UNEDITED TRANSCRIPT

2018 US-China Forum — Chinese Leadership in Global Clean Energy Investment, Green Finance, and Sustainable Infrastructure Development

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FOR ECONOMICS AT UCHICAGO

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MICHELLE CARUSO-CABRERA: So the panelist, Chinese leadership in global clean energy investment, green finance, sustainable infrastructure development. Let's tell you who's sitting here. Starting the far end of the stage, Michael Greenstone. You're probably familiar with him. Milton Friedman Professor in Economics, the College and the Harris School, and the director of the Becker Friedman Institute. This is out of order, here we go. There it is. Richard Sander is chairman and CEO of the American financial exchange, the [INAUDIBLE] director lecturer in law and economics, the law school at the University of Chicago. Hold on, got this in different orders here. Wow. I thought I set this up.

Here we go, is vice chairman of the Paulson Institute, which she helped launch. Senior advisor to the chairman on US-China relations and also helped to devise an established the US China Green Fund, which is going to be a significant part of our discussion today in terms of what they're seeing on the ground in terms of investments. P'in Ni is president of the Wang Xing American Corporation. It's a company he started in 1994. Company's revenues grew from $0 to $4 billion to date. All kinds of investments, automotive, clean energy, real estate. Real on the ground investor with market-driven incentives.

Good to have you all here. Michael, I'm going to start with you. If you could set the stage for us. Chinese leadership in green energy, what is the state of the environment and what's going on in China right now? You've got some good slides.

MICHAEL GREENSTONE: Yeah, excellent. Thanks, I'm going to break all the slide rules here at once. So I think this picture helps illustrate what I think of as the global energy challenge, of which China is really at the absolute center of it. And this picture, when I think of the global energy challenge, I think of it as a stool that has three legs. And all three legs are illustrated very clearly in this picture. This picture is from Beijing a couple of years ago.

And what you can see in anyone who's been to China will recognize it, is like it's a place on the make. There's lots of motion, there's lots of action. It was not very long ago that our guy in the cab was probably on a bike, and it's not going to be very long till the guy on the bike is going to be in a car. And in the last 25 years or so, China has had, I think, a historically unprecedented increase in living standards. Almost all made-- made it possible by enormous increases in energy consumption.

The first leg of the stool is how do you make sure that societies get access to the inexpensive and reliable sources of energy that are necessary for improvements in living standards. All that's embedded in that picture. The second leg of the stool is also embedded in that picture. And that's in the process of doing that, how do you avoid severe health and environmental problems associated with that energy consumption?

And so it's the middle of the day and you can't see the sun. That happens in Beijing some, less than it used to. And everyone is aware of it. The guy on the bike has the mask on. And you can tell people are cognizant that this growth has come-- the downside of that has been exposure to air pollution and health problems associated with that. The third leg of the stool is also visible in-- or it's not visible in this picture, but you know it's there, which is the same fossil fuels that are driving all this income growth and causing all this pollution are also involved in the release of CO2.

And that CO2 is increasing the odds of disruptive climate change. So I view that as the global energy challenge. How can societies, particularly China, find ways to balance between all three of those goals? It's not hard to think of policies that are going to be effective at achieving one or sometimes two of those goals. But to get all three, you're going to require tradeoffs. And so let me talk about those for a couple minutes.

So this is just some data about leg one of the stool. And in economics, you don't really often see graphs like this. What it reveals is just an enormous increase in energy consumption, which drove most of that income growth. So between 1990 and 2010 energy consumption went up by a factor of three. You can see going out to 2040, there's expected to be very large increases, further increases in energy consumption. And importantly, the three gray bars, or blobs at the bottom of there, are the fossil fuels.

And so much of that occurred because of fossil fuels and is projected as you go out to 2040 to continue to be driven, the energy consumption, by fossil fuels. By 2040, fossil fuels are projected to still account for 80% of total fuel consumption in energy-- in China. OK, so that's leg one. Leg two, that air pollution that was so visible and was hiding, obscuring the sun in Beijing. Here's some where Chicago and the BFI were going to release something called an air quality life index in a couple weeks.

And here's a map that comes from it. This is a map using satellite data of PM2.5 concentrations in China. And you can see that the average person lives with about 40

micrograms per cubic meter of PM2.5. That's against the WHO, the World Health Organization standard, of about 10 micrograms per cubic meter.

Now, what are the consequences of that? To what are the consequences of the guy driving the bike and having to breathe in air like that? The second part of this air quality life index is it provides a way to measure that. And here, the different colors relate to the number of years of life expectancy that would be gained if each of those areas were brought into compliance with the WHO standards.

And so at country wide, if the entire country was brought into compliance, the average person would gain about three years of life expectancy. And now this is a first that we're going to try and pull off, a live action slide, but let's see how this goes. And what it will show you is how that varies across different parts of the country. You can see that from the colors.

But hopefully we'll do this with some animation here. OK, now there's China-- OK, now we're moving to different regions. And this data is available at the district level. And we're going to zoom in on Beijing. So in the case of Beijing, the average person would live about six years longer if Beijing's air quality were brought into compliance with WHO standards. And it just underscores this tension between all the energy consumption that has happened and that people want to continue to have that has to be balanced against the pollution problems.

Now, the third leg of the stool that I want to highlight is the possibility of disruptive climate change. So this same fossil fuels that are causing all that air pollution are also increasing the odds of disruptive climate change in the world. And to put it into perspective how critical China's role is in resolving this problem, I created this graph, which shows the share of greenhouse gas emissions in the atmosphere that are due to three big countries, the United States, India, and China, from the beginning of the Industrial Revolution to the present.

And you can see that in the United States' case, although we're only 300 million people, we account for almost 18% of those emissions. India is about 4%. And China is 12%. But I want you to see, and this is cumulative, I'm going to now move forward in time to 2050. And you can see that this starts to change quite dramatically. The United States share is down to 16%. And you can see the Chinese share really start to increase.

And if you go to the end of the century, what will be true under standard projections is that by the end of the century China will account for about a quarter of all cumulative emissions. And what that highlights is it doesn't take-- without taking a stand on who should pay for it, that

there is no solution to the climate problem that doesn't run to greatly altered reductions in greenhouse gas emissions from China.

So to summarize, I think Chinese-- the Chinese and the global energy challenge all involve these three goals, some of which are in conflict with each other, that China and the world are going to have to navigate as we move on.

MICHELLE CARUSO-CABRERA: Thank you for setting the stage. That's perfect. As I like to do, refer now, most of the times first, in this case you're second, but generally to our visitor from China who can help speak about the situation firsthand. P'in, tell me, you have an investment fund. I assume that part of your investment thesis is helping to eliminate some of the problems that Michael is talking about. Tell us about what you're doing in terms of investments when it comes to green energy there, and what impact it's having.

PIN NI: Sure. So I just recognize the difference between professional and non-professional.

MICHELLE CARUSO-CABRERA: He's a professor, you're a-- you're an active doer.

PIN NI: I couldn't get into UC. So I don't have the--

MICHAEL GREENSTONE: We like to talk. You like to do.

PIN NI: Yeah, but I do have a bunch of experience, good experience and bad experience. So let's be honest, you know, many years ago when we started business in the United States, our goal was very simple, just to make money, as much as you can as fair as you can. Then our chairman really set up a goal to say, hey, while we are making the parts for the auto industry, which create a lot of pollution, one of the reason for Beijing, you know, everybody's complaint about is the bumper to bumper, you know, the car produced so much pollution. So you know, that's a major issue.

So the goal to setup at the time was saying, hey, let's try to see if we can look into the clean energy space. And is that feasible? Is that possible, business-wise, would that be a smart business decision and so forth and so on. So we had a lot of debate. And I personally at that time did not believe it. And the reason I didn't believe it is because I do see a lot of

government money coming. And I usually would like to say, you know, the government usually screw up the industry, not helping industry.

MICHELLE CARUSO-CABRERA: You'd fit in fine here at the University of Chicago, by the way.

PIN NI: OK, OK. And so, you know, but one thing I missed that that time was the technology impact. And I remember we were in DC for the energy conference between US and China. And Secretary Chu, he was the Secretary of the Department of Energy. And he was talking about the solar industry. That was 2011 in January. He was talking about-- Hank knows this. And the solar industry he say, actually, he published a paper saying that hopefully one day the solar industry will be at the $0.50 per watt.

At that time, it will be equal to other energy source. And so people can afford it. It doesn't need to be the government's subsidy anymore. And we were building the plant in Rockford, Illinois, not too far from here. And our budget was a $3.50 per watt at that time. And we had a contract for $4. So it was great. Was wonderful. And now, yesterday, when we had our weekly meeting, the market price is about $0.38 to $0.41.

MICHELLE CARUSO-CABRERA: Wow.

PIN NI: So even Secretary Chu was wrong because he was thinking, you know, far down the road this is going to be there. But now we only are seven years. And not only the solar energy is affordable, but to some extent, in many other cases, it's more competitive energy source.

MICHELLE CARUSO-CABRERA: So just so I understand, so it's $0.38 to $0.41 per kilowatt? Is that the--

PIN NI: We talk about per watt.

MICHELLE CARUSO-CABRERA: Per watt.

PIN NI: Per watt. And so we see the solar sort of roll it out very, very quickly.

MICHELLE CARUSO-CABRERA: Coal is what per watt?

PIN NI: I would say-- let me give you another example on the coal side. China has a huge reserve on the coal, especially on the west part of China. So due to the transportation logistic costs, was not economically feasible to gather the coal from there to the east coast.

MICHELLE CARUSO-CABRERA: Heavy to ship.

PIN NI: Yeah, which is the major demand for the energy consumption in China is on the east coast. So many years ago, we look at the technology in the United States, a great technology, originally invented by Shell. It's called coal gasification. So you can-- it's ideal because natural gas is in such short, you know, supply situation in China.

So if you can gather the coal, gassify it, that would change everything. So we put more than $100 million in that company. And after three years we realized it's not going to go. And in fact, not only us, I think China has done more than $10, $11, or $12 billion coal gasification project, by Sinopec, by [INAUDIBLE], by many other companies. Every single one of them failed.

MICHELLE CARUSO-CABRERA: Failed.

PIN NI: It's not about technology of the coal gasification. It's about the shale gas technology. It completely changed the landscape and the gas prices, you know, got pushed down so low that coal gasification is no longer feasible. So that is another lesson.

MICHELLE CARUSO-CABRERA: I guess what I'm just trying to get at, is when you talk about $0.38 to $0.41, which is much lower than what you were thinking, where does it fit competitively versus fossil fuels? I mean, when I see that chart that Michael put up, and coal's going to be one of the biggest suppliers, it says to me that's got to be because it costs less.

PIN NI: Yes. So I would say, you know, again depending on the region, if you are in Hawaii, the

electricity costs you about, could up to 20-something cents per kilowatt hour. If you are in Chicago, in the suburb, it's about $0.04, without the delivery costs which come at a charge, no matter how. So I would say the solar energy cost-- now, this is only the panels.

So you have installation. You have inverter. You have all the others. So it could be anywhere between $0.04 to $0.06 and then you can still make money on your solar farm, which we have. We have one in Rockford. If we didn't make money by making the solar panel, we've made a lot of money on producing electricity.

MICHELLE CARUSO-CABRERA: OK, I guess I'm still to the $0.38 to $0.41 on the renewables versus what on the fossils.

PIN NI: No, that's on the panel cost a watt.

MICHELLE CARUSO-CABRERA: OK, but that's a renewable, right?

PIN NI: Yeah. When you convert into the kilowatt hour, which is energy cost, you could be anywhere between $0.04 to $0.06 to $0.08, depending on your installation cost. So that's where we are. So I would say the solar is very competitive. Obviously, it's less cost competitive if you only install five panel on the roof, which is going to be a lot more costly. compared to you build on the vacant land and the land has no real estate tax on there. It's very easy to mount to the solar panel. Then you can be very competitive.

MICHELLE CARUSO-CABRERA: To fossil fuels.

PIN NI: That is correct.

MICHELLE CARUSO-CABRERA: Deborah, tell us what the Paulson Institute is doing in the US China Green Fund.

DEBORAH LEHR: Great. Before I get into the details, I just wanted to set the stage just a little bit on that the Green Finance issue, because I know during this conference there's been a lot of discussion

about US China relations and the tensions that are rising. And typically, as we have followed these issues, there are three areas of cooperation between the two countries. One, you know, security and diplomacy, foreign policy, trade and investment, and the other was cooperation on sort of the common good issues.

And climate change fell right in the center of that. And as the administration is moving away as a policy issue from climate change, China is the one who is out there kind of leading the charge. And as we've heard a lot and as Michael was saying, China is the big player. And what China decides to do will have an impact not only globally, will have an impact on America's interests.

And China has demonstrated that they've got the political will to try and address a lot of these issues. But as we have seen through Paris, there's lots of countries who have the political will and the good intentions to try and address climate change. But they've come across one major obstacle. And that's how to pay for it. And as China is looking at what its obligations are in the green finance area and meeting its obligations on climate change, estimates are it's going to be almost a trillion dollars per year for the foreseeable future. And the government can only cover about 15% of those costs.

So therefore, they have to look at how they can put together the right combination of market mechanisms, of enforcement, of policy, of incentives, to then attract the type of capital necessary to finance their change and address those challenges that Michael was talking about. China has announced a very ambitious policy around green finance. In fact, Xi Jinping in May announce that they were going to really expand what they're doing.

Two years ago, China launched green bonds and already they, in their first year, they were actually the largest issuer in the world. Ironically, the US took over last year as number one. This year they're on track again to be the largest in the world. China launched a national carbon market. And I know that we'll hear a lot more about what's going on in the carbon area. But just because it's China by the mere fact that it launched this, it was one industry, 7,000 companies that are trading on it, or hoping to be trading on it.

But already it's the largest carbon market in the world. And China's the leader in fintech and fintech is getting into the game to try and gamify behavior around climate change, and helping this transition to low carbon. In fact, Amp Financial has a game that it has participants larger than the population of the United States. And it's a game, and maybe many people here play

it, it's on WeChat. But a game where you compete against what your carbon footprint is each day. And you earn points.

And you can build a tree online. And when you actually build that tree, it's a commitment they have with an NGO to go out and plant a tree. And they have planted 15 million trees in about the two years that they've actually had this game going on. And so you can see how it starts to change behavior. And China is seeking very innovative ways to try and price pollution. They're now looking at how they can set up and put a price on the right to pollute the air, to pollute the soil, and to pollute water.

So in addition, in the steps that they're doing at home, China is also hoping to become a major exporter of green finance. And this is going to have implications around the world and implications for the United States. They are already in discussions with countries in Southeast Asia, in the Middle East, and in Africa about setting up carbon exchanges, for example.

And they would set these standards up by a Chinese standard, by Chinese rules, and allowed then these companies to be able to trade on China's national carbon exchange. And the Belt and Road, Xi Jinping's big foreign policy effort, is another major initiative. China has pledged that it is going to have green standards applied in the build out for this. And there's a huge amount of need for infrastructure building. The ADV actually estimates that there's about $8 trillion needed to build out just in Asia, the infrastructure there. But if that building isn't done right, it's going to have serious implications.

And there are estimates that have been done recently by the UN to look at this, that if the build out isn't done by green standards, within 10 years that build out and the BRI countries could have a carbon footprint that's three to four times larger than China's is today. So the implications are significant. So it's important both that they get the standards right but we find creative ways to look to finance these.

And so that's what the Paulson Institute is focused on. And we're looking at a number of different things. One is working on voluntary financial standards for countries who are providing lending to the Belt and Road. But we also set up about two years ago the US China Green Fund. And the focus of the fund is to look at finding and sourcing the most innovative US technologies, and not bringing the company but bringing the product to China and deploying them.

And one of the biggest obstacles is a very simple thing in employing these technologies is

people just don't know how to use them. So we have a center that works in training contractors, and architects, and others of how you actually deploy these technologies in creating greater energy efficiencies. And our start had been focused on building energy efficiencies. And actually today is the second year anniversary of the launch of our fund.

MICHELLE CARUSO-CABRERA: So we want to get to more of that, but I'd like to get Mr. Richard involved here. She's talking about carbon exchanges. You helped establish one of the first ones in China. Weigh in what you've heard here. I know you've brought some great slides too.

RICHARD SANDOR : Thank you. It's really great to be here. This university has helped me realize my life and my dreams. And my mentor, Ronald Coase, helped me steer my way towards climate exchanges, per se. I want to pick up on what Michael said because I think that there is a general lack of understanding how powerful pricing and externality can be. And if we take a look at the--

MICHELLE CARUSO-CABRERA: Pricing and externality, pricing the cost of a repercussion of something.

RICHARD SANDOR : Yes. In 1960, Coase wrote an article on the theory of social costs. And he suggested that there were other ways besides command and control and taxes and subsidies--

MICHELLE CARUSO-CABRERA: Command and control, when the government from the top decides this is the way it's going to be versus a market system.

RICHARD SANDOR : Right. So in there, the seeds of that were a market system. And a market system, you put a cap on the amount of emissions. And then if Richard Energy can't reach his cap because he's not good at it and hasn't got enough land to build a scrubber device to take things out of the air, but Deborah energy is Michael energy and far better, and they can innovate, they can reduce more or get below their cap and Richard Energy can buy it, and yet systemically we've reduced.

So that's called cap and trade. In the United States in the '80s, we had a vast problem with acid rain. You know, even Michael Douglas made movies like Black Rain. It was a metaphor for the end of Western civilization as we know it. And if you take a look at concentrations--

MICHELLE OK, here comes your graphics.

CARUSO-CABRERA:

RICHARD SANDOR : Acid rain, this is what it looked like. Rivers were being acidified. People were dying of lung diseases.

MICHELLE CARUSO-CABRERA: Rivers caught on fire they were so polluted. There were moments it was so bad.

RICHARD SANDOR : Yeah.

MICHAEL GREENSTONE: Not in Chicago, but in Cleveland.

RICHARD SANDOR : Never in Chicago. So we passed something called the Clean Air Act in 1990. It called for a reduction first to 50% and then 75%, to be phased in over a decade. And that act passed. And one important thing is we did the first trade, the predecessor to my company. And it wasn't actually carbon trading, buying and selling SO2. Everybody thinks of this as a market.

It was actually a financing transaction. There was a utility in Kentucky that had to build a $50 million scrubber. They were going to borrow and do construction financing and then bond the rest of it, finance it through bonds. And the city was highly leveraged. Interim construction financing was high. Building the scrubber was $50 million. We went to them and said forget all of that. By the time you build your scrubber, you will be well below the cap.

So we will present value, that is taking 30 years of SO2 reductions, give you $300 a ton, and then we will sell that to a Carolina utility that had no acreage to build a scrubber. So if you look at it, it looks like trading of tens of 1,000 of tons. It was nothing more than financing a construction in Henderson, Kentucky, and then finding the hedge. It had-- we had to finance on the other side, and issue a zero and do a whole bunch of things. But ultimately, it was financing.

So what happened in the United States after 1990? And I think the next map is instructive. We went from 18 million tons down to 9 million tons, down to 4 and 1/2 million tons. And we're now at a 90% reduction. Following on Michael's work, which I have such great regard for, we don't put it in the context of human lives and what it means. So what did that mean?

If you go to the EPA website, that first nine million, which was low hanging fruit, really according to the EPA, reduce medical expenditures by $148 billion, annually, at a cost of $3.5 to $4 billion. I don't know--

MICHELLE CARUSO-CABRERA: Total.

RICHARD SANDOR : Total.

MICHELLE CARUSO-CABRERA: I want to understand something. The progress that was made, you're suggesting it was because of the Clean Air Act or because of this financing tool that drove incentives?

RICHARD SANDOR : It was the Clean Air Act, which put a price on SO2 emissions. Some of it could be used for financing. Some of it to be used for trading and annual compliance. The point I'm trying to make, that sometimes what's thought as an annual trading system can be a 30 year stream and can be a financing technique.

So it's not just buying and selling Apple stock or soybeans or cryptocurrencies. It's actually a financing tool as well as an annual--

MICHELLE CARUSO-CABRERA: Are they doing the same in China?

RICHARD SANDOR : The question is perfect and I'll get into that. China, by comparison, has 36 million tons of emissions vs. 18 million at our type. If you do the math, arithmetic, and say we had 150 billion annual gains and 9 million tons of reduction, there's four times the population density in China, so the health effects are such--

MICHELLE CARUSO-CABRERA: Huge.

RICHARD I make a back of the envelope kind of sixth grade economics that that's a trillion dollar drag on

SANDOR : the Chinese economy and--

MICHELLE CARUSO-CABRERA: In health care costs.

RICHARD SANDOR : In the health care costs annually, 10% potentially of GDP. We're talking and that's one pollutant. That's not NOx. It's not mercury. And it doesn't even touch on carbon. So let me kind of with the three minutes I have left, tell you--

MICHELLE CARUSO-CABRERA: One minute.

RICHARD SANDOR : Then I'll wait for the Q&A. We started the first climate exchange in China. And actually, our job was to raise awareness. And our job was to coin something called climate exchange. We did it when we coined something in '74 called derivatives. You have to have a name for something. And it can't be complicated. And everybody has to sum it up.

MICHELLE CARUSO-CABRERA: Branding is important, yes.

RICHARD SANDOR : Branding. We were there to brand, raise awareness, and educate. The US quickly, you pass a law, you get the Environmental Protection Agency, then you build an exchange, and then you design the contract. Four elements of costs. China, nothing like that. You set off in 2005. You visit NDRC. You visit [INAUDIBLE]. You visit MOST, the Ministry of Science of technology. You visit CSRC.

You have to find a strategic partner. In our case, it was CNPC. You make 30 trips there and you host from morning to breakfast to evening. You speak at universities. You lecture. You build a brand. And the final point is, we ran a public company, we got a great bid. We sold it out. We own 25% of the Tianjin climate exchange. And for those who might be skeptical about China and where it's going, we sold it to the New York Stock Exchange.

Ultimately those shares became owned by Alibaba six months ago. So this is telling me something. When the high tech companies and the fintech companies end up owning a share in a climate exchange in the city of Tianjin. It's, I think, something we should be aware of.

MICHELLE CARUSO-CABRERA: Michael, I see you wanting to weigh in here.

MICHAEL GREENSTONE: Yeah, so since I made more slides than everyone else, I thought I would [INTERPOSING VOICES] turn to this. I think what Richard is--

MICHELLE CARUSO-CABRERA: Can we bring up the slide that he's got here on the screen in front of him? Thank you.

MICHAEL GREENSTONE: Yeah. I think what Richard has highlighted is China has these multiple goals. One is how to keep consuming lots of energy in the name of further economic growth. Incredibly important goal. The second is how do you do that without also leading to the health problems that Richard was talking about. What's very striking is that they're, I think, they're pursuing multiple approaches. Through Richard's work on the carbon exchange, they're using kind of market based approaches that are being shown over and over to be the most cost effective.

Simultaneous, there's also in 2013 the premier declared a war on pollution. And really turned particulates pollution, which is the source of largest health problems. Put that right in the bull's eye. And in four short years, there have been incredible reductions across the country, maybe 20% to 40%. All this is illustrated here. All the white areas are areas where there isn't monitoring. And just to put it in context, in four years they achieved pollution reductions that it took the US after the passage of the Clean Air Act in 1970, a dozen years and two vicious recessions. China continued to grow and they got 20% to 40% reductions.

If those reductions are sustained, they can expect to have improvements of life expectancy of about 2 and 1/2 years. So as Richard was highlighting, there's a lot of low hanging fruit. Now currently, not unlike with CO2, with particulates, they're pursuing that in a very ham handed kind of command and control ways. Shutting down businesses. Declaring that you can't use coal. And without allowing markets to work.

And I think the challenge going ahead will be to get further reductions or sustain the ones they've achieved, but to do that in a more cost effective way. And I think that's in front of them to be grabbed. And Richard's highlighted the markets for pollution can work in China.

RICHARD SANDOR : I think there was a slide up here--

MICHAEL GREENSTONE: Backwards maybe.

RICHARD SANDOR : Backwards.

MICHAEL GREENSTONE: Yeah.

MICHELLE CARUSO-CABRERA: That one.

RICHARD SANDOR : Yeah, [INTERPOSING VOICES] I think what's interesting if you take a look at the use of markets as a tool, you'll notice some in Mexico. You'll see in California. You'll see a European Union, ETS. You'll see the beginning of markets in India and China. It's important to note that the adoption of market-based solutions to environmental challenge is directly proportional to the distance from Washington DC.

The further you go, the more there is the adoption of markets. And in particular, look carefully at California, which has now a bipartisan cap and trade program. And look to China. And if one takes a look at progressions and financial innovations, and the ones that I've had some experience in, whether it's the Dutch East India Company in 1605-- I didn't have experience in that-- or acid rain or Ginnie Mae's, or we trading, it's a 20 year cycle.

And same as power steering, which was invented--

MICHELLE CARUSO-CABRERA: I'm sorry to interrupt you, but here's the thing. Michael put up a slide earlier that showed that actually US emissions are going down. And the data shows that. So I understand, OK, they've got the further away you get from Washington, the more likely you are to have some kind of market-based system. But it sounds to me like we have actually been very efficient with the private sector here in achieving some of these reductions that we'd like to, right? I mean, compared to other parts of the world.

Square those two things for me. This is-- am I reading the data wrong?

RICHARD SANDOR : There's a couple of things. You have, and I think is very important to understand for the audience, if you take a look at the size of the gold open interest, which is, in fact--

MICHELLE CARUSO-CABRERA: Gold open interest, so if you trade gold how many people are interested-- to generalize-- how many people are interested in trading gold, yes.

RICHARD SANDOR : What percentage do you think environmental markets in North America would be of gold? Would they be 10%? What does--

MICHELLE CARUSO-CABRERA: I don't understand the question.

RICHARD SANDOR : If the gold market is at x, what percentage would environmental market--

MICHELLE CARUSO-CABRERA: In terms of how many people want-- what would the open interest be at the environmental-- you're saying it's less or more? I don't--

RICHARD SANDOR : Well, one would think gold is a pretty widely traded commodity and that it's worldwide of interest. Anybody here know of environmental markets in the United States? Probably not. You will be surprised to learn that North American environmental markets are 20% bigger than the gold market in the United States, between California, [INAUDIBLE] renewable energy certificates.

MICHELLE CARUSO-CABRERA: That's dollar volume? That's contract volume?

RICHARD SANDOR : Contract outstanding, breadth of the market.

MICHELLE CARUSO-CABRERA: And is that why we have the numbers that I talked about.

RICHARD SANDOR : I think it's far more pervasive. And what [INAUDIBLE] was saying, we have-- there's a price out there at the local level for renewable energy, for recs. There's a lot of buying for voluntary markets. And a lot of this is spurred by price of carbon or anticipation of a regulatory regime that might come back. And so the technology, of course, is fostered by a million other things wind, efficiency, solar, an inexorable trend away from coal.

I served on the board of American Electric Power, which was the biggest consumer of coal in North America. In my class here, we had the CFO come last year right after the announcement that coal is going to be revived out of Washington DC. And he said quite flatly, we will never build another coal plant in North America.

MICHELLE CARUSO-CABRERA: Because it's not economical?

RICHARD SANDOR : No, natural gas.

MICHELLE CARUSO-CABRERA: Right, other things have come down in price.

RICHARD SANDOR : It took to build anything, the environmental lawsuits, the risks, the BUCs, all of these things make-- coal is a civilization gone with the wind. It's not coming back.

MICHELLE CARUSO-CABRERA: On that note, I want to talk to-- pin in here because Michael mentioned the command and control, the back and forth decisions instead of maybe using market incentives, just simply shutting down businesses because they pollute. What's that like on the ground for you as an investor in these kind of technologies?

PIN NI: Sure. There is no doubt, you know, first of all I would say the Chinese government's more effective, more efficient--

MICHELLE CARUSO-CABRERA: China's market?

PIN NI: China government.

MICHELLE CARUSO-CABRERA: Chinese government.

PIN NI: Yes. So that is the issue in term of one is that obviously they can shut down the plant very easily. But that's not market-based initiative. So in the long term, it could have impact. But I just want to echo what Michael was just talking about. China took two, three years to the war on the pollution, you know.

MICHAEL GREENSTONE: Incredible achievement.

PIN NI: And now at least you can still see the blue sky in Beijing now. Actually when I saw your picture, it rather reminded me of a joke in Beijing. A taxi driver didn't see the stoplight, so he ran through it. So he was complaining. He say, Jesus, I'm going to get a ticket. So the passengers sit back and said, no you're not. If you didn't see the stoplight, how did the camera see you? How could the camera see you?

So it was very bad at the time because I remember, we have customers-- we once set up a meeting in Beijing, usually people say no. We want to go to Shanghai. Or better is in Hong Kong. So it is very effective, no doubt.

MICHELLE CARUSO-CABRERA: They don't want to go because the pollution is too high.

PIN NI: That is correct. That is correct. I had one guy moved back to Beijing. He had to install the air filter in every single room he has. And then he say he doesn't even go out. You know, if he goes out he will, just like in the picture, you know, wear the mask. So anyway, so that is very effective. But it does come with a lot of penalty. That's the balance the Chinese government is struggling with, no doubt.

Because last year I remember in November, December, we basically couldn't get any product out of China at that time the reason was the central government-- the local government all commingled together with the private business there. They didn't want to shut down any plant. So I call this Tom Jerry game, you know. So the central government will have to send auditing team to where our headquarters in Hangzhou.

So they will send a team down there and that they will shut down plant. And the funny part was that the shutdown is from 8 AM to 5 PM. And then lot of plant, they know how to play this game. So they will go back in the plant in the midnight, open it up, and then finish the production before 7:00 AM. So nothing happened when the team came back.

So the team recognized and they came back. And they did the second shift. So there was a lot of this [INAUDIBLE] going on at the time. And it was effective, no doubt, no doubt. It was a very, very effective. But I still like what Richard, you were talking about, in the end, those kind of a market-based tool or initiative, then really that make this more as economic, logical for the business to pursue.

So from that point of view, I would say-- and [INAUDIBLE] you did a fantastic job. China is learning on that side. And when you have very effective government tool, then you probably don't want to pay too much attention on the other side because it's slow. It's educational process.

MICHELLE CARUSO-CABRERA: You keep using the word effective, you mean rapid, right? I mean, we would call it almost ineffective sometimes. Right?

PIN NI: Depending on the University of Chicago standard on that one.

MICHELLE CARUSO-CABRERA: Yeah, exactly. Command and control, right? You're going to shut that plant down because we said so.

PIN NI: That is correct. When I say effective, at least I couldn't recognize-- I went to Beijing I think a few months ago. It was completely different when we landed. Before that time, when we land in the airplane, I was talking about, I say, this is a like a 5:00 PM or 4:00 PM in the afternoon. How come it's that foggy? They say no, it's not foggy, it's just smog. You know, you just couldn't see the runway.

So a few months ago when I was there, it is blue sky. No doubt. So it is there. It happened.

MICHELLE CARUSO-CABRERA: So it's improving.

PIN NI: It's significantly improved, but at what kind of cost? That's really the issue is. Now, one of the--since we were just talking upstairs, and I say the private businesses are losing the confidence regarding investing more in the business today. One reason was the environmental control. Because I have some friend. They have their workshop. They say, you know what, it's too much hassle. I'm not going to go forward.

So I'm just going to shut down the plan and then move on. You know, for example, the air quality inside the manufacturing plant, nobody cares before. Now you have an OSHA standard type of sense. And you've got to have a window. You've got to have fan. You cannot let the smoke out of the grinding equipment. You gotta do a lot of things. So the cost has increased. There's no doubt.

MICHELLE CARUSO-CABRERA: And it raises that whole question that you brought up at the beginning, the growth versus the environment. Deborah, go ahead and weigh in here about what the US China Green Fund is doing in terms of trying to tackle these very enormous problems there.

DEBORAH LEHR: Great. We had decided to start with buildings because about 40% of global greenhouse gas emissions in China come from energy efficient buildings or energy inefficient buildings. And so that's what we started. And so have been working on actually buying and managing energy service companies, ESCO companies, who will source the product and then go in and actually apply them. And in the two years that we've been in business, and I should say the Paulson Institute is a non-commercial advisor, it's a not for profit. We're not involved in the commercial side, but we track this very carefully.

We've seen about returns of about 30% in the fund. And you can see that there are real opportunities for companies and using these market mechanisms to be investing. And we've seen a significant difference, as P'in is saying, in what's been happening in energy efficient buildings. Because in the infrastructure, they're now being very strict about applying the standards.

The enforcement is the thing that's really critical. I think that gets to the point of the shutting down of the factories. It's been very random. And in many cases it's been that they've been shut down for political reasons if there's a meeting going on. Like the APEC, they shut down all the factories for a certain period of time. They've been unwilling to close down factories permanently because of the job loss issue.

And we're starting to see that all kind of becoming much more systematic. And that, I think, is just an issue of over time that as they start to create the channels for market mechanisms to work, we're going to see more progress.

MICHELLE CARUSO-CABRERA: Michael, you wanted to say something?

MICHAEL GREENSTONE: Yeah, I was just going to add, I think there's this tension between the absolute need for continued economic growth and what has now become an enormous political priority for dealing with [INAUDIBLE]. And what I hear is a common view, which I certainly agree with here, is thus far, at least in case of particulates pollution, that has not been executed by using markets. It's been used, you know, you can't operate between 8:00 AM and 5:00 PM, or all these. You know, you have to shut down this factory.

The solution is just staring people in the face, which is to grab hold of markets in the way Richard described. And that, I think is the best way to navigate and minimize the tension and the trade off between the need for economic growth and continued environmental improvement.

MICHELLE CARUSO-CABRERA: What kind of impact are we seeing when it comes to all of this technology and what China's trying to do when it comes to the trade war? Is there a direct impact when it comes to, I don't know, are their products that you'd like to bring in that now have high tariffs on them? How's that playing out? Deborah, do you see effects?

DEBORAH LEHR: I can see as I started with, I think it's not so much in the tariff war, per se, but in the lack of willingness to cooperate on projects. And so a lot of the areas where there was the US and China uniting in whether it's in our kind of fund, which was looked at suspiciously because it's focused on technology, to some of the other entities that were set up between government to government that those discussions had broken down or that they're tackling not only the issues climate change within China, but together in third countries.

All of that has stopped. And so I think that's one of the things that that's going to have an impact and is potentially detrimental to the US, because then it's China's standards who are going to dominate.

MICHAEL I think natural gas is an area that is lurking as a potential real problem. I think China would

GREENSTONE: love to stop using so much coal. And as P'in said, there's not enough natural gas there, and we're just swimming in the stuff. And so the trade war could interrupt very profitable trade between the US of natural gas from the shale and being exported to China. And I think in principle, that would help China solve both of its economic growth and pollution. But the trade war could disrupt that.

MICHELLE CARUSO-CABRERA: I think it could also help solve this trade deficit obsession that the president has, right? If we started selling them a lot more natural gas, even if it's inefficient maybe to go that long a distance. But go ahead, P'in.

PIN NI: So we're seeing a perfect example about this global cooperation, why this is important in the clean energy space. So again, the same situation. In 2010, the battery for the electrical vehicle costs about $1,000 per kilowatt hour. So it's not economically feasible to have electrical vehicle without government subsidy. So we saw the Leaf, you know. Any, like in Georgia, if they cancel the subsidy, then the sales drop 90% right away. However, now the battery price last year is $209 per kilowatt hour. And now with the current trend, it's going to be $100 kilowatt hour by 2025.

So what does that mean? By 2022, not even 2025, by 2022 when you get down to 125, 130, no subsidies are ever needed and the electrical vehicle will be equal, economically, to the combustion engine vehicles. So that means that they're right on the corner. It's not too far. So now I was asked the other day, you know, what we're doing in the United States. I say, unfortunately we're not doing much because the activity going on is in China.

And also, even Europe is way ahead of us in today in terms of electric vehicle. So the interesting part is they say, oh OK, then USA is isolated. I said, no, that's not necessarily true. The very interesting part is that the core technology, even today, for the next generation, which is a solid state battery, all those technology are still concentrated in the United States, whether it's in Boston or San Francisco. And MIT or--

MICHELLE CARUSO-CABRERA: CalTech.

PIN NI: Yeah, whichever.

MICHELLE Chicago.

CARUSO-CABRERA:

PIN NI: We have argon here. And they are very good on the solid state as well. So it's kind of interesting to say we're developing so much technology here. Billions of dollars have been invested. We were looking to one company out of San Francisco. And they have a, b, c, d sample. The d sample is four years down the road. The company is already worth a billion and a half dollar. And they don't even have the a sample yet.

So there's a lot of money being spent in there. So if we have the market isolated, or if we have disconnection to the other part of the market, then this technology really have no use. So I can see that's not going to be possible. No matter how we describe it, a tree or whatever, eventually I think of that issue. I call this is a gravity issue. The gravity will pull us together. There's no choice.

MICHELLE CARUSO-CABRERA: We're going to take questions from the audience. There are people walking around with cards. We're going to start that in about five minutes. So please, if you have questions, fill out the cards. Here's something I don't understand about the move toward electric cars, to me, that just means you need a much bigger power grid to power the cars. And power grids, at least in this country, are driven by coal and natural gas, right? Maybe nuclear, but they're not-- so you get rid of the gasoline, the petroleum fossil fuel, but it's just a different reliance on something else.

PIN NI: It's a very big debate, yes. And the best argument, I'm not necessarily saying I 100% agree, but the best argument is that the power plant is industrial scale and industrial technology, which you have much better control. Consumer product, which is the car, you have much less control so the pollution, if there is a pollution, one is a controllable, centralized, you can deal on a much bigger scale, one is random on the street. You just cannot deal with it.

So that was the best argument I have seen so far. And that they do-- I think--

MICHELLE CARUSO-CABRERA: But I'm right to ask about the trade off, right? Because I think a lot of people think, oh, when I drive this electric car, it's much better environmentally. But if you're plugging it into a coal fired plant--

PIN NI: It's coal energy versus gasoline, something like that. So that was the worst on this side.

MICHELLE Richard.

CARUSO-CABRERA:

RICHARD SANDOR : We have to think about the way the grid is going, distributed power, building 1,000 mile transmission line or 500 or 100 is very expensive. And I was on the board, again, of a utility. We built a 90 mile transmission line from West Virginia, where the coal was to Virginia. And the project took 18 years, 17 years of permitting and 11 months to build.

This whole nature of being a federal republic and not allowing electricity to be shipped from one state to the other, Texas has its own grid, I think we have to take a look at distributed power and what's happening in wind and solar. And are we going to have the need for, and will the grid go the way of telephone lines in the ground and all of a sudden stop being built a decade from now? And transmission as a business is not a very attractive business.

MICHELLE CARUSO-CABRERA: That would have to mean that one of Michael's slides was very incorrect about its prediction, right? Because there's that slide, the projection for usage in the future, if we can bring that back up, I think it was slide number two, coal is still expected to be the largest provider of energy. Is it wrong?

RICHARD SANDOR : Those are incompatible. I think Michael and I would agree, that displacements of technology take a significant amount of time.

MICHELLE CARUSO-CABRERA: No, keep going. It's number two. Slide number, I think, maybe three. That one, right there. Doesn't this tell me that the greatest source of supply in 2040 for energy is coal?

MICHAEL GREENSTONE: But your question is spot on. And actually, let's just level set. In the US, I think it's, let's say, roughly half the places in the US, it is actually more CO2 polluting to use an electric vehicle than a combustion engine car, currently.

MICHELLE CARUSO-CABRERA: OK, I didn't want to say, but yes, that's what I thought. OK.

MICHAEL GREENSTONE: So what is all this talk about electric vehicles? I think the bright green future, what you have to have in mind, like I think the most likely play to get there is enormous improvement in the efficiency of batteries. That's P'in was talking about. Because that would drive down the cost of

electric vehicles. But then to your point of where it's going to draw the electricity, that would unleash renewables on the grid. It would in principle drive out coal and natural gas.

That's the theory. It doesn't have to happen but that's the theory, that the bright green future runs through the batteries in my view.

MICHELLE CARUSO-CABRERA: Everybody is in agreement there. OK, you want to hand me-- hand me one or two that you like. There you go. OK, thank you. What is your opinion on the US's withdrawal from the Paris agreement and what impact is this having on China?

RICHARD SANDOR : I think it's irrelevant. And that we have trends going on, we have state and local. I think it was Brandeis who said that states are the laboratories. And if you take a look at California and its trading markets and things like that, the trends that P'in's talking about, the adoption, the headlines aren't important.

MICHELLE CARUSO-CABRERA: What country's doing the most to reduce-- what country's been the most effective in reducing their emissions?

RICHARD SANDOR : Europeans have been fantastic, Scandinavian, northern Europe.

MICHELLE CARUSO-CABRERA: How's the US doing?

RICHARD SANDOR : US is doing very well, given there is no federal functioning in the area.

MICHELLE CARUSO-CABRERA: I guess the point of trying to get at is--

MICHAEL GREENSTONE: Richard's the half full guy here. I'm a little half empty. Yeah, it's true, the fracking revolution is driving coal out in the US system. And there's been improvements in renewables. But this is like a global problem and there's a lot of exporting of pollution to other countries. And I think the US dropping out greatly reduced pressure on the rest of the world to increase the aggressiveness of their targets. And I think we're going to bear the fruit of that.

MICHELLE CARUSO-CABRERA: But is there something to be said about-- we're so focused on market solutions. I mean, isn't the Paris Climate Accord this great government dictate, all these federal-- together we're going to deem that capital will flow to where we say it should.

MICHAEL GREENSTONE: No, no, you're off.

MICHELLE CARUSO-CABRERA: We just spent this discussion about how-- and the US isn't a member and yet our emissions are going down.

MICHAEL GREENSTONE: That's a couple climate agreements ago. No, no, that's not true.

RICHARD SANDOR : No look, I think Michael said, it's-- I'm again because I go where there's nothing, I tend to have to be an optimist. And I have to be accustomed to failure and look at everything as a clinical experiment. But yeah, the Paris Accord comes. It goes, all of a sudden the price of carbon is $5 a ton in Europe. And then the European Commission meets and said, OK, the targets were too low. Let's make it 24% from '19 to '22, then make it 12%. Price of carbon goes from 5 to 25.

So there's a lot happening outside the US. And one could take a bleak view or positive. And I think it's a half full half empty thing. But it's a very important question. And the question that I hear is that the reaction of no national policy is putting enormous pushback pressure on people who weren't involved in the environmental movement, students, young people who are now seeing, hey, there's nothing going on in Washington. We have to do more.

And so there's pushback. And I don't know what the answer is. But--

MICHELLE CARUSO-CABRERA: Here's the thing, just pure observer, nobody's walking around with masks on in the United States. But they are in Beijing. But they are in Beijing. China's a member, was full on board with the Paris Climate Accord. We weren't. But they're the ones with the pollution problem. Right, I mean, there's a disconnect, isn't it?

RICHARD SANDOR : Yeah, there is. I want to mention one thing because there is a big elephant in the room. One of the licenses we got in Tianjin was to trade energy efficiency, SO2 and water quality. And we haven't really talked about water. And I think that that is ultimately, perhaps even more

pressing. China with, you know, 20% of the world's population and 7% of the water, and flip that around in the US, you know, with 20% of the water and a third of the population, I think the challenges for China are going to be in water.

You know, I mean nine out of the 10 rivers that go through or originate in Tibet. But one questions the political ramifications of things like that. So I think in any discussion on climate, energy, economic growth, the water part really has to be included in that.

MICHAEL GREENSTONE: Sure.

MICHELLE CARUSO-CABRERA: I think it's probably for P'in and for Deborah. How much of the technology being deployed on the ground to improve air quality in China is indigenous research, particularly battery technology? Or where is most of this technology source from to purchased?

DEBORAH LEHR: I don't know the specific percentages but I think it's a combination. I think what we've seen is a big trend. Initially, a lot of the leading technology and innovation is coming from the United States. And the market is in China for it. And so they're being tested there. I know a number of green funds were set up in the United States, for example. And as far as I know, very few of them have been successful.

In China last week I was told there are now 250 green funds.

MICHELLE CARUSO-CABRERA: 250 green funds.

DEBORAH LEHR: 250 green funds. And they're sourcing a lot of innovative thinking in how to address all of these different types of pollution, as you were saying. I mean, the air quality is the most visible and the one that was politically necessary and expedient for the Chinese government to address. But in addition to water, soil pollution is another major issue. And Goldman Sachs did a report recently, and they said that they saw that there was a trillion opportunity in environmental services in China.

And you see a lot of companies rushing in to try it--

MICHELLE CARUSO- But did you say most of them aren't profitable or aren't doing well?

CABRERA:

DEBORAH LEHR: No, I'm saying in the US. In the US, a lot of the green funds were not profitable. In China, a lot of these funds are government funds.

MICHELLE CARUSO-CABRERA: But the green funds in the US are investing in China? I'm not understanding--

DEBORAH LEHR: No, I'm saying a number of green funds were initially set up in the United States, investing in the United States. And I think it's been very hard to find some in the early years that were profitable.

MICHELLE CARUSO-CABRERA: Got it. But the ultimate answer to the question is--

MICHAEL GREENSTONE: How can they be profitable when there's not a market for the thing they're producing?

MICHELLE CARUSO-CABRERA: Right.

MICHAEL GREENSTONE: And until there is a price on carbon that's widespread, which is right, there exists in California, it's going to be very hard. I think a lot of those were set up with the expectation that there would be markets.

DEBORAH LEHR: And hopefully, I mean, with all due respect, I think that the seven pilot projects, and certainly led by Richard, what has been done in trying to price carbon in China is exceedingly impressive. But the reality is, there is no market. It's more spot trading and kind of trading than it is any kind of real-- there's no futures market yet. There's no national market yet.

RICHARD SANDOR : Let me let me finish the thought and I think that that's exactly right. And it isn't. And I started to say earlier it's a 20 year curve. If I mark 2006 and the opening of our exchange, market to 2026. On October 31, two days ago, they moved the emissions trading from NDRC, which is the real powerful guts, over to EPA. And everybody said, uh oh, that's a slow down.

I happen to know that they move the person [INAUDIBLE] and his assistant Li Gao from NDRC over to EPA 10 years ago. We said to them, you have to move this ultimately like the US, but the registry and the environmental part. And so I think the chatter in the business is allocation of permits come in July 2019. Simulated trading comes in 2021.

And 21, CSRC overlooks a futures. And they take the 7 pilot. They give them all equity. They start a new climate futures exchange. And by 2022, you're off to the races. So I think it's not a zero one. I mean, they've been building human capital for 12 years in markets. Just remember that they never had financial futures until recently. This is a new thing for China. And the one thing that they needed to learn which I think they didn't learn is this is not like batteries, where you build a blueprint and all of a sudden you can replicate that process if you have the blueprint in manufacturing.

Capital markets are complex webs of regulation, rule books, contract, design, and they've had a tough time in getting their organized markets because it's not like manufacturing. You need a whole different set of skills. Bearing in mind what that says, just to conclude, I think Deborah's right. But if we look at it a continuum and say, given that it's a 20 year process, look to 2022, to the futures, you'll be in line and look to implementation in 2025.

And then we'll be able to judge whether this experiment on markets is going to work out.

MICHELLE CARUSO-CABRERA: Last word to P'in Ni.

PIN NI: Yes, so I would say there is a very big difference between the technology versus the economic to all the market driven system.

MICHELLE CARUSO-CABRERA: Sure.

PIN NI: So that part I would 100% that China is at the very beginning of learning because they have the socialism system or whatever, so the government is everywhere. So the market force is not there yet, not as much as we have. On the technology side, I would say it is a very different measurement.

And clearly on the battery business, the technology is much more valuable in China for two

reasons. One is the demand is much higher. Mike, as you say, you know, it's a four versus one. So if you can sell one, you can sell four there. Secondly, same to Michael you say it is the low hanging fruit. For us to increase our life here for six years, that would be great. But I don't know what else we can do to get there. For Beijing, it's easy. You take this one out, you can live longer for six years.

So it's very effective. So I give you example. You know, we bought a company-- Deborah knows this. They're called A123, the battery company.

MICHELLE CARUSO-CABRERA: Yep.

PIN NI: It was very controversial.

MICHELLE CARUSO-CABRERA: It was.

PIN NI: And we bought it January 2013. 2012 they lost $300 million--

MICHELLE CARUSO-CABRERA: I remember [INAUDIBLE] review.

PIN NI: Yeah, they the $300 million. And then 2014, in the middle of 2014, we got invited to the White House and we were greeted to say, oh, you guys did a fantastic job because only less than 18 months you turned a company around in a positive cash flow. So the policy is great, right? So it's a good policy. It can work.

And honestly, it's really because with China. Because that time that year, we shipped 75% of the volume to China. And we could--

MICHELLE CARUSO-CABRERA: That would help cash flow if it went up that dramatically.

PIN NI: We couldn't even keep up. For a few months, we airfreight containers of the battery to China

every single week. So in that way, I say, if I cannot make a money, something got to be wrong. So that shows that demand is so huge. So just answer the original question about technology, China, USA, I would say, you know, we have a very big horsepower here in terms of innovation, no doubt. We are dominating in terms of the global market, still today.

But the demand is in China today. So that's the balance.

MICHELLE CARUSO-CABRERA: You can see from that photo that we started the whole panel with. Lady and gentlemen, thank you so much. This has been terrific. Good discussion, guys. Thank you very much.

[APPLAUSE]