PROFESSOR: Let's get started. How about the spring weather?

AUDIENCE: Oh, yeah.

[LAUGHTER]

PROFESSOR: Tomorrow.

AUDIENCE: Someone needs to tell New England that it's the end of April and it's got to warm up.

PROFESSOR: Yes. It's getting boring now. We need the spring weather to come quickly. Right. Good. Great. So let's see. So today we have the pleasure to have Professor Noelle Selin to lead the lecture. And Professor Selin is not only a professor of [INAUDIBLE] systems division, but also the Department of Earth, Atmospheric and Planetary Sciences. So Noelle previous was on modeling of air pollution. And has been doing lots of work on how to develop an understanding of policy related to air quality and pollution, specifically of mercury.

And through work, she has observed firsthand international negotiations of policy-- basically how this [INAUDIBLE] is done, I guess. A policy meeting, where you really see all the parties getting together. And they the role off science and ultimately how these effects how to look at a global scale. And as we have been talking throughout the course, one of the aspects that is new from a business perspective as you get into environmental topics is you have to interface more with stakeholders or in other traditional ways. So last lecture we had a chance to hear from EDF, NGOs. EDF is of the nice kind of NGO. From a business perspective, they want to engage, but [INAUDIBLE] attack.

On opposing front, as a company you also need to understand what kind of shape could policy take in the future, and what is the role of business? How could this impact business? Especially how it impacts supply chains are global. So with that, Noelle, the floor is yours. And thank you for coming.

NOELLE SELIN: Great. So I want to right off that I don't know much about supply chains. So I'm hoping that this can be very much a discussion. I'm hoping to learn from you guys as well as talking to you a little bit about mercury.

AUDIENCE: Switch your microphone.

NOELLE SELIN: How do I do that? Can you hear me now? All right. So why is the case of mercury interesting in the context of sort of international business supply chain regulation? Well, mercury is the latest, the most recent global environmental treaty. So the Minamata Convention, which is an international convention on Mercury, was signed just this past October, 2013. And it is widely thought of as it's the first real new global environmental treaty in over a decade.

The previous one was also on a chemicals related topic, the Stockholm Convention. So it's an example of international environmental cooperation of which we don't have a lot. We don't have a lot of concrete stuff coming out of the climate negotiations right now. But this is a brand new agreed global treaty. And it's widely thought of as the first entire life cycle international convention. So I'm going to talk about that in that context and how it emerged, what some of the science behind it is, and how it might influence thinking about chemicals regulation in a product context, because products are a core area-- mercury in products are a core area of mercury regulation under the convention.

I'm going to talk a little bit about the interface as well between domestic regulation in the US, international regulation in the European Union context, which sort of is a sub-global regulation, and how that interfaces with the global context. So that's sort of where I'm planning to go. Please feel free to interrupt me if you have questions or want to go in different directions. So what I'm going to start with is just a little bit about the scientific backgrounds. And we're on the same page on why we're

concerned about mercury, why we're having a global treaty on mercury in the first place.

The reason that mercury is a global problem is the mercury that we're emitting doesn't stay within our borders. So the main criteria for having an environmental regulation internationally-- there's a general principle of international law that you can do whatever you want within your own borders. If you're ruining your own environment, it's kind of your problem. But the minute you start ruining other people's environments, that's when it's subject to international concern.

So if you just emitted mercury deposited right next to your power plant or something and contaminated your local environment, it wouldn't necessarily be subject to international regulation. But mercury in the atmosphere is in a pretty volatile form. And mercury when you're emitting it's to the atmosphere, lasts for about half the year to a year. So that means it blows around. And it blows around pretty much globally. If you think about watching the weather map and about how far weather goes in different winds, you get about 7 to 10 days to go across continents basically.

So in about six months, you can imagine that something that lasts in the atmosphere that long is going to mix pretty effectively. Intra-hemispheric mixing time is about half the year to a year as well. So anything emitted in the northern hemisphere is going to go to the southern hemisphere too. So mercury all over the world in the atmosphere. Now the reason it's a problem is because of what happens when it rains out. When it rains out, it accumulates in ecosystems. It turns into methyl mercury. Methyl mercury is even more toxic than mercury.

It builds up in food chains-- goes into little fish, big fish eat the little fish. In the Arctic, there's a really long food chain. Polar bears eat the big seals, people eat seals, you get high levels of a neurotoxin of concern. So methyl mercury is a neurotoxin. It has effects on people's IQs-- in particular, pregnant women who consume things high in mercury, particularly fish, during pregnancy, their offspring have neurological impacts even at of background doses. Lower IQ outputs.

So this comes from a range of epidemiological studies. More recently, lest you think

all of you might be off the hook, cardiovascular impacts in the general adult population. Some mercury is bad for everyone, not just pregnant women and kids. I'll talk a little bit about gold mining communities. Mercury's used in artisanal and small scale gold mining. And mercury itself, at really high levels, can also be very dangerous if you breathe in too much of it, but not really acutely toxic in the concentrations that we might likely be exposed to.

So although it's a concern to break a thermometer and you shouldn't go and sniff it, you're not going to expect to see effects at that kind of a dosage, and particularly not at the dosage of ambient air concentrations. But once it gets into methyl mercury, once it gets into the food chain, you have a problem. Now think about sort of what's happened over the last several decades in terms of where mercury is coming from. So you have mercury that's used in products.

Mercury has been used for millennia. In cinnabar ore, which is the really red rock, used as a dye, mercury was used in hat making. It was used in mining all the way back to the Roman times. So it's a very useful substance. But one of the really recent things that's happened is that mercury is also a contaminant in coal. So if you look at what's happened in the Arctic, you can look at the concentration-- this is kind of squished. This is sort of normalized to levels you can look in various different archives.

So what happens when they find the unfrozen polar bear, they can actually look at what the concentrations are in the unfrozen polar bear that died in the 1200s over here that was stuck in the ice and they found him, as opposed to current day polar bears, as opposed to the museum polar bears that they killed in the 1800s. And you can track that with things like falcon feathers and ringed seal teeth and various things.

AUDIENCE: What exactly does the percent concentration mean? Surely, human teeth are not pure mercury.

NOELLE SELIN: Right. So it's normalized to present day levels at 100%. So because the concentration just to show everything on the same scale, because the concentration

in polar bear hair is obviously different from feathers, is different from teeth. So with 100% present day concentrations, this is how much it would have increased relative to. So we can do modeling of what happens in the atmosphere when you emit mercury and it blows around all over the place.

This is what the global cycle looks like. It comes from some of my modelling work. But again, you're looking in the Arctic where there aren't a lot of sources. You have a lot of increases. You have health effects that you can estimate hundreds of thousands of new ones every year. So there's growing scientific concern about this substance. So now what you do about it? You've got mercury used in a whole range of different products. You've got mercury coming out of coal. You want to figure out how it gets into the atmosphere.

So you do something like an emissions inventory. And this is what the UN Environment Program put together on anthropogenic emissions to the air. Coal being about a quarter. This is this artisanal and small scale gold production. I'll talk a little bit more in detail about that and how they get their mercury later. The really interesting part about this is we didn't realize that that was such a big chunk. I've been working on mercury for over 10 years now. 10 years ago, that wasn't even in our inventory.

So realizing how much mercury was actually admitted to the global atmosphere from these gold mining communities was actually a big step. And you've got a bunch of other different all kinds of uses of mercury, uses in the chloralkali industry. Disposal of waste for mercury containing products is a chunk of emissions to the air. Also important in emissions to water, releases to water. Cremation is always an interesting one. You got mercury in your teeth. Guess where that goes? Yeah?

AUDIENCE: Being a heavy metal, what's the mechanism by which say someone mining for gold-- I assuming it has to be highly atomized to be able to go into the atmosphere and travel a ways.

NOELLE SELIN: So mercury's a funky heavy metal. It's the only one that's liquid at room temperature, so you've got elemental mercury that you can-- basically thermometer

kind of elemental mercury. And if you put that in a pan with gold, it'll form amalgam. And then all you have to do, you take that amalgam, you burn, and mercury will burn off.

AUDIENCE: [INAUDIBLE].

NOELLE SELIN: Yeah. So sometimes that's done in gold shops. And I'll have a slide later about the process and where the mercury goes. But that's essentially the principal. And that's why it goes to air. Of course, there's going to be some rinsing. And that's why that numbers are all uncertain, because again, this is a sector that's not very regulated where the mercury ends up.

AUDIENCE: Why was it overlooked? What changed that made it show up in the rater again?

NOELLE SELIN: So it was whether it goes to air was the question, and what fraction, and how much is used. So there weren't very good estimates because this is generally kind of an illegal sector in a lot of places, or at least an unregulated informal one. So it may actually have increased over time because of the price of gold. There's more money to be made in mining gold, so more use of mercury. And then what fraction you assume of how much people actually keep versus how much they burn off has changed over time.

And just the difficulty in-- it's pretty easy to get coal statistics. Actually, I was one of the first ones to actually put an estimate into a global model of artisanal and small scale gold mining. And what I did is I just took the total amount that was used, which we had estimates of, and I said, these are the countries in which it's used. We're going to assume 30% goes to the air and I'm just going to grid it, because I didn't know what to do with it. Now we have a little better of a handle on it. Yeah?

AUDIENCE: What is [INAUDIBLE] major discovery that will change [INAUDIBLE] that you have showing on the site?

NOELLE SELIN: Probably. I think that artisanal and small scale gold mining we could learn a lot more about. And the uncertainties are huge. So we're doing some work with the modeling and also looking at measurements in the atmosphere to try to back calculate what

the emissions are. One of the key uncertainties in emissions is-- the key is that when you emit mercury, it doesn't stay, because it's a volatile heavy metal, weirdly enough. So when it goes into the soil, something like lead will stay there. But mercury pops back up. And because we've been emitting mercury for decades, centuries, millennia, there's mercury enhanced in the surface ocean, enhanced in the soil, it keeps popping back up.

We don't have a good handle on what that source is and how much of it is human versus natural. So this actually I did the human in red, and then it's technically pre-industrial. But the problem is-- so there was a recent paper that came out that said, yes, mercury circulating in the system has gone about a factor of three since pre-industrial and we can use lake sediment cores to figure that out. But again, the Romans used mercury. So labeling pre-industrial equals natural is kind of problematic, because although we've had a real big spike from coal, there's probably human mercury that's been circulating that we don't have a good idea.

So they're saying maybe it's a factor of seven now as opposed to a factor of three. But regardless, current emissions play a role, and if you look at deposition to the US, this is mercury actually coming down in rainfall entering the US environment. What you see is you see a bunch of patterns. So the highest wet deposition in the US is actually in Florida. And that comes from global sources. But you can see that there's also deposition in the northeast that comes directly from the coal power plants. So not going to go through all the chemistry of this because it has to do with chemical reactions in the atmosphere.

But the upshot is that if you want to reduce deposition over the US in all these different places, you have to tackle both the local sources-- because some of it actually deposits right near the source, and some of it circulates globally-- and the global atmosphere deposits. And then actually affects you. So this is really one of the motivating things for the US to get involved both in mercury policy nationally and mercury policy globally. So just giving you a little bit of the history. I'll talk a little bit about what happened in the US as well.

But this is something that's come up in the last 15 years or so. The first global scientific assessment of mercury that gave this idea that mercury is a long range problem-- global action is necessary to address it was the main conclusion that came out in 2002. So you get this group of scientists together under the UN Environment Program Chemicals Division and they say, mercury's a problem, global action needed to address it. Now, look, what do we do?

And so the global treaty as I said was last year. Now that's a long, long state. That's 11 years difference. So what happened during that time. Well, what happened was a lot to do with the US. And this shows sort of the influence of domestic regulation in the international context. Those of you who remember 2002 in the US, thee US administration wasn't so pro-internal environmental regulation. Didn't really like the idea of signing up the US to something that might be questionable in terms of its cost benefit ratio. And you know, why mercury?

International cooperation wasn't necessarily a priority. International environmental cooperation even less so. And the idea that we shouldn't waste time getting everyone on board, we should just do what we want to do with the willing partners was an idea that was sort of widespread in the administration. So they applied that to mercury as well. So what they have is the global mercury partnership. They said, let's get together various coalitions that are going to attack different aspects of the mercury problem. So they had a task force on artisanal and small scale gold mining. They had a task force on coal fire power plants.

And they did some voluntary activities, capacity building in different countries to try to reduce emissions. But there was an ongoing discussion about whether that's actually effective at reducing the mercury problem or not. It's pretty much keeping the mercury levels constant at this point. And the European Union in particular was very in favor of a global legally binding treaty and had been since 2002. So every two years the UN Environment Program governing council meets. The governing council is the environment ministers of all the nations.

And they're the ones really that would set a mandate actually negotiate a global

treaty. It would be done under the auspices of the UN Environment Program. Every two years they met. And in 2000, 2003, US said now let's do a program. 2005, not so much, US. Now let's strengthen the program. 2007, still nothing, although a couple of other countries are on board by that time. Latin America's actually really interested in doing something particularly because of the concerns on artisanal and small scale gold mining.

Canada also has its phases of liking or not liking international regulation. In the organic pollutants example, the last convention, Canada was very much in favor of negotiating something. Canada mines a lot of metals. Not necessarily mercury, but Canada was a little afraid that this was going to be a global metals treaty and didn't want to really push for it so much. So Canada wasn't pushing. Australia, again, up and down, but likes its metals too. So you didn't have a lot of developed countries pushing. You had some developing country blocks getting on board.

So you think about what countries and what their different motivations are. And then we get to 2009. And suddenly in 2009, you have the European Union still saying we need a global treaty. By then Latin America's on board. We need a global treaty. And now you have the US saying, hey, let's not such a bad idea. Guess what? We had a administration change. One of the things that is important to note about the US is that President Obama has made mercury a pet issue.

The US-- and I'll talk about mercury in products and how it relates to the treaty-- has a mercury export ban. That came in the mid-2000s, when entry enforcement was passed I'm not 100% sure. But the sponsor of that legislation in the US Senate was Senator Obama. So he had a interest in mercury in general. And also the US had gone through about eight or nine years of trying to regulate mercury from coal fired power plants under a court order, under the Clean Air Act, and had kind of messed it up under Bush. And when Obama came in, the clean air mercury rule had been thrown out of court and they had to go back and do it again.

And so Obama, being interested in mercury, said let's regulate again. And the Mercury and Air Toxic Standards came in 2012 in the US. But that was well under

way. So the US starts saying, hey, this isn't that bad an idea. Because if we want to solve our mercury problem domestically, we need both international and domestic action. This is kind of a win. It's also a political win because protecting babies and not having mercury in our food is a kind of clear public message as well. China-- yeah?

AUDIENCE: Can you speak a little bit more about the cost benefit analysis and what type of decisions a politician and some of these people are making to make them more attractive for this type of law?

NOELLE SELIN: I can't. I'm actually doing a lot of work on that in my group right now. So what they did for the cost benefit analysis for the Mercury and Air Toxic Standards, it was a little bit of an end run around the idea of cost benefit analysis. Because what they said was, we're going to regulate mercury. It's going to have benefits particularly on sensitive groups. So in terms of overall economic benefits, it was hard to get that number up, in terms of a strict cost benefit analysis.

Because the people who are most harmed by mercury are the people like subsistence fishers, who eat a lot of local fish, particularly for the domestic. A lot of general public gets their fish from cans of tuna from the Atlantic, the Pacific. That's going to respond to global emissions and not local emissions. So in the US context where you have to do a cost benefit analysis, they ended up showing the cost benefit of-- the Mercury and Air Toxic Standards passed the cost benefit analysis because of the particulate matter benefits.

Atmospheric particulate matter contributes to cardiovascular impacts, respiratory impacts. You can show a lot of deaths if you reduce it. Multiply that by a value of statistical like you paid for almost anything, and that's what they did for Mercury and Air Toxic Standards. Now are group is actually doing a more thorough benefits analysis of the Mercury and Air Toxic Standards out to 2050. And we get some reasonably big numbers because we look at both the Minamata and the Mercury and Air Toxic Standards, the global and the regional. But that work's in progress right now.

But as far as what they needed for the regulation, that's what they did. Globally, they didn't really do a cost benefit analysis. It was we need to regulate where we're kind of agreed that this is a problem. Let's go with it. Partly that's because a lot of other countries don't have the tradition of requiring cost benefit analysis that the US does. So hopefully that gets to your question. Yeah. So again, China-- China is about half of global emissions of mercury right now.

China wasn't particularly thrilled about this whole thing. But China came around. Again, the US and the EU and Latin America, you get three major blocks. Canada came around, too. Australia came around. Africa didn't really have anything against it. They probably a net gain of resources from this kind of analysis. So it's China and India really who are the most worried about what they have to do. And in response to China, it delayed a year when negotiations were going to start. So they didn't start till 2010.

China wanted to delay them a year because China was putting in its own mercury regulations for its power plants as part of their next five year plan. So China does have mercury regulations. They're not particularly binding. They're not particularly strict. But they copied Germany's and said let's put mercury in our regulations. They do you actually have quite a bit of technology on their power plants. Whether it's operating or not is another thing. But in terms of build out capacity, they're there.

So actually negotiating the instrument took five negotiating sessions. It was signed in 2013. Now once an international agreement is signed by countries, they have to go and ratify it, make it consistent with their US law. That in the US usually has to go through the Senate. In this case, it did not. The US accepted a procedure equivalent to that of ratification, the Mercury Treaty becoming the first party because it was so consistent with US law that it essentially was an executive decision.

The administration said, we don't actually need to do anything. It's pretty much an embodiment of US law. Because we're doing so much on mercury, this does not go much further than the US already goes.

So that's one particular lesson is that the US and the EU in particular, and you can

see this also in the reading about the EU, these national laws often are sort of leading the international standards. So it's actually predictable in the sense that you're not going to get countries like China, countries in Africa, to do the same kinds of end of pipe expensive power plant controls that you might expect in the US when they don't even have the basic controls or maybe don't even have power plants to begin with.

So again, thinking about what it's sort of a lowest common denominator that you often get in these international agreements. So one emphasis of the agreement was emissions. And I'm not going to talk too much about emissions given what you guys are interested in-- again, that's the power sector part-- but that was only one component of the tree. Another is mercury in products and processes, which I think is of probably more interesting to you guys.

So I'm going to talk about products and processes. And I'm going to talk about what they did with artisanal and small scale gold mining, because those both have kind of supply chain type issues. So where do you see mercury in products and processes? So one that is pretty familiar is thermometers. So again, phasing out in places like the US. You don't see them that often. But thermometers, blood pressure measuring devices, some of the old thermostats have mercury. So this whole idea of electrical control and switching, measuring and control. Batteries, older batteries. Again, phased out in the US and the EU, but common elsewhere sometimes still.

Lighting. Fluorescent lamps. Both regular fluorescent lamps, the tube versions, and compact fluorescent lamps. So save energy on balance, but use a small amount of mercury. LEDs don't have mercury. But again, with people encouraging more and more compact fluorescent and fluorescent use in lighting because of their energy efficient properties, mercury becomes an issue, and safe disposal becomes an issue. The other is your teeth. Dental amalgam.

So again, some countries have phased out the use of mercury in fillings. Others don't. It's pretty cheap. Even in the US, if you actually go to the dentist and you need a filling and they say, do you want the silver one or the white one, and the

white one's a lot more expensive even here. So think about if you're in a developing country what your option is. Your option is probably no dental care at all, but the silver filling is probably much better to have-- you save your tooth-- than the white filling, the composite, which is much, much more expensive for you. So use of mercury in dental amalgam was, are we going to keep using it or not? Again, can be an environmental issue when people get cremated and get across.

And then there's a bunch of other things. Chloralkali plants-- so use of mercury in industrial processes that are phased out in some cases, but not in others. Vinyl chloride monomer, particularly in China, mercury is used. So you've got a substance that you think, mercury, it's a really concrete thing to regulate. But then think about all these industries that you've now involved. So you've got a group sitting in negotiations. I actually took a group of 10 graduate students to the final negotiating session, which was in Geneva. And you've got a group of maybe 75 people in the room, representatives from all the different countries. Industry could come in as observers.

But again, if you're an industry that does this, think about how long and how intense your observation had to be. You're going to send a person to every week long meeting during five negotiating sessions through 2010 to 2013, spending a week in Geneva each time just to think about, if you're in the electrical control and switching industry, to raise their hand every time electrical control and switching comes up. And they're not really even allowed to raise their hand, because the only people that are technically allowed to talk on the floor are countries.

So what you can do as an electrical control and switching person is you can go and lobby your friendly countries. You can put out a poster in the lobby and say, hey, this is how these regulations would affect us. There's probably somebody next to you that says, we have the mercury free version. Come buy it. And so depending on your country and where you are, this is what it looks like. In the products group, it became a little bit more informal. There were companies that participated in discussions as observers. They talked about thresholds of where mercury would be restricted or not.

And the companies started saying, well, there's an alternative for this, but there's not an alternative for this. So as you think about the major categories, you have ones that are a lot in developed countries and then ones that are primarily in developing countries. And these are things that used to be in developed countries quite a bit but have often phased out. So how do you think about regulating something internationally? Now there was two different approaches and they refer to them as positive and negative lists, which is a little bit confusing because it meant the opposite of what you might think.

But the idea is that you either say, I'm going to list all these things that are banned and you can't use mercury in them, or I'm going to ban mercury in all products and I'm going to make a list of the ones you can still use mercury in. So the idea of banning mercury in all products was kind of a nonstarter because, again, things like compact fluorescent lamps had benefits that were greater than the cost of mercury. Actually no one was really suggesting that you go back to incandescence because they've actually done on the assessment that if you actually have a very heavy coal load in your power, the mercury that you save by going to a compact fluorescent is much larger amounts than the mercury that's actually in the light bulb.

And there's a move to get less and less mercury in that light bulb. So the idea that they came up with was-- there was a lot of discussion. Do you have the blanket ban with the exceptions? Do you just list the ones that you're phasing out and banning? And they came out the latter approach. But then they had to negotiate which of these things on this list was on there, which was exempted, and if there were thresholds to each of these. So what kind of level of mercury would you accept in these or not? Yes?

AUDIENCE: I'm just wondering why they would go about it that way trying to create an exhaustive list when they don't know future technology that's going to come out rather than setting out a set of criteria that's saying if thee product meets a, b, and c, then you can it?

NOELLE SELIN: Who decides on those criteria? Or actually reviews whether you actually met those?

And part of that is transparency. So what countries have to do is then go back to their countries and say, what am I allowing? What am I not? You have to know what you can put mercury in and not. So there's kind of a transparency approach that happens. I think the two options that came up, the either blanket ban plus exceptions or the we list the things that they we're banning, were kind of the two approaches that they most looked at. Because again, that would make it even more wishy-washy, I think, because then you could show, oh yeah, well I fulfilled these three requirements.

So that wouldn't be that stringent in international context because there's no body that can really certify those requirements. So the key with international regulation is that there's no enforcement essentially. It's an environmental treaty. You can barely enforce the ones that actually involve weapons. You're not going to go bomb someone that is using too much mercury. What's going to happen is you're going to say, hey, you're using too much mercury. We're going to caution you. We're going to shame you in the international context. We're not going to let you vote.

Maybe we'll actually give you more money, because probably the reason you're not complying is because you can't afford it. That's what really happens. Yeah?

AUDIENCE: [INAUDIBLE]. So I've heard from friends that we have an island in French Polynesia called New Caledonia. The island basically has a lot of copper. And so copper is an industry there. And to say the only industry. And basically the rivers that were blue once have turned red because of mercury. The level of contamination of the rivers and the island is-- it was a paradise. It's extremely high. And it's still the only industry. So it's the main and only sort of employment in the island. And there's nobody who will say anything about it, or nobody pretends to do anything about it because I feel that if it's not a consensus, there's still an understand that it's the only way the island can have any income.

And there's nothing to develop. The [INAUDIBLE] is not developed. There's really [INAUDIBLE] except for this. So how would you go about it? Because when I was there it there it was really sad to see that such a beautiful place could be damage

with nobody really wanting to do anything.

NOELLE SELIN: I think that's really the larger challenge that you see in these global environmental negotiations because you have a lot of places like that with various different specifics. But the idea is, how do you balance benefits to people-- like building energy-- versus environmental damages? And the solution that the international community does-- I wish I had a better solution-- but it's basically throw money at the problem. Capacity building, different techniques, try to get cleaner processes, build awareness. That's pretty much the--

AUDIENCE: [INAUDIBLE] allowed to the big countries or--

NOELLE SELIN: A lot of it's local awareness, too. So in mercury--

AUDIENCE: Seek a solution locally?

NOELLE SELIN: Yes. So in the mercury negotiations, there was a lot done-- so a lot of the nongovernmental organizations have banded together internationally into a more mega group. So you have some local nongovernmental organizations who have kind of partnered across in mercury action network or something. I forget exactly what it was called. But that was an umbrella group of a bunch of different very local nongovernmental organizations, a lot of whom work in these artisanal and small scale gold mining communities, which is actually very similar to this kind of issue, which I'll talk about next.

But yeah, the idea is that you can do awareness raising workshops. So they bring in international experts, national experts, talk about the damages of mercury, talk about what you could potentially be doing about it. That's sort of where the state of art is, I think, at this point. But yeah, so you had to go through these major categories of mercury use. And then I just want to flip ahead a little bit to actually what happened. Again, you have different phase outs and phase downs. And then there's this very legalese exemption period where you can have either general exemptions or specific exemptions.

Another area where mercury was generalized exemption was mercury used as a

preservative in vaccines. So that was one that, again, this sort of cost benefit analysis-- there's no evidence that it's harmful. Again, other than the general sense that we want to phase down mercury. But it's been phased out for precautionary reasons and also because, again, don't want to use too much mercury in developed countries. But what happens is in developing countries, you have vaccines that it means it doesn't need refrigeration if you use a mercury containing preservative. So again, you're getting vaccines to places where you don't have refrigeration if you use it. So that's why that ended up in a general exemption.

AUDIENCE: I do go through this process. And when does the science get into the discussion. Because you have at some point to decide [INAUDIBLE]. They know exactly what levels to be allowed and they want to just being reflected. So I'm wondering where does this get in.

NOELLE SELIN: It's a lot less technical than you think is. So where the scientific analysis came in was really in that global mercury assessment 2002 and the updates of that. And then the negotiator said, yeah, the scientific case is made that we ought to reduce mercury. There is no particular substance by substance sense of when they actually thought to phase out. No one did an analysis of what the benefits of phasing out in switches and relays versus linear fluorescent lamps. That just wasn't even on the radar screen.

There were assessments that said where are the sources? Where does mercury go? But then it was really a horse trading kind of thing. I'll give you switches and relays if you give me cosmetics. Because each country wants to sort of protect its own interests there. Some might have mercury free alternatives that they might want to sell. Others it might be a particularly pressing issue, like this cosmetics. It might be a particular public health issue in countries and in regions. Mercury is a component of some skin lightening creams which have been-- people have tried to ban them.

But again, countries with less of a regulatory infrastructure, it actually-- again, putting mercury directly on your skin, not a good idea, and can be a big public

health problem in some communities where there's an interest in using these things culturally and also in cultural practices, like use of mercury in religious types of practices that can be dangerous. So those cosmetics again, greater than one PPM. Also topical antiseptics, pesticides, biocides, that kind of thing, use mercury to toxic kill the bacteria. There's other ways to do that. But again, in countries where you can't really control import very well in terms of your capacity, international regulation can be an end run around that to think about.

And again, for dental amalgam there was a goal of phase down. But again, no set date. So to the extent that you can, use the more expensive but more environmentally friendly alternatives. And that actually ends up getting into the environment quite a bit. Story in Massachusetts when they required dental separators in dental offices-- it used to be that they just flushed the stuff down the drain when they changed your filing-- they required dental amalgam separators. You can actually look at that date and look at the mercury level in fish in the waterways of Massachusetts and it goes dramatically down right after that. It actually does wash right into the waterways. Again, it's a lot of mercury that's in a particular filling. Yeah?

AUDIENCE: [INAUDIBLE]. When they pick a date to phase this out, 2020, is this just sounds good or is there some--

NOELLE SELIN: It just sounds good.

AUDIENCE: Let's make it far, far, far away. Not next year, not two years. Something that--

NOELLE SELIN: And it's negotiated. So people that want-- again, a lot of these things are phased out in Europe. And so the companies have figured out a way around them. Europe has an interest in getting these things globalized because they have very strict regulations like we and like rows that talk about what you need to sell products in Europe. And to the extent that becomes a global regulation, that obviously favors-- Europe thinks it's the right thing to do, first of all. But also it makes it a global standard as opposed to different standards throughout the world.

So you've got European countries often pushing for earlier and earlier phase outs. Now maybe China for example, which actually produces a lot of these compact fluorescent lamps, probably wants later phase in dates. So 2020 emerges as a compromise. Again, thinking about the timing of actually entering into force for a treaty, I think you need 50 parties ratifying. US ratified really, really quickly, because again, it just said rubber stamped it. It's the only country to ratify so far. So conservatively at least 2015 before it enters into force.

So setting a day before that would be kind of weird. So yeah, you have to phase it out before you actually signed it. So 2020 is a relatively early date in this area. Mercury mining is phased out also under the treaty, and it's 2035. Or no-- I think it's 15 years after entry into force for that particular country or something like that. So it can be quite a long time. So going back a little bit talking about mercury trade-- so this just gives you a sense of where mercury is flowing and where it's going-- again, since we've had the mercury export ban act.

But this is actually just of commodity mercury. So this isn't mercury in products. So the compact fluorescent bulbs that we import from China are not included in these flows. Yet primary mercury mining in Kurdistan, they're actually closing their mine partly because of US assistance. China has no interest in actually closing their mine, although they will have to under the treaty if they ratify it. But China's mostly using itself. So the mercury that gets used in products-- so you don't see much of an arrow there coming out of China because it's not internationally traded.

But again, a lot of flows for a lot of this mercury is coming from recycled mercury, mercury stocks, mercury in use. So you've got mercury flowing as mercury, then getting incorporated into products. You get obviously the trade in products, and then trade in wastes. So once the product is no longer useful, what do you do with it? I said that the mercury is a full life cycle convention. It does is actually sort of yield a lot of the waste issues to the Basel Convention, which deals with wastes internationally. So it has sound guidelines of trans-boundary movements of hazardous waste. And that pretty much covers the mercury. So they tried to make that consistent. Problem is that it doesn't have the same set of parties.

In particular, the US is not party to the Basel Convention. But pretty much does the required things that the Basel Convention does in the sense of being able to deal with hazardous waste in a reasonable way.

AUDIENCE: [INAUDIBLE] if they cut off the influx of mercury then they will only be stuck with trying to manage their own creation of mercury?

NOELLE SELIN: Right. And to the extent that they actually use mercury-- I'm not sure exactly what the use of mercury will be. But again, trade is restricted under the treaty. US already has an export ban. EU has an export ban. Mercury trade will only be allowed for exempted uses. So if you're making one of those exemption processes like dental amalgam-- that might be Australia. It might just be importing for teeth. Who knows? But again, if you're using it for an exempted use, it's OK. If you're not, it's not. And that sort of actually is a really good segue into the artisanal and small gold mining story.

Because again, thinking about where mercury goes and where mercury is in trade, artisanal small scale gold mining is a really big deal in a lot of countries, big emission. But the question is, how do they get their mercury? You're a small scale gold miner in a developing country. You need to buy mercury to figure out how you actually mine your gold. So this is a figure from a paper that looks at what the artisanal and small scale gold mining process is and how that relates to the gold supply chain, which I thought would be interesting for you guys.

So you started at the top with mercury exporting countries. And a lot of those exporting countries think they're exporting to dentists. So one of my colleagues works in the artisanal small scale gold mining area and he showed this picture of an artisanal small scale gold mining community. And it was mercury dental shop. Like yeah, right. You're a mercury dental shop. You're in a gold mining community. But in a lot of cases, they'll buy mercury from dentists or a dental middleman and actually sell illegally to the miners.

So then you're the miner, and miners over here, they dig your pit. You get the ore.

And then mix it altogether. So then what you're left with is you're left with some mercury amalgamated with gold. And you've got some waste. And that's where you have this amalgam ball and you have the waste. Now the waste is going to have some rock in it, it's going to have some water, it's probably going to have some mercury in it, because you couldn't get all of it to stick to the gold.

And what do you do with that? You just dump that. So you release mercury laden byproduct into the waterways, which could have local impacts. But probably not going to enter the global pool. Because again, you just rinsed it out into your local place. It might. We don't know the science on that. But you've got amalgam ball, which is must your money, with your gold. But it's bound up with the mercury. So what do you do? You can do a couple of things. You can burn it yourself.

So this would be the artisanal part. You're actually going to just get a pan, you're going to light a fire under it, and you're going to let the mercury burn off. Now that's not particularly efficient, but it's probably the cheapest way you're going to do it. Now one of the ways to minimize the mercury loss is to have a retort. So basically you have a little cap on it. The mercury condenses and then you drip the mercury back into a little cup. You could use the mercury again. It saves it from going into the atmosphere. It also saves you some money because you don't have to go back and buy more mercury, or buy less of it.

So that's been one of the things that has come up in trying to minimize the mercury lost. But again, as you think about it, not the most healthy place in the world to be, breathing over a burning mercury pit. Again, lots of local issues. So you've got this AGSM product. Sometimes that burning can happen in local shops as well. That's more of a small scale. So you take your amalgam ball to your local shop. More efficient. That guy's going to get a cut. So you think about that depending on the community. That might happen.

Usually a buyer, who can double as a mercury dealer, buys that intermediate gold product, does a final burning step that makes it more pure gold, then you enter the regular gold supply chain. And you end up with, on the market, about up to 30% of

artisanal and small scale gold mining gold that then goes to a combination of jewelry and investors in industry. So it really is not a insignificant amount of gold on the market that comes out of this process and involves mercury.

So again, with the price of gold the way it is, this is something that has a lot of influence on the livelihood of people who are involved in this. So it's a development issue. It's a local community issue. It's also an international market issue. So there's a lot of different certifications that come into gold, some of which-- at least one, I forget the-- I don't have it in my notes, the particular ones. But one of which does incorporate mercury into the certification standards and one doesn't.

So there's a difference in-- there's a couple of different, like fair trade, fair mine, the talk about the conditions of the miners and various things. Whether or not-- and how-- they cover mercury is an open question. So will that help if you have more of a certification process? Not sure. Now how does the treaty deal with this? Well, it has a number of provisions that really boil down to essentially capacity building, suggests that to the extent possible these sectors be regulated and sort of formalized, because they're often informal sectors. Again, illegal mercury, black market mercury essentially, that's from dentists. The types of technologies that can prevent the releases of mercury and make it a little safer be adopted in a more widespread basis.

But again, it's not eliminating artisanal small scale gold mining because that is a livelihood for a lot of people. It's trying to make it less mercury dependent and less toxic, both for the miners and for the environment. So they've basically estimated that they could probably have the amount of mercury based on these estimates. So there's a lot of opportunity for reductions, again, because a lot of these processes are really inefficient. So I want to just end with talking about sort of the general context in which this mercury regulation is happening, which is the overall international regulations and what's happening globally.

Because obviously these producers and people who are dealing with mercury related issues aren't just dealing with this as an international environmental issue.

There might be other chemicals, other different kinds of considerations. So this is a figure that one of my students put together after going through the negotiations of all the different international organizations that had a roll in the mercury treaty. And one really obvious link is through the existing chemical treaties and institutions. So the Stockholm Convention is on persistent organic pollutants. So a lot of pesticides-- DTP, PCB, industrial chemicals like PCBs, also regulating dioxins and furans internationally.

The Rotterdam Convention is on trade in hazardous chemicals. It's a prior informed consent provision, so it mandates that countries that are taking imports of hazardous chemicals must give their informed consent prior to that chemical being exported. This is trying to prevent the idea of something's banned in the US. The US decides you guys will take it, so let's just export it to you. The idea is it shifts the burden to the exporting country to make sure that that country knows what it's getting and knows that you think it's dangerous. So there's a list of chemicals on that convention. Again, that's similar to the prior informed consent process that's in the Basel Convention that deals with wastes. So again, there's potential synergies there because Rotterdam and Basel also have things potentially containing mercury and also this issue of trade.

Funding often comes from the Global Environment Facility, which is basically donations from the rich countries. Minamata Convention has an additional new designed specific funding mechanism to be negotiated fully. But that has to do with issues that developing countries in particular have with the Global Environment Facility and its responsiveness. So that was negotiated as kind of a hybrid compromise. Possibly some multilateral funds that actually influence other environmental negotiations. But you have a bunch of other international organizations like World Health Organization that sets guidance for mercury levels in fish and also is involved in the vaccine thing, related to the dental thing.

So thinking about connections with that because you get very health relevant issue. International Labour Organization-- obviously in particular the miners, and what people are exposed to in particular factories is often in ILO. Food and Agriculture

Organization, to the center that involves pesticides. That's one that comes up. So that's the international bits. You've also got a bunch of guiding principles that come out. The idea that you can do whatever you want to your own environment but you have to watch out with others comes out of the Rio Declaration. That's 1992.

There's the general discussions over a sustainable development. These all kind of inform in a general way the kinds of regulations that are developed under the Minamata Convention. Things like the precautionary principle come out of these principles. And then, of course, you have multilateral regulations-- domestic agreements, bilateral agreements, regional agreement-- that are also dealing with mercury but on different levels and among different countries that may or may not be consistent or not.

Again, domestic governments try to make it as consistent as possible in the negotiations. But everyone's trying to do that, so it might not be possible. So that's all I had for prepared slides. I was told to keep it to about an hour-- I think I made it-- and open up for discussion after that.

AUDIENCE: I was just wondering what happens to mercury once whoever's doing the proper disposal gets it. Do they convert it to some safe chemical? Do they put it barrels and bury it under a mountain in Nevada?

NOELLE SELIN: The latter. Mercury's an element. You can't get rid of it. So not much you can do about it. The nice thing is, the quantities are pretty small. So again, encapsulating it, burying it barrels is pretty much what you want to do with it. Again, you're talking about tons per year. When you're talking about carbon it's gigatons per year. Mercury is in actual tons per year. And mercury is pretty dense. So this is also why your clump of mercury in your tooth or in the thermometer is actually pretty significant, because there's a lot of mercury there in comparison to the global budget, whereas the amount of carbon is teeny tiny.

But yeah, I'm not sure about Nevada specifically. You could put it in a trailer. I've seen mercury trailers. The strategic mercury stockpile was in trailers for a while.

AUDIENCE: Sounds pretty secure. So do you see a company that you thought was doing something right, in terms of understanding the role that they could play? Because this seems pretty out of my hands. So as a company at the end of the day, there's nothing I can do. I just probably can go to local state official, voice my concerns, hopefully get him elected, and let the whole thing just kind of--

NOELLE SELIN: There were definitely companies involved, but in a limited way. The lighting manufacturers were there a lot. But mainly I saw them talk about their products and their minimization and really kind of get the message that we are trying to take the mercury out of our lighting and we're doing a good job, so don't ban us. And I think to that extent there was a lot of awareness raising of technologies and available technologies that was done by companies in these international fora.

Again, it's an opportunity to trumpet your green technologies. So that would be sort of the positive end of companies advocating-- mercury free alternative companies, definitely. If you had a mercury-free something, you definitely were waving the flag for it. There were other companies that were there to make sure that their interests were protected. Oil and gas. Mercury is a small contaminant in oil and gas. Mercury is mostly a concern on site. So because of the way oil is distilled in the final product, there's not of mercury. If you have the unfortunate location of being near a mercury deposit when you're drilling your oil, you've got a problem.

But you've got a problem there, and you have to deal with it there. Because if you get mercury into your oil distillation process, it really gums up the works as far as I understand. So the companies were saying, hey, this is not really an international problem. This is something we deal with. We would really prefer that you not regulate mercury and oil and gas in an international way. And there were a lot of countries on that bandwagon, too. Once it was clear that mercury emissions regulations were not going to be applied to oil and gas, Saudi Arabia decided that they were going to go to lunch.

So things like that. And again, awareness raising of the kinds of things that international industries do. So even if it's not subject to the regulation, you have

assessments that come up that say, what are best practices? Because your multinational companies might know this is what you do when you hit mercury in your gas deposit, but not all companies might be aware of that. So again, that comes into the capacity building, awareness raising, making toolboxes to figure out how much mercury you're emitting in your process. These things come out of international negotiations a lot.

AUDIENCE: The other observation-- we we're going through the importance of US and European relation to set the way-- so in some sense, if you do what Europe is doing, you're in pretty good shape in terms of anticipating what could become global. Is that a fair assessment?

NOELLE SELIN: I think that's fair, and I think that's a strategic choice. So one of the things that that's changed over the years-- it used to be that the US was really the global standard leader in international environmental things. And the US was kind of a first mover in a lot of things like the Clean Air Act, pesticide regulation, et cetera. And in the last decade, decade and a half or so, it's really been the EU. The EU is really the global standard leader in the international environment, particularly in the chemicals area.

And I think there's a clear effort by the EU to actually globalize these kinds of standards. A strategic goal, in a sense. And part of that's competitiveness, part of that is, well, we think it's the right thing to do. Because it makes everybody safer, and if we think something's too dangerous for our population, why should it be OK for others? But again, with these kinds of chemicals regulations that are going in the EU, you see that. Now, you do see push back on that. The US saying, hey, this is too far. And it ending up in trade disputes and various things. You see that with CO2. But I think you do see chemicals versions of that.

But again, it's a multi-level thing, too. In the US traditionally how a lot of these environmental regulations came to pass was that you have a leading state. So the US regulation for the Toxics Release Inventory, where you have to report if you release toxics, came out of really a state initiative in New Jersey first. So you get a few leader states. California does a lot in terms of leading environmental regulation.

The interaction between California and the EU is actually really interesting because you see California now copying a lot of the EU regulations. You do see a lot of copying as well.

A lot of developing countries when stressed with the idea of doing environmental regulations says, gee, what's Germany doing? What's the US doing? Can we just go with that? Because again, the capacity to do these kinds of real technical analyses of, well, do we set it at five? Do we set it at seven? What does really make sense? A lot of developing countries don't have that, so they say-- that's really how China developed their mercury threshold is took the one from Germany.

I talked to the Chinese researchers that have informed that. And there's a lot of research on Mercury in China. But we've interviewed them and they said, yeah, basically took Germany's. Seemed reasonable. And also that's going to be where we're going to buy our emission control equipment until we can figure out how to make it, so if they're going to make it for German market, we're not going to set a more stringent one and then we're not going to be able to buy the equipment and meet it until we can make it.

It just makes sense with a globalized market for those things.

AUDIENCE: You mentioned that the Basel did the same for [INAUDIBLE], copy just like that. They just didn't-- no local analysis, no country-- same thing.

NOELLE SELIN: Yeah. But that's something that you really start to see in these negotiations. So it's even more prevalent in climate. But even in mercury you see this, that a lot of developing countries have one person at this negotiation. US delegation was about 20 people. so US would have someone from the EPA, and someone from the State Department, and someone from the US Trade Rep's office, and they had some health experts, they had people that did vaccines.

So they had a broad range of expertise-- the emission control, the products people, they were all in different groups. And even in mercury, which is a fairly small area, you could assemble that team. Now, you've got people from African countries and

you've got one person. You've got two or three groups going at the same time. You have to deal with emissions from power plants. You have to deal with products. And the way it works in the US is-- I know the people who work on mercury-- mercury's almost their whole job, because they're dealing with mercury in Air Toxic Standards, they're dealing with scientists, there are scientific assessments going on.

The person in a developing country in mercury, they're probably running the whole environment division. They might be running environment and labor and health. Especially smaller island states, you've got a couple of hundred thousand people in your population. How much can you environment ministry? So a lot of these regional consultations become very important. But capacity really, really comes into play. When we were at negotiations, this negotiation to exhaustion comes in, too. Because like you would expect, no one wants to compromise till the very last minute.

So when we were there at the final negotiating session, the deadline was-- the meeting was scheduled through Friday, 6:00 PM. We got to agreement Saturday morning at 8:00 AM after negotiating all night. So if you have a couple people on your delegation, you can take naps. If you don't, you're kind of challenged.

AUDIENCE: Take naps.

NOELLE SELIN: Yeah. And you miss something. Yeah. Exactly. So again, you have to rely on other friendly countries in the region. And a lot of that is done to try to facilitate-- in a sense, a lot of the African countries have a lot in common in the negotiation and sort of bond together. But again, countries that have a very particular interest might not get that represented. And then they have to go back and figure out what it means for their own legislation in the context of all the other things that they're doing.

AUDIENCE: So will you please talk again about this pace of negotiation? Because I remember I saw in one of your talks about basically how exactly the dynamics of the negotiation-- so this kind of explains--

NOELLE SELIN: So yeah, nothing happens until the very last minute, which is interesting. It's sort of

like grad school. But there's a lot of spinning wheels for we have to discuss things, we have to be deliberate. Again, 2002 was when there was a global scientific assessment that says we ought to do something about it. And then years and years. Mandate for negotiations was 2009. So then you schedule a meeting. Usually scheduled meetings may be for a negotiation like this every six months or so, five or six day meeting. Everyone has to get there. You've got interpretation issues. So the six UN languages are simultaneously interpreted in the main room in main plenary discussions.

Most of the in the card discussions are in English because everyone speaks English except for a few. And if you're one of the few that doesn't speak English, that's a problem. We try to avoid sending those people. But some countries don't have a great English speaking capacity. That's been mostly a problem in my experience with French-speaking African countries, have the most problem with finding the person who speaks English. Lately it's been a little better. The older people often didn't speak English. Younger people are actually sort of taken over now in a lot of these countries. And so the idea of the 65 year old person that didn't quite get the message that English was-- wasn't taught English in school is no longer at the head of the delegation.

It's now the 40 year old that basically went to school in an English speaking country in a lot of these countries. So that's one issue. Again, if your country's language is not one of the six UN languages, you've got to speak on that language on the floor. So if you're from Brazil, you're probably speaking English on the floor because Portuguese is not a UN language. So again, if you're from Japan, you're probably speaking English on the floor unless for some reason you know French.

But you've got to pick one of the six. So English, French, Spanish, Arabic, Chinese, and Russian. So that's another thing that makes things go fairly slowly, when you have simultaneous interpretation. And it means that it can kind of be a glacial pace for awhile while people say, hello, I'm going to thank the chair for negotiations. And I want to respectfully say that I disagree with paragraph two. But in a 10 minute speech. And then the next person says I also disagree with paragraph two. And you

have to go through everybody in the countries before they actually say, you all go talk about paragraph two in the room over there. Once that happens and you get to a deadline, you can agree on paragraph two relatively rapidly.

But you need that whole process of getting to agreement there. So again, writing the text-- the secretariat supports a lot of that. But again, you're drafting in a big group of people with 160 countries going word by word through a document that has legal force. It's a tough thing. And that's why the science, I think, doesn't really come in. Because the complexity of the negotiations, it's part of the reason why I think the chemicals program has set up this process pretty well, is that they say, we're going to do the scientific assessment. We're all going to agree. We're going to stamp it. We're going to move on. If you have a question on the science, we'll kick it back to the scientific group, we'll do an assessment, we'll agree, we'll move on.

So it's kind of like the science sets the basis and then we're going to negotiate, which means it's not always the optimal outcome. But it gets done. Something gets done. Now I did some analysis actually of what would happen in mercury in the environment as a result of this treaty with the best guesses of what it would involve. And pretty much the conclusion was avoided increases. So without the treaty, our business as usual would be mercury increasing in the environment.

With the treaty, probably pretty steady. So again, if you want mercury to decrease in the environment, you've got to then go through and look at your technology regulations for emissions and probably ratchet those down through the treaty process itself. Otherwise, you're not going to actually improve. It's also more legally and politically important at this point then environmentally important because it sends a pretty clear message that mercury is a pretty bad thing internationally, and that has a really big signaling mechanism.

If you're a company and you're thinking about using mercury in a process-- which might be the easiest way to do things, because mercury has some really neat chemical properties-- this kind of thing will make you think twice about it. So that idea that there's sort of a consensus around mercury is bad, and they're increasing

amounts of regulation, and countries are beginning to figure out that mercury is now going to regulate more has a strong political force, whereas the technical regulations might not be the operative part. So again, legally and politically important. Not so much environmentally yet-- but might be in the future as amendments come in, as the technical requirements-- there's a lot to be decided on exactly what technologies might be considered in terms of emissions regulations.

And that's an open question right now. And it's going to be decided by the technical groups and by conference of parties negotiations. Yes?

AUDIENCE: So after ten years of working on this, do you eat fish?

NOELLE SELIN: I do eat fish. There are fish that are relatively low in mercury. So the key in dietary advice on mercury is you don't want people not eating fish. Fish high in omega 3s, but low in mercury-- unfortunately, that's the herrings of the world. And I don't want herring. But again, I also figure there's lots of things that are going to kill me faster, like French fries. So you've got to take them one at a time.

PROFESSOR: Any more questions? Thank you very much.

[APPLAUSE]

All right. So we're not going to go through today your deliverables. Tony may have mentioned, or Alexis last time, that we divided your groups. Did they tell you? Yeah? So we're going to be meeting with you independently over the next few days to go over where your project is in preparation for the final report. And then next week we're going to be talking about strategy. So we're going to try to get everything we have covered and try to frame it in a more concrete discussion. So what are we going to do with everything we've learned.

You're going to eventually want to make-- drive a change in a company. How should I start with all these inventions, the technical side, now the political side, the NGO side, the complexity of the networking you have to deal with. And we're going to have a discussion around that next time. And we're going to probably bring some of the things you have already worked on your specific case studies. And Wednesday

we're going to have the head of EMC to decide to actually tell us how they did it.

It's very interesting. Today I was meeting this morning with-- the last few days I have met with P&G, Intel, and Nike sustainability heads, and how they have been thinking through this process. So it strikes me they're as confused as probably you are at the point. Exactly what do I do about it? At the end, you have to make some specific actions. So we're going to at least bring some of the ideas to the table over the next two sessions. With that, I that I will see you on Monday. Thank you.