforts, which over the long term will deliver environmental and human health benefits in China and globally.

4. How has each side invested human, technological, and financial resources in the bilateral clean energy cooperation programs? What are the major government and nongovernmental actors on each side? What are their respective objectives and goals for the clean energy partnership?

Human, technological, and financial resources are organized separately at the two partner institutions. Human resources are deployed at the direction of the MIT and Tsinghua project directors, creating small teams of researchers responsible for the completion of particular studies of mutual interest to the collaborating institutions.

Technological resources include the models developed under the collaboration, as well as data sources, policy documents, and other primary and secondary research materials. Both the MIT and Tsinghua participants maintain access to an archive of all resources while they are involved with the project, including modeling tools. All outputs resulting from the project are placed in the public domain.

Financial support for the CECP at MIT is provided by founding project sponsors Eni (Italy) (an energy company), Shell (U.S. and Netherlands) (an energy company), ICF International (U.S.) (a consultancy), and the French Development Agency (France) (an international development assistance provider). MIT has also received limited funding for synergistic studies from the Energy Information Administration at the U.S. Department of Energy and the Energy Foundation. Researchers on the Tsinghua side access funding from various Chinese government sources as well as several corporate sponsors.

None of the founding sponsors of the CECP are part of the U.S. government. The only U.S. government actor on the U.S. side is the Energy Information Administration at the U.S. Department of Energy, which engages with researchers in our group as part of a cooperative agreement. Non-government actors include our founding sponsors Eni, Shell, and ICF International. As corporate partners, their interests center on better understanding the current situation and likely future evolution of China's energy system and related policy. The French Development Agency (AFD) is associated with the French government. AFD supports our research in part because it informs long-range planning with respect to their activities in China.

5. How are the costs of the programs allocated among the governments and companies?

Research efforts in the U.S. (MIT) and China (Tsinghua University) are funded separately. Sponsorship of the MIT component involves annual contributions and a multi-year commitment. We also occasionally apply for additional grants to investigate specific research questions, including grants from the U.S. Department of Energy and the Energy Foundation. We are not involved in the allocation of funding at Tsinghua University, our partner institution.

6. What steps has the U.S. side taken to ensure protection of U.S. intellectual property utilized in cooperative programs?

The project has developed new energy-economic models based on templates that are either open-source or made available by the parent groups for research purposes only. As part of the project, researchers on the MIT side have shared models developed at MIT for the purpose of helping students involved with the CECP collaboration design two new models that include unique national or regional detail for China. Both the MIT and Tsinghua sides have agreed that these models are exclusively for use in ongoing research activities within the broader parent groups at both MIT and Tsinghua, although versions of both models will eventually be placed in the public domain in China and the U.S., along with all other outputs from the research effort.

OPENING STATEMENT OF DR. HUEI PENG
PROFESSOR, MECHANICAL ENGINEERING; U.S. DIRECTOR, U.S.-CHINA CLEAN ENERGY RESEARCH CENTER-CLEAN VEHICLE CONSORTIUM, UNIVERSITY OF MICHIGAN

DR. PENG: Senator Goodwin, Commissioner Cleveland and also members of the Commission, thank you for the opportunity to present the perspective from the worker bees.

Since I do not communicate very effectively when I speak too fast, and I know your coffee is wearing thin, --and third reason is I really know how to kill students slowly by PowerPoint. So I sneak in a few PowerPoint slides at the end of my testimony. I'll go through the slides, and I hope the graphical design is helping me to communicate the big picture of CERC CVC, Clean Vehicle Consortium, to you effectively.

The CERC CVC is jointly led by University of Michigan from the U.S. side and Tsinghua University from the Chinese side.

Slide number two, please refer to the number on the lower right corner of the slides. The main motivation of CERC is, of course, China is now overtaking U.S. as the largest carbon emitter, but the one thing that a few people talk about is on the right-hand side, you see on the per capita level, China's emission is already exceeding that of EU27, and that's alarming. It's very important that we help them to find lower carbon content energy sources.

Slide number three. CERC is one of the seven joint clean energy initiatives launched in 2009.

Slide number four. CERC CVC is one of the three CERCs. I think you know this very well.

Slide number five. On the vehicle side, Professor Ouyang Minggao, professor in Tsinghua University, serves as the Chinese side director. I serve as the U.S. side director.

Slide number six. Overall picture. Department of Energy puts in $2.5 million per year, and there's a requirement of 50/50 cost share; therefore, university and industrial sponsors fund larger than $2.5 million per year for matching.

Slide number seven shows the participants. On the U.S. side, it's mainly led by the University of Michigan supported by Ohio State, MIT, Sandia, Oak Ridge, Argonne, and JBEI from the DOE laboratories.

On the Chinese side, they are all primarily academic partners even though you could argue the Chinese Academy of Science whether it's a university or not, but there are ten players from the Chinese side.

Slide number eight. These are the participants. We are very fortunate to have ten industrial members supporting our effort, both financially and intellectually, and they are listed as such.

On the Chinese side, they also have a long list of industrial members, but many of whom, first of all, are only loosely engaged, and none of them financially support CERC in the Chinese side. So all the China-side funding is coming most from the Ministry of Science and Technology.

Slide number nine. The money from the U.S. side is coming from the Department of Energy and in particular from Vehicle Technology Office under EERE, and on the U.S. side there are also potential funders such as the Basic Energy Science Division of DOE or ARPA-E, but actually no money flows from these two divisions.

On the Chinese side, on the contrary, if we look at the detailed divisions supporting

CERC CVC, they come from the so-called 863 projects and 973 projects. 863 is more application oriented. 973 is more basic research oriented.

On the U.S. side, we also again are fortunate to have money coming from industrial members.

Slide number ten. We do not believe in a silver bullet. We actually think that technology progress in many different fronts is necessary to push clean vehicles to become high performance and affordable. So we engage in a large area of basic research.

First is batteries; second is advanced combustion including biofuels; third is vehicle electrification that includes power electronics, motors, and controls; fourth is lightweight structures, and primarily we do not invent new material. We engage in how to manufacture these things in lighter-weight vehicles. Fifth is vehicle-grid integration. One of the key challenges for China is they don't have parking garages in most people's homes, and the lack of charging infrastructure is a major bottleneck of having plug-in vehicles for China. The sixth is trying to understand the big picture influence of clean vehicles.

And slide number 11 and 12 are lists of the detailed projects and the major participants, and they are designated as either cooperative or joint. Joint means there are both U.S. money and Chinese money supporting researchers, and we coordinate these research efforts, and cooperative means money only coming from one side.

Slide number 13 shows the leverage opportunities for the U.S. If you ask whether by jointly collaborating one side is getting more than the other side, I think the answer is clean energy is a large field. In 2012, the total investment in the world is more than $200 billion, and to create a viable battery for mobile application such as clean vehicles, there are plenty of technical challenges.

Let me just give you one example. On the U.S. side, the battery research is focusing more on lithium-air, which is a next generation high energy density battery, and the emphasis is more on modeling and in terms of understanding degradation of today's lithium-ion batteries, we focus on lithium ion phosphate.

On the Chinese side, for next generation batteries, they focus more on lithium sulfur and more focus on degradation of lithium manganese batteries.

So again these are opportunities for leveraging rather than competing.

And finally slide number 14 shows the overall picture. Clean vehicles is a large problem and it takes a team to solve. We do not believe technology is the only problem. We need to think about the ecosystem, we need to think about education, and workforce development.

So CERC serves the function of helping both U.S. and China to make technology progress as well as in developing the ecosystem.

Thank you for your attention.

HEARING CO-CHAIR GOODWIN: Thank you, Doctor.
Commissioner Slane.

PREPARED STATEMENT OF DR. HUEI PENG
PROFESSOR, MECHANICAL ENGINEERING; U.S. DIRECTOR, U.S.-CHINA CLEAN ENERGY RESEARCH CENTER-CLEAN VEHICLE CONSORTIUM, UNIVERSITY OF MICHIGAN

U.S.-China Clean Energy Cooperation: Status, Challenges, and Opportunities

Testimony before the U.S.-China Economic and Security Review Commission

Huei Peng

Professor, University of Michigan
Director, US-China Clean Energy Research Center, Clean Vehicle Consortium

April 25, 2014

1. Describe the current and future projects you are working on.

The US-China Clean Energy Research Center—Clean Vehicle Consortium is jointly supported by the US Department of Energy and China Ministry of Science of Technology. The research projects of the center officially started in January 2011, and their focus is on developing and promoting clean vehicle technologies in the US and in China. The current work encompasses a comprehensive scope, combining systems analysis with key clean vehicle technologies, including vehicle electrification, energy storage and conversion, lightweight materials, grid integration and biofuels.

The first phase of the 5-year research center is scheduled to finish in about 2 years. For the next two years, we will focus on translating the research results to practice. This will be done by working closely with the Center's industrial members on selected subset of the research projects. The future direction of the Center is likely to continue on challenging bottleneck problems such as high energy density and reliably battery systems, lightweight materials and structures, and combine aspects of electrification with opportunities presented by connected vehicle technologies.

2. Are there economic or national security concerns associated with U.S.-China cooperation on clean energy? What about Chinese investment in U.S. clean energy/clean technology?

China and the United States are the two largest producers and consumers of primary energy sources, and the two largest automotive markets. Both countries invest heavily on technologies aiming to lower carbon foot-print and environmental impacts of ground transportation. It is mutually beneficial to leverage and coordinate the research and development work in these two countries to address the grand challenge related to energy sustainability and climate change.

The Chinese vehicle fleet continues to grow and with it the Chinese consumption of fossil fuels. The majority of U.S. OEM's have a significant presence in the Chinese market and continued collaboration between the U.S. and China will further support their efforts to expand in to this growing market. The Chinese automotive market is dominated by foreign or joint-venture brands. The top 6 brands are all foreign (VW, GM, Hyundai, Nissan, Ford and Toyota), with more than 50% market share. The top-selling Domestic (Chinese) brand, Great Wall, has less than 4% of the market. Winning the clean vehicle race helps the US companies to compete in the Chinese market. The Chinese auto makers currently are not competitive in clean vehicle technologies, including in Chinese and US markets.

3. To what extent is each country benefiting from the joint initiatives? Is the United States accruing benefits to the same extent as China?

While U.S. funds only support U.S. researchers and Chinese funds only support Chinese researchers, the collective impact of the funding is amplified because of the CERC collaborative efforts. CERC avoids cross-border duplication and leverages shared knowledge, accelerating research and development of clean vehicle technologies as the world confronts

the global challenge of shifting to a low-carbon future.

On the U.S. side, industrial partners are playing a more active role in guiding the research activities. In addition, U.S. industrial partners are participating more actively in discussions with Chinese academic partners as well. This is allowing U.S. industrial partners to reap more benefits from the partnership compared to the Chinese partners.

4. How has each side invested human, technological, and financial resources in the bilateral clean energy cooperation programs? What are the major government and nongovernmental actors on each side? What are their respective objectives and goals for the clean energy partnership?

Investments have been made to support basic research, with funding going predominantly to graduate students and researchers at the partner institutions. The key government actors are the Department of Energy in the US and the Ministry of Science and Technology in China. The goals of the DOE and MOST are to build foundational knowledge, develop technologies, and develop human resources to achieve a future with very low energy intensity. The research work in the US side are done in three universities (University of Michigan, Ohio State University, and MIT) and to a small extent in two DOE labs (Oakridge and Sandia). On the Chinese side, ten universities participated: Tsinghua University, Shanghai Jiaotong University, Beijing Institute of Technology, Tongji University. Tianjin University, Wuhan Institute of Technology, Chinese Academy of Science, Beihang University, Hunan University, and North China Electric Power University.

5. How are the costs of the programs allocated among the governments and companies?

The 2.5M per year funding from the US department of energy is matched 50/50 by the academic and industrial participants. On the Chinese side, there is no matching requirement. The industrial partners only provide guidance and in-kind contribution. They are not providing any financial contribution to the Chinese program.

6. What steps has the U.S. side taken to ensure protection of U.S. intellectual property utilized in cooperative programs?

CERC includes a framework for protecting and sharing intellectual property that provides a strong foundation for U.S.-China clean energy cooperation. The framework enables research partners to share information with confidence and to retain appropriate rights for new technologies they create. Research partners can share the benefits of breakthroughs according to IP agreements established before work begins and extend those benefits by entering traditional commercial contracts to set the terms and to allocate their rights to—and royalties from—their creations.

The clean vehicle consortium is somewhat different from the other two CERCs (clean coal, and building energy), in the sense that the automotive industry is highly competitive and the US funding model requires pooled membership to jointly support research. As such, much of the research work, especially those with close Chinese collaboration is pre-competitive. In addition, all projects that are supported by (US) industrial membership fee are US-only and do

not have Chinese collaborators.

7. The Commission is mandated to make policy recommendations to Congress based on its hearings and other research. What are your recommendations for congressional action related to the topic of your testimony?

Excessive carbon emission is a primary contributing factor to climate change--which is one of the biggest challenges we face today. Continue to collaborate on clean energy research, especially on pre-competitive and basic research topics, can be beneficial to both US and China through leveraging, collaborative innovation, and sharing of knowledge.

PANEL III QUESTION AND ANSWER

COMMISSIONER SLANE: Dr. Peng, thank you for coming.

I didn't hear you talk about natural gas. Are you working on that for cars?

DR. PENG: No. There are a few things that we didn't--when we wrote the proposal, again, this is $2.5 million per year from DOE. We looked at the critical technology. We decided two things we do not work on from a very early start. One is fuel cell; one is natural gas. But there are still plenty of problems for us to solve.

COMMISSIONER SLANE: You know, in the United States, the trucks and the buses and the taxicabs are all going to natural gas. Now, the Chinese are putting a big emphasis on fracking and trying to put in the infrastructure. It's complicated over there. It's more complicated than ours.

But do you see the future of clean vehicles in China being operated by natural gas?

DR. PENG: Yes, we do have lighter-weight, lighter-duty vehicle focus. So our major expenses are mostly cars, not trucks, even though Eaton is one of our sponsors. We understand that natural gas is a very important next generation clean energy, and we do think that they do have an application potential, especially on heavier, larger vehicles, such as trucks and buses.

For passenger cars because of the storage requirement, they would take up too much of the trunk space. In the U.S. today, there's only one passenger car model available, which is Honda Civic.

COMMISSIONER SLANE: When we were in China a couple of years ago, we went to a company that was manufacturing batteries, pretty impressive, but they still don't have the ability to drive the distances. Can you bring us up to date on is that technology I'm sure is rapidly improving?

DR. PENG: Absolutely. There has been a lot of progress in lithium iron battery for their applications. They are still about a factor of two to three--too expensive and life needs to be extended by almost a factor of two to three for the chemistry we like, and the energy density is still too low. We're now talking about roughly 100 watt-hour per kilogram, and we want to make it about 200 or even more to make it viable.

COMMISSIONER SLANE: And that might overcome some of the sales resistance?

DR. PENG: Absolutely. The operating range and cost are two major issues. Reliability is largely underwritten by companies. Most of the plug-in vehicles, including Chevy Volt, Nissan Leaf and Tesla, all offer an eight-year warranty. So that's no longer a concern for most consumers, but cost and range are certainly still issues.

COMMISSIONER SLANE: And here in the United States, to incentivize U.S. car manufacturers, states, even the federal government passed these regulations that are out in the future by 2016, you have to have this. Are you seeing any of that in China?

DR. PENG: They have a target, but I don't think they are going to make it.

COMMISSIONER SLANE: It's unrealistic?

DR. PENG: Correct. They are targeting five million. They are far away from that target.

COMMISSIONER SLANE: Thank you.

HEARING CO-CHAIR GOODWIN: Commissioner Wessel.

COMMISSIONER WESSEL: Thank you to the witnesses. Very helpful.

Dr. Fletcher, I would love to get a little more insight and advice from you. Coal is a vital part of our nation's energy infrastructure, and it's not going away any time soon. I certainly

hope it's not going away any time soon.

So what can you tell us? In the best case scenario, what are these efforts going to result in, and how does that result in terms of--and it was noted earlier--West Virginia, Kentucky, and Illinois, a number of other states have vast coal deposits that we want to continue to be able to utilize for well into the future?

How early do you think we're going to be able to harvest some of these gains, and what does it mean to the workers in those states? What's a best case scenario? What are your hopes --

DR. FLETCHER: In the U.S., I believe it's pretty problematic at this point. I think the last numbers I saw said that West Virginia coal exports dropped about 25 percent last year. That's a very significant impact on the state economy.

It's interesting to look at what we talk about in the CERC, both in vehicles and in the ones we've got, in that the world is very different now than it was five years ago when this was conceived, and what we see in China is tremendous concern right now with air quality issues.

On the other hand, they've got a growing economy that's growing very rapidly. The pent-up energy demand in China is amazing if you realize that the south part of China still doesn't heat buildings in the winter. You look at as people move up the economic scale, they want air-conditioning in the summer.

The potential demand for increased energy use in China is off the charts. Some of what CERC is doing will help that a great deal. The energy, the building's efficiency, which is not represented here today, but that has a tremendous impact, potential impact in China.

In the U.S., I think it's a policy issue that has really changed. When we started the CERC, and when we wrote the proposal, if you would have talked to most of us involved in the coal sector in 2009, there was a fairly significant belief that we were going to be looking at some kind of policy that started to develop to deal with the carbon issue and the climate change issues.

COMMISSIONER WESSEL: Uh-huh.

DR. FLETCHER: I would have to say that if you looked at that policy environment, it changed radically between 2009 and 2011 and 2012, and it hasn't really returned yet.

It's interesting to talk to people in China. They certainly are aware of the long-term issues. They're extremely aware of the long-term issues, and I think the society in China tends to take a longer view of things than the U.S. society does, and that's reflected.

However, they are very, very, very much involved with the near-term things as you read in the news about the pollution in the cities and the health issues that are currently driving it, that China has an immediate problem that they have to deal with before they can look at the future.

One of my last comments was really aimed at that. I think we need to help China get over that. We went over it. Not that we've solved all of our environmental problems, but I started out, my first paper as an academic was in '69. I remember flying. I was a country boy from Wyoming. I had never really been to a big city. I flew into LA to give it, and it was like flying into an orange soup bowl. I'd never seen anything quite like the air pollution that occurred in the U.S. at that time.

China looks a lot like the U.S. did then. And I think that we solved those issues to a great--not that we've solved them. We've addressed those issues, and in many ways very successfully over the last 40 years.

I believe that China will also address those issues, and probably more rapidly than we

did. When they decide to do something, China is able to marshal and extend resources in a fairly significant and fairly rapid way.

But it's left us with a picture of the world that is a little disturbing if you look at the latest climate change reports that are coming out, and you look at what we need as an economy to keep us going. We need to figure out how to solve these problems. We're working on it.

I think that one of the short-term solutions that will at least help is if we can figure out a way to store some of the carbon that's produced, if we can figure out a way to increase our efficiency. We don't need as much energy as we are today, and we are seeing that in many of the things that we see.

The biggest thing we've seen in the U.S. probably recently is the advent of the LED light, but the impact on the energy consumption is probably more than most of the other things we've seen.

So I don't think I've got any good answers for this. I am certainly concerned as a resident of a coal state as to what the economic issues are going to be. I also came from Wyoming. That's now the number one coal state. So I've been involved in this for some time. We see this, but we also realize that we have to figure out how to deal with energy, and we think that there are ways to deal with renewables to bring together solar and wind and coal in a way that can increase the overall efficiency and allow us to really increase the amount of renewables that are usable in our economy. It's not a one-size-fits-all answer.

COMMISSIONER WESSEL: Understand. And I see my time has expired so I'll come back later. But I think the fracking boom, and if you look at the NERA study, and others, I think you'll see that the expected results probably aren't going to be what everyone hopes might come with LNG exports, everything else, the entire infrastructure.

Coal is a vital part and therefore we have to make sure what you're doing, that people don't lose sight of it, and look to some new equation that may never happen. Wind is not generating anywhere near what people had hoped five years ago. Coal is here to stay I hope. And so how do we deal with that? So I want to come back at that.

Thank you.

HEARING CO-CHAIR GOODWIN: Commissioner Shea.

CHAIRMAN SHEA: Thank you, all, for being here.

I'm going to just address my question to Dr. Karplus. Impressed by your biochemistry and political science background so it's an interesting mix. You said that your group has five studies in progress at any given time in four broad thematic areas, and one is on an integrated assessment of the impacts of climate and energy proposals on China's economy and energy system.

I was just wondering if you could maybe in four minutes or just give us a glimpse into what your assessment is of these policy proposals on the economy and energy system in China?

DR. KARPLUS: Great. Thank you.

So this year, we have the models ready and at a point where we've actually been able to apply them to produce our first energy outlook for China. This was a joint publication between MIT and Tsinghua University. It will be officially released in June.

The main messages are as follows: so we simulate three scenarios.

One is a counterfactual that assumes from 2010 onwards, China didn't have energy intensity and carbon intensity targets. They really didn't do anything. So that's scenario one.

Scenario two is a case where they continue with their efforts that were announced within the last three to five years, continued carbon intensity and energy intensity targets. China

announced in 2009 in Copenhagen that it would commit to reducing the carbon intensity of its economy between 40 and 45 percent by 2020 relative to 2005 levels. That policy is part of what we call our current effort scenario.

And then we have a more aggressive effort scenario, which builds in a set of new recent initiatives around air pollution control and around market, further market reform that would allow energy prices potentially to be market determined, and in our model that means that they increase because right now, end-use energy prices are to a large extent controlled for electricity, for heating, for natural gas.

And so we have sort of three levels of effort, if you will, and what we see is that if China continues with its current effort, first of all, it can't continue to do that. I think, Ms. Joanna Lewis mentioned that China has managed to increase energy or improve the energy intensity, reduce the energy intensity of its economy significantly in the past 20 years. The low-hanging fruit is not necessarily going to be there for the next ten to 15, 20 years going forward.

So what we find is that China does need a carbon price. They're already piloting cap and trade in seven areas in China, and they're serious about scaling that up at the national level. Part of our project actually has done--one example of our integrated assessment is actually simulating the impacts that a nationwide trading system would have on China's economy.

It turns out that the combination of price reforms and this cap and trade system can go a long way in just a current effort scenario to bringing energy and emissions to--the increase in energy and emissions to a halt in the 2030 to 2040 timeframe so what that means is that in that scenario, coal continues to rise for about the next ten years and then starts to level off.

If you look at the more extreme measures now in the--well, extreme may not be extreme when you think about how dire the air quality problem is. The accelerated effort scenario shows that that peak and that that decline would start to happen sooner, more in the 2025 to 2035 timeframe, and that you would actually see a peak in coal use between 2020 and 2025.

So this is, again, if accelerated measures and market reforms in line with what President Xi has outlined really do go forward and are implemented effectively, they actually have huge opportunities to reduce energy and carbon emissions relative to a baseline no-policy scenario at relatively low cost compared to, for example, some of the cost estimates of what it would look like in this country.

CHAIRMAN SHEA: Thank you very much. This is extremely helpful.

Let me boil it down to sort of a lay person's question. When will the air clean up? I mean have you been to China? When will you see it get a little bit better? Under say current efforts scenario, say in Beijing, you go to Beijing, and actually see a blue sky?

DR. KARPLUS: That's a great question. I think that's the multi-billion dollar question on the table. I think it's very hard to say when. It requires effective implementation at the level of industries of controls on pollution. It requires careful monitoring of energy use and every type of energy use, including maybe diesel or low-quality coal that is to some extent maybe not as carefully managed as large suppliers.

So it's really about kind of getting in and making sure that all of this progress can be verified. If that happens, I think you'll start to see clearer skies in the 2015 to 2020 time horizon.

CHAIRMAN SHEA: Okay. Thank you.

HEARING CO-CHAIR GOODWIN: Commissioner Cleveland.

HEARING CO-CHAIR CLEVELAND: I'd like to follow up on what Commissioner Shea was talking about. I want to acknowledge up-front that, like Commissioner Shea, I am the

lay person. I am doing my doctoral dissertation and nothing, nothing is harder that I've ever done in my life than two-way ANOVAs and dealing with SPSS. It is the most daunting thing I've done other than raising a child.

So please, if you can, keep it simple for me. So I was looking online at the modeling that you're doing, and part of it is designed to study behaviors and trends that address micro-level decisions at the household and firm level to understand supply and demand.

And then you're analyzing China's technological potential, and then looking at how environmental and economic impact on--looking at the environmental and economic impact on energy policies.

I'm interested in how you construct that model given how vast China is and how differentiated the pollution levels and energy consumption levels are? Are you doing this on a province-by-province basis? Are you doing it nationally? How are you kind of scaling and addressing the data collection issues?

I'm curious as to how you develop an accurate modeling system?

DR. KARPLUS: Thank you. Yeah, that's a very important question.

Let me see if I can just describe the basics, and if you have specific questions, I'm happy to answer them. First of all, we have two models. We have one that represents China as part of the global economic system. So we have a global trade data set which is made available through Purdue University, the Global Trade Analysis Project.

That is the fundamental basis actually for both of our models since both are global. They just have different levels of detail in China.

What we do for China, however, is we don't use the GTAP China data. We obtain the input-output tables, the national input-output tables, which are basically a snapshot of all the economic flows in the economy. We match that with the energy balance information which is published in the National Statistical Yearbooks.

And we basically, using some sort of relatively straightforward rules from basic economics, we try to reconcile those statistics on a global scale minimizing the differences between reality and what's in the model.

So it's basically a technique for trying to create a consistent modeling system that also embodies the richness and the detail in the data set.

So moving from data to model, we have a couple simple rules by which the model solves. We have to create a benchmark year data set, and so to do that, we try to preserve as much of the reality as possible, but in some cases maybe the trade flows reported by the International Data Set may not directly match what you see in the internal Chinese data.

We deal with these sort of tough problems on how to match, and we decide which number we'll take, and we believe the overall result is true to capturing the structure of China's economy and energy system, and it importantly connects the energy flows to the economic values in the model.

So the other important thing about this modeling system is that over time, as we forecast, we are looking at how energy demand evolves in response to prices and in response to changes in trade, in response to changes in policies, both in China and elsewhere in the world. So prices evolve inside the model.

Now when it comes to representing in our second model the detail, the richness at the provincial level, we have made available to us, actually now I believe publicly available, the regional energy balance and input-output tables for China.

So this is again snapshots at the provincial level of the economic flows in each of the

provincial economies, and also to the extent that we can manage, we also estimate the trade flows across the provinces. So we can do that because we have some limited trade data for each province, and we have to match that data. There's a lot that goes on under the hood in terms of understanding these data.

There are a lot of issues that we come up with. For example, in terms of discrepancies which are well documented in literature between the provincial data and the national data, if you sum the emissions at the provincial level, you exceed the national reported emissions by up to 20 percent.

HEARING CO-CHAIR CLEVELAND: Right.

DR. KARPLUS: Which is the size of Japan's emissions. So we actually will look in detail at the way the statistics were collected and try to understand which source we should, we choose to rely on in developing those models.

So in the end, what we come up with is what we believe is a robust simulation structure for thinking about the impacts of policies in the Chinese context. It's not a crystal ball, but it really helps to discipline your thinking when you have ideas or conjectures about how different pieces of the economy will interact with each other or respond as a total system to the implementation of say a carbon tax or a cap and trade policy.

And we find that policymakers in China are very receptive to this type of scientific analysis, especially when it comes through this collaboration like ours, and I think many others also have similar stature in these types of discussions.

That's a description of the models. I'll stop there, and see if there are any questions at this point?

HEARING CO-CHAIR CLEVELAND: Can I just finish this topic?

HEARING CO-CHAIR GOODWIN: Sure.

HEARING CO-CHAIR CLEVELAND: So we don't have to come back to it. So I'm interested when you said that you have relatively simple economic rules, I don't know that the simple and economics go together in my mind, but how do you factor in fixed pricing and the way China prices energy? Because you can have a carbon tax and you can have a policy approach that is aggressive and innovative, but as long as you continue to subsidize energy, your model may experience turbulence.

DR. KARPLUS: It's a great question, and this is actually something we have looked at. One of the reports online that looks at the implication or the comparison between a carbon intensity target policy and a national cap and trade policy, or emissions trading policy, actually includes a scenario in which we fix the electricity prices at subsidized levels.

So the nice thing about simple economic rules is that in an optimization framework, you know, you have this set of rules that you're starting from. You can selectively change or bend or constrain the way those rules operate if you think the reality is something different. That's why we actually study what happens on the ground in China so that we can incorporate that into the models and understand how much of a difference that makes.

So, yes, we do try to incorporate those sources of realism in the Chinese context and also think about how data quality issues affect the results that we're developing.

HEARING CO-CHAIR CLEVELAND: Thanks.

HEARING CO-CHAIR GOODWIN: Commissioner Fiedler.

COMMISSIONER FIEDLER: I have a couple of questions. I think it was you, Dr. Fletcher, who made the comparison between China now and the United States in the past. And I've heard the Chinese always sort of say, hey, you industrialized with pollution so what's

wrong with us doing it? But the principal difference there is that in our industrialization, the technology did not exist to say scrub smokestacks, for instance, right?

So I think that's a bit of a fallacy. I will grant that the politics of environmental degradation may be similar in their evolution. It took damage in order to wake people up.

Has anybody ever retrospectively looked at the cost that they passed up on of installing the then existing technology say in the '80s or early '90s with the cost of clean-up now and the cost of damage to the economy?

DR. FLETCHER: I am not aware of any such economic studies.

DR. KARPLUS: I'm only aware of studies that have estimated the total cost of pollution in the past in China. You could look at how that compared to what it might have taken at the time to install the appropriate control equipment.

COMMISSIONER FIEDLER: The energy sector is largely state. I want to make sure that the blame for this is not like a market economy situation that existed in the United States. I will blame the government or successive governments in the United States perhaps for inaction.

But we're talking state enterprises here that they made a conscious decision not to install.

DR. FLETCHER: One of the things that I think is true in China is sometimes it's installed, but it's not always turned on.

COMMISSIONER FIEDLER: Well, okay.

DR. FLETCHER: There are certainly significant issues in regulatory control in China. I mean just because it's a controlled state doesn't mean the rules are always followed.

COMMISSIONER FIEDLER: That's for sure.

DR. FLETCHER: I think my comparison is not so much in the technology, and one of the reasons that I think China can come out of it faster is the technology is available. They don't have to invent it.

COMMISSIONER FIEDLER: That's right.

DR. FLETCHER: They do have to use it.

COMMISSIONER FIEDLER: They have to buy it.

DR. FLETCHER: They have to buy it; they have to use it.

COMMISSIONER FIEDLER: Now, which leads into the second thing that bothers me a little bit. Earlier panels and then you mentioned again the sort of teaching of IP protection; right? We've been talking about IP protection with China for the last 20 years, and it's not a particularly difficult concept to grasp, i.e., you don't steal other people's technology, and yours won't get stolen, and it's more valuable, blah-blah-blah.

And my cynical view of this is that they just haven't decided yet on sort of whether it's carbon capture technology, whether it's cleansing technology, whether it's the classifier, which technology to steal. That the practical problem of rapidity, the need to clean up and the need to go, actually increases the probability that they will steal stuff rather than buy it, which I mean--come on--we've seen it in other sectors, including aviation. We saw it in the automotive industry in terms of technology.

We see it in every industry that we look at. I'm worried that all the cooperation we have, and I believe that the common goal that we should all have is to clean up and make sure that there is not an environment that people can't live in, but that the situation we're in is that we're going to replicate what we've seen in other industries, which is we're selling it to them now, they'll steal it, and they'll manufacture it.

It will destroy our manufacturing base, and we'll buy it back because our companies have gone out. Yes?

DR. FLETCHER: I just have one thing, I think. I do think that what you've said is certainly historically correct. I think, though, that the IP issues in China are probably changing as fast as much of the other things we see changing in China.

The legal structures that they have in place, the learning about it that's occurring in China, and another thing, they're actually at the point now where they're starting to develop some technology that they may want to protect themselves.

So I think we have to realize that China, it is very dynamic in the environment, and I wouldn't say that I'm completely comfortable that IP is safe in China, but I think it's a lot closer to being safe than it was. I guess I see some of the U.S. companies making investments in China, they're pretty protective of their IP, and they deal with it in a way, but they're at least comfortable enough to now do business in China. So I do think it's getting better.

DR. PENG: So let me echo what Jerry said. There might have been the mind-set that, look, you polluted before, now we have the right to pollute. I'm pretty sure that at the very high level, that concept is pretty much nonexisting.

COMMISSIONER FIEDLER: Well, because it's impinged on individual health which has impinged on--

DR. PENG: Right.

COMMISSIONER FIEDLER: --I mean stability.

DR. PENG: Sure, sure, sure.

COMMISSIONER FIEDLER: Now we're talking about survival of the Party.

DR. PENG: No problem, but let me just use vehicle as one example. So the issue is it takes a long time to solve. So if you only look at say commercial passenger cars, their cars are not that bad. Okay. So they are not as good, but they are not that bad. What's really bad are the agriculture machines, the three-wheelers that are not subject to the same standards, and some of the heavy-duty trucks are not under the same standard.

So you probably heard that in China, there are millions of pure electric vehicles being produced, and they don't need actually a license to produce because the government wouldn't allow, but in certain provinces like Shandong, they have been produced in the quantity of millions, and those cars do not need a driver license to operate because they were basically glorified wheelchair.

And so they don't have a license--

COMMISSIONER FIEDLER: With or without a windshield?

[Laughter.]

DR. PENG: With windshield now. But they don't need the driver license. They don't have license plates. So even police couldn't issue a speeding/parking ticket.

COMMISSIONER FIEDLER: That's another set of problems.

DR. PENG: But they are just around like that, and so some things like that exist in the so-called agriculture machines segment in which case buy these very cheap cars and operate them as cars, not as agriculture machines.

COMMISSIONER FIEDLER: Machines.

DR. PENG: So, and the second thing, for example, is sulfur content in the Chinese fuel is much higher. It takes time to really find out what do we do, staged implementation of the low sulfur content fuel, and then make sure that these loopholes of agriculture machines or pure electric light-weight vehicles do not exist.

So it's not like they don't know what is right. It just takes time to execute.

DR. KARPLUS: Let me be the economist here and just point out that I think historically

China didn't fail to adopt this control technology because of the technology, they didn't know what technology to steal. Basically they didn't have any incentive to do it. They didn't have a price on the pollutants. They didn't have credible enforcement.

They may have installed some technology. There may not have been an incentive to run it. You know, today, there is an incentive, and it may not the same incentive that it does in a market economy. So, in China, you're held responsible. Your job might be on the line if you don't meet your provincial target for cleaning up the sky. If the sky is not blue tomorrow, you might in a year lose your job.

I mean you can ask about the kind of appropriateness of the incentive, but the incentive is now there, and I'd point out that if you're concerned about technology going to China and then China selling that back to us, then why don't we create a demand for that technology here now with the policies that we need, for example, price on carbon that would actually make that possible?

COMMISSIONER FIEDLER: Perhaps.

DR. KARPLUS: Just a thought.

COMMISSIONER FIEDLER: Yeah. Thank you very much.

HEARING CO-CHAIR GOODWIN: Commissioner Tobin.

COMMISSIONER TOBIN: Thank you.

Actually Commissioner Cleveland's question was exactly the territory that I wanted to explore with you, Dr. Karplus, and your answers covered just about every element that I wanted to hear about, but let me say do you see a point in time where the model, the tools, will be such that China will do this work independently and that was one question?

And the other question is you said that six months from now, there will be a report, or very soon, and you gave us some indication of what that will contain. Do you publish it? Do they publish it? How is that handled?

DR. KARPLUS: Great. Thank you.

So I'll take the second question first. In terms of publication of the report, that is jointly published and published widely by both MIT and Tsinghua. So first it comes out in the form of our annual project newsletter, which is much more of a document for lay people, English and Chinese.

It's put in the hands of the policy community representatives in Beijing who attend our annual meeting. So these are representatives from the National Development Reform Commission, the Ministry of Industry and Information Technology, the National Energy Administration, sort of the constellation of institutions involved in policymaking on these issues.

So they take that home with them, and they see that's a joint MIT-Tsinghua product.

However, our Tsinghua colleagues, and I think this is fully right and expected, also meet individually behind closed doors without Western faces in the room and present their results of the modeling exercises and the thought process to members of these different bodies in much more of a kind of intimate setting.

I think the idea there is to, I think that signals that these are, I mean they certainly mention MIT but may downplay that. That's fine. I mean that's sort of, that's actually one of the nice, in my view, features of this model of collaboration is that the consensus can be based on the science, that it can be developed jointly within the research team, and then we also go to our sponsors, some of which is a U.S. company and say, look, we see this. And they say, wow, that's a business opportunity for us.

So there are benefits on both sides beyond just the joint product of the outlook. It's also communication around these issues based on knowledge that we're generating.

COMMISSIONER TOBIN: Since you've got findings that could be at different points, down at the province level, potentially dangerous and therefore political, are you having things edited out? How many years have you been doing this for them?

DR. KARPLUS: This is our third year.

COMMISSIONER TOBIN: Okay.

DR. KARPLUS: And we have actually so far not had any issue around publicly communicating the results of our studies to the government officials in Beijing. Sometimes we discuss carefully which of the results we want to publish in academic papers given that I think there's a view within our team that the information should go to the people who maybe are closely associated with our group.

We want to be constructive in the policy process in China. We're not there to point fingers, and above all to do it in peer-reviewed publications, which, I'm not sure how many people ultimately read some of the analysis that we put out through those outlets anyway. So, again, I think we try to be very sensitive about data issues and kind of head off at the pass.

I think because there's so much effort in the policy community in China to address air pollution and energy security and with it climate change that people, the national policymakers really want to know what's actually going on.

COMMISSIONER TOBIN: Is it covered by the press or is it largely for specifically the policymakers?

DR. KARPLUS: It's covered by the press in the U.S. When we come out with a paper, it goes out through a press release process, and then it's widely disseminated, and we do get calls from media and the U.S., Europe, sometimes sort of specialized outlets in Hong Kong that cover China. It usually does not go out through the media in China.

COMMISSIONER TOBIN: Okay. And the other part of the question.

DR. KARPLUS: Oh, sorry. So around--could you repeat that, please?

COMMISSIONER TOBIN: Sure.

DR. KARPLUS: I'm sorry.

COMMISSIONER TOBIN: You have worked with your partners in China, and you have modeling tools, and this will be used over time. Is this model and tool something they will independently be able to use? Have you structured that in? Is it something that you foresee for the next 50 years?

DR. KARPLUS: Yes. Thank you.

So the answer is yes. We absolutely would see as one of the goals of this project as not just having the model at Tsinghua, having it used by students, but having it deeply understood by the students. I think there has been a culture of going out and kind of amassing models just for the sake of having the code somewhere in the library.

I think one of the explicit goals of our project is actually to build capacity around understanding, using these models, and with it, the logic and the policy, the sort of decision-making support power that these tools can possibly have in their own energy and climate policy discussion. And that actually means that you have groups in China that are prepared to engage in discussions based on a shared set of tools, given that we have our own separate version of the global model that we've developed over 20 years at MIT.

We actually view it, it's kind of one of those rare cases where it's good if groups develop models that can be used to look at some of the same questions, and then over time, as their

model diverges, maybe includes different features, is used for different questions, we can engage in that kind of discussion on where do our models diverge in terms of predictions and so on.

COMMISSIONER TOBIN: If I mayjust say that last summer on our Asia trip, we were focusing on food safety, agricultural practices, and we were at a marvelous university center, and one of the things we talked about with the faculty and the students there is how they could perhaps play a more active role in insuringquality going forward. In a way they should be almost training people for that.

So there could be some shared knowledge that could serve other industries that are trying to become more effective and safe.

DR. KARPLUS: Thank you.

COMMISSIONER TOBIN: Think on that, agriculture and food.

DR. KARPLUS: Great. Thank you. Yeah.

HEARING CO-CHAIR GOODWIN: Commissioner Wessel.

COMMISSIONER WESSEL: Thank you.

My wife has become somewhat of a connoisseur of The Weather Channel, and over all of our storms this year started arguing to me how the European model of weather prediction was better than the U.S. model so I hope that your model will become sort of that standard of The Weather Channel, and you actually can make this something that is brought down to the public level--my wife has a very high degree of intelligence--but down to the level where the public is actually asking how policy changes will be reviewed by your model, what the outcome will be. That it will actually help drive some of the decision-making; so I think what you're doing is very vital.

Dr. Fletcher, I have a slight disagreement with you in terms of how far advanced the Chinese are in their IP enforcement, but be that as it may, what I'd really like to understand, from your discussions, one of the things we lack is a cooperative relationship with the Chinese on this.

And here we have what is a critical area. I think anyone who goes to China or knows what's going on there knows how bad pollution is and knows that it is something that is on the minds of the average citizen there everyday.

Could this area of technological development IP be an area where maybe there's a model of nearly joint enforcement, understanding it's the Chinese court system? They have to do what's right, but are you seeing willingness for them to look beyond the current model and find a new cooperative effort here?

DR. FLETCHER: Well, I think there is one being developed. A good share of, if you read the TMP, which has been talked about today--it's a Technology Management Plan, but it really deals with IP.

But it was one that was written and developed jointly with the Chinese with the idea that it had to mean the same things in both countries even though the laws were different, and that was a very difficult thing to do.

I didn't mean to imply that I thought that the IP issues were good enough in China.

COMMISSIONER WESSEL: No, no, I understand.

DR. FLETCHER: But I think it's coming along.

COMMISSIONER WESSEL: Yeah.

DR. FLETCHER: And what we've seen in this is, first, tremendous interest in China. When we, this was something that was agreed to by the two countries in terms of the protocol.

When we went to China the first time and met with our Chinese counterparts, they thought the IP part was going to be another research question, and they didn't realize at all that they had to do something about it. And so what I'm saying is that the whole issue of IP has been growing very rapidly in China. It's changing very rapidly in China.

Their laws have been rewritten a couple of times over the last --I'm not saying they're mature, but they're certainly different, and they are certainly growing significantly.

So I do think we're starting to develop methods of cooperation. At one of the workshops we held in Hainan, they had one of the representatives to the equivalent to the Supreme Court there trying to understand what was going on in IP. So it is getting attention at the higher levels.

There certainly are issues where there are people that are trying to short-circuit the system. That's actually true probably in the U.S., as well, but I think we're at least working in an area and on an issue that has, that goes well beyond what we're doing.

The implications for changes in IP, the last workshop we held last spring in Stanford, started out by the coal group, but we had all the high tech folks from Silicon Valley there. They are very much aware of the issues, and they are very much trying to engage China on it.

The first time I went to China in 2001, you could buy--this was just when China had joined the WTO.

COMMISSIONER WESSEL: Right.

DR. FLETCHER: But I had a student that took me down into one of the underground places in Beijing, and Microsoft had announced new software the week before. It was all available for a buck a CD in China. That's not true anymore.

COMMISSIONER WESSEL: It is true. It may be a little more limited. You may have to know which door to knock on, but it's still there.

DR. FLETCHER: But it's true somewhat in the U.S., too.

COMMISSIONER WESSEL: No, no. I Understand. You know we have met with and heard testimony from many business leaders who have had problems.

DR. FLETCHER: Oh, yeah.

COMMISSIONER WESSEL: And many don't know how to access the Chinese system. So what you're saying is important, if there's a way to impart upon the Chinese that if there's a way, because there is such a critical area, that there can be some new model. Maybe it's a Chinese ombudsman who would work with U.S. entities to say when there's a problem, how can we work rather than just hope the system works? Can we walk people through it?

DR. FLETCHER: And we're trying to do that.

COMMISSIONER WESSEL: Good.

DR. FLETCHER: One of the things that's happened with the CERC is that it started out there were the three issues. The IP issues have become so visible that at DOE, Bob Marley, who is the director of the U.S. operation, calls the IP his fourth CERC, and he's gotten separate funding from the State Department to actually support some of the issues with IP development.

It's certainly not a done deal. It's certainly not something that's not influx, but it is certainly something that, and depending on which court you go to in China, you may get a different answer. I think we're aware of that as well.

But it is one that the Chinese do know they have a problem with if they're going to engage in the world markets. We argue with IP even with our European colleagues and with everyone else. So it is a contentious issue, and it's one that's changed drastically in the U.S.

When I started as an academic, anything universities did were basically in the public

domain. With the Bayh-Dole Act, we changed dramatically in terms of the way we deal with IP.

COMMISSIONER WESSEL: Uh-huh.

DR. FLETCHER: And so I think that it is something that we will continue to struggle with in terms of how do we manage what's best for our society and our country? What do we protect? What do we not protect? How long do we protect it? How do we make sure that it does what's best for our people and our countries?

COMMISSIONER WESSEL: Well, if you can continue to keep us updated on this, this is an area where there's a lot of shared expectations, hopes, and hopefully outcomes.

DR. FLETCHER: And angst.

COMMISSIONER WESSEL: And angst, but, again, it's critical to both our countries. So maybe this is one of the areas that can be a leading edge in terms of creating some confidence. So thank you.

HEARING CO-CHAIR GOODWIN: I want to thank the witnesses for being here today and for all your time, Dr. Peng, Dr. Karplus, and, Dr. Fletcher, I especially want to thank you. As a fellow West Virginian, seeing this type of important work going on in our state's flagship institution of higher education is really a great thing. So thank you all very much.

We're adjourned.

[Whereupon, at 1:00 p.m., the hearing was adjourned.]