

THE FIRST CUT

For the first time, the US Congress has begun crafting comprehensive legislation to tackle global warming. *Nature* brought together five experts with various backgrounds to discuss the current political climate as the United States moves towards mandatory emissions caps. This is a full transcript of what was said.

Senators Warner and Lieberman introduced their bill last week and that obviously had support from some leading Democrats, including Boxer, who actually represented that as a watershed moment. Can we just talk about the advantages and disadvantages of that legislation as compared with say the Bingaman-Specter bill? Maybe we'll start out with you on that, Jason.

Jason Grumet: Well, I think the most important reflection is that the fundamental architecture of the bills is extremely similar. I think that's what gives me some real optimism that we can now see legislation, because we have two serious detailed bipartisan proposals that have a great deal in common. There are some important differences, but I think it's worth noting that those differences are not philosophical or ideological. They are different approaches to trying to achieve similar ends.

So there's a difference in how the bills seek to contain costs or address kind of worst-case fears about costs in the early years. But both bills recognize both substantively and politically that has to be part of an ultimate compromise. The bills have some differences in how they address the issue of offsets, which also relates to questions of environmental certainty versus cost certainty.

The bills have a number of important but really quite minor differences in how they allocate permits, a different percentage to low-income heating programmes versus different percentage to states, slight differences that Jim can speak to on how they approach the utility question. But fundamentally, their approach to the international linkage, the basic structure of the bill are really very much aligned. It's my sense that if there is political will to pass legislation this year, you could reconcile the differences between those two bills in an afternoon and have 60 votes.

Do you agree with that, Jim?

Jim Rogers: I do, and I think Jason did a very good job in describing it. I think the fact that the nationwide cap and trade, that fundamental architecture is really critical to moving forward. It seems a consensus is building on that and that is critical. I think the other important thing I would say that, of course, this is the Senate side and we have more work to do on the House side. I think the House is generally moving in that same direction. And from my

Who's who

Julian Braithwaite works on climate issues as counsellor for global issues at the British Embassy in Washington DC.

Jason Grumet is executive director of the National Commission on Energy Policy, a non-partisan group whose work served as a platform for Senator Bingaman's legislation.

Michael MacCracken is the chief scientist for the Climate Institute in Washington DC.

Jonathan Pershing heads the climate, energy and pollution programme for the World Resources Institute in Washington DC.

Jim Rogers is the chairman and chief executive of one of the nation's largest electric utilities, Duke Energy in Charlotte, North Carolina.

standpoint, I applaud the work of both Lieberman-Warner, as well as Bingaman-Specter.

And we need every good idea to get this done in a timely way and to get on the road to addressing this issue. The two observations that I would make that really, unfortunately but realistically address differences in the country in terms of how they use fuel to generate electricity. And it's a question that really, depending on your point of view, is a question of fairness and it surrounds the concept of safety valves, which is a long conversation we could have. And the second involves the use of allowances and the allocation of allowances.

And that's another long conversation we could have, but the important point is the recognition, although in different parts of the country you'll perceive this differently, is to try to minimize any disproportionate or adverse impact on any certain region of the country because of historic decisions that were made about the type of fuel they used to generate electricity. So that debate will be ongoing.

It's a question of fairness, so there isn't a formula that necessarily works for everybody. And at the end of the day, it's going to create a certain amount of pain, like all difficult compromises, for everybody because there is no perfect solution here. And Jason, who has tracked this issue a lot as well of others of you, know that this is where, when you get down to getting the votes that you need, it's going to

be critical to have flexibility around how you address this fairness and impact on specific regions of the economy.

Right. Well, let's pause here real quick. We have had an addition. Jonathan, I believe you know everybody?

Jonathan Pershing: Hi, this is Jonathan Pershing.

So in talking about that, you mentioned the possibility of legislation this autumn. Most of the folks that I've talked to think that that is exceedingly unlikely and maybe even next year might be optimistic. What are the chances we can get this done this autumn or in this Congress? What are going to be the big sticking points, where do we need the breakthroughs?

Grumet: I can start as you're asking kind of a DC policy question and Jonathan can jump in. I think it is unlikely that you will see legislation signed by the president this year. However, I think there is a real possibility that you can see legislation garner 60 votes in the Senate if there was a political will to do so. And once that happens, that legislation becomes the centre of gravity for what will ultimately pass the Congress.

So although I think there is a general agreement that we're not going to see an absolute conclusion to this first step, people are very engaged because the stakes are extremely high. Once we come together around some of these key points, I believe that those will be reflected ultimately in what does pass.

I think there is a tactical question that I think our commission has some disagreement with other advocates about. And that is whether in fact the legislation could be so much stronger environmentally in 2009 or 2010 that the best thing to do ecologically would basically be to rope-a-dope and actually not try to pass legislation in this Congress. Our commission fundamentally believes the opposite, that the most ecologically responsible thing to do is to get an economy-wide mandatory programme adopted in the United States. Because that is the predicate, obviously, for not only reducing our emissions, but for allowing us to re-engage credibly in the international discussion.

And so we also believe that when the discussion truly gets serious, it becomes less partisan and, as Jim was saying, more regional. So it's our view that although it's more likely that leg-

islation will pass in 2009 or 2010, the actual substance of that legislation, we believe, will be quite similar to what you could pass now. So our view is that we should get on with it.

Rogers: Let me make an observation here, because I do agree with that analysis. I would add a couple of facts that reinforce it. First of all, and I've spent a lot of time on the Hill talking to people, once you get beyond the committee and the committee staff that have been working on this, there is not great depth on this issue. So I think I would say there is a need to continue to educate, to build the type of consensus that is so critical.

I would just drop a footnote to say every major piece of environmental legislation that has ever been adopted in this country has been overwhelmingly adopted bipartisanship, and it's never been a close vote, it's been huge votes. This goes all the way back to the Clean Air Act in 1970. So what I hope and I see in the future is this strong consensus growing out of both Houses. So there is an education issue that is an impediment to getting it done before the election.

Second, there is a complexity issue. I think the deeper people get into this, I think you see greater complexity evolving. Third, it's the fairness issue as people start to put the numbers down and look at the impacts, that is going to inform the debate. And then last, and Jason I think he was talking the politics of this, and I do believe this will become the centre point.

Another way to say that is this will become the conventional wisdom that everybody will work from — it will become the deal to beat going forward. I think every candidate that is running, and I'm not sure of this, but I've heard this — almost every candidate in both parties says they are prepared to address this issue. And so without getting into it is an advantage for Democrats or Republicans or whatever, I think it's these other issues' complexity, addressing the fairness, educating everybody about this that is going to create the momentum, not to get it done now, but to get it done in 2009.

And let me just say one last thing, and I apologize for having such a long answer, I have spent a lot of time working with the Human Foundation and the Club of Madrid. If we don't act in 2008 to be a meaningful part of that international negotiation, we have got to act in 2009 so that we can be at the table helping to shape that. And I think one of the things that we see, and this is really a question for the scientists to address, we're seeing the changes occur so fast and maybe faster than we thought, that there is no question that mitigation is still critical. But we're going to need significant adaptation measures in certain parts of the world.

And so because of the fact that we have two tracks now that we are on, adaptation and mitigation, although I have a great sense of urgency to do it as soon as possible, if we recognize that we're going to have to do adaptation also in some parts of the world, that delay into 2009 is, unfortunate as it may be, is not going to nec-

essarily undermine dramatically our capability to go after this issue.

Pershing: Let me add just a few things about it. First of all, I would agree with both Jason and Jim that I don't think that we're going to likely pass it this year. My sense, however, of what we shape this year will dictate what we ultimately pass. So this is the year for design, this is the year for discussion, this is the year for movement forward in detail, as well as in broad generality. It does seem to me that another piece that Jim didn't mention, but I think is quite critical, is the level of popular support.

So what we end up with now is we've got a whole host of states moving forward, the level of public opinion is enormously supportive. And what I've observed in the conversations that I've had with staff primarily on the Hill is a sense of more information certainly needed, but more moving in and a sense that there will be a large majority moving forward. And I would actually would agree that we're likely to pass this with a substantial majority, not by small, small shares.

But that brings me back to the question of what the individual pieces are that might be the conflict, what's holding this back. And one of the things that Jim mentioned earlier was this whole question of whether or not we have price certainty and how much that price certainty, what will it cost — how much is it going to be to do this problem? My own sense is that if I look back over the past three to five years, I've seen an increase in the willingness to pay.

If we begin, for example, with a discussion that we had in the Regional Greenhouse Gas Initiative in the northeast states of the United States, we had an agreement at that point that we could pay on the order of \$5 to \$7. That was the modelling number, and over that particular issue, a number of states actually weren't prepared to move forward. We then move and we have the first bill from Mr Bingaman and we have a willingness to pay that's \$10. Then we move to the second Mr Bingaman, we have a willingness to pay that's \$12.

We now move forward and we have some discussions going on on the West Coast and the willingness to pay seems to be substantially higher than \$10, not least because the kinds of impacts that we're observing. So the forest-fire discussion, which is beginning to be linked, I think credibly, but linked to the issue of climate change creates billion-dollar damages in San Diego and leads to the statement of emergency, people's willingness to pay increases.

So our perceptions of the need to have certainty is certainly high, but our perception of what we're prepared to pay also increases. And to me, that brings us back to the question of what kind of technology costs are there, what kind of options do you have and what kind of price might you need to pay to get to those options. Clearly there are things such as capture and storage for sequestration. I don't think it's particularly plausible the United States is going to move away from coal.

There are clearly issues around what the differential price is for renewable energy. My sense is that those prices are still higher than you would be justified paying based on current electricity costs. There are also things that have to do with industrial opportunities, those are probably higher than the \$12 we're currently seeing. How much higher I think is a bit unknown still. But creating some sense of lack of spikes, lack of discontinuities in the price system, allowing for planning by the private sector, allowing for planning by the public sector, those seem to be quite critical. And I think that is what Congress is going to debate.

Grumet: One just quick point on this question of the price needed to motivate technology that I think is important is there tends to be appropriate, but maybe over-fixation on the price per ton. I think, and I assume that Jonathan would agree, that if you're assuming a price per ton such as \$30–50 for carbon sequestration, I don't think we're going to see that price in the first instance in our climate bill. But two things give me greater optimism.

The first is that we are, and I will say we — Jim is building facilities that will have a 50-year lifetime. And so when making those kinds of economic assumptions, you're not just looking at the cost in the first year, you are obviously projecting forward for half a century. Second, there is a push and pull aspect to all of these bills, both Bingaman–Specter and Lieberman–Warner, which provides very significant technology incentives targeted generally for important things such as efficiency in renewables, but very specifically for carbon sequestration.

The Bingaman–Specter bill has incentives that based on permanent prices would be somewhere between \$35 and \$50 a ton in the very first year of the programme for carbon capture and sequestration, which gets added to the \$12 a ton. The Lieberman–Warner bill outdoes it, I think, considerably and I believe if I'm reading it right, probably provides about \$100 a ton credit for CCS, in addition to whatever the carbon price is. So to really understand the extent to which these bills will advance the critical gap technologies, you have to think about both sides of that equation.

And because any carbon price generates a significant amount of revenue, one of the key aspects of this legislation when it ultimately passes is going to be those technology incentives. One of the key challenges is to figure out how we effectively spend the money.

Rogers: I would make an interesting observation from the third largest consumer of coal and probably the third largest emitter of CO₂ in the United States serving the industrial heartland, as well as the southeast. I see this really through the eyes of our customers and what the cost impacts will be. It is fundamental in my judgement and we can and should and will build a bridge to a low-carbon world. To build that bridge, we are going to have to build it on technology.

And I make a couple of quick observations. Carbon capture and sequestration, I've seen a

lot of detailed studies. I think the MIT study is the most informative with respect to the cost and the timeline, but that's 10–15 years if we put massive investment in terms of developing new technology. And in fact, we're building a plant in Indiana, the only commercial IGCC where we will be doing a large carbon-capture experiment there to really try to get it done.

So that is part of the solution, part of the technology, but that's 10–15 years in a country where 50% of the electricity comes from coal. The second thing that's happening is I'm encouraged with the prices of renewables coming down, but they become increasingly more valuable to us if we can accelerate development of storage technology. That is happening, but that's still a ten-year process before we get those calls further down, as well as get that storage technology in place.

The third technology, and I'm almost reluctant, but I'm the fourth-largest operator of nuclear in the country and what's going on around the rest of the world is the whole nuclear option would play a key role, because there is zero greenhouse gases. But that option won't really come into play because we have not thought — it's been a fuel issue — will not come into play for probably another ten years. And the reason I've said it the way I just did, it's 10–15 years in carbon capture, it's 10 years on renewables and storage, it's 10 years on the nuclear option at a minimum.

So when we build a cap system we look at the cost, and the cost is a critical issue when you think about where the major manufacturing is in this country. I mean, it's not in California, it's not in the northeast, it's in the midwest and it's in the southeast where the heartland is in terms of manufacturing.

These technology solutions, and I left out energy efficiency, which I think is the number one thing that we can pour a lot more money into and get some good results and slow the growth, we almost had to have a timeframe of how long is it going to take to get the technology that allows the bridge to be built to the low-carbon world going forward. And it's going to be critical that we match that up with caps and with the use of the dollars that will be generated.

Pershing: Let me just come back and add on that particular point. I think, in fact, we've often thought of the technology-penetration pathway exactly the way that Jim has described it. There has been a sense of the timeliness of how quickly you can move before you have stranded assets and have substantially higher costs. But it does seem to me that if we are looking at a process in which we wait for 10–15 years before we have any significant movement on a technology, particularly in the case of capture and storage, we've lost a substantial part of the battle.

And I frame that in two contexts. The first one is to look just at the United States which, as Jim notes, has about 50% of our power in coal. Ten more years from now we will have locked in that much more of our capacity and

our supply, and my sense is that without some more certainty in a regulatory sense, we actually won't build many IGCC plants or at least capture the CO₂ at the end of the tailpipe.

But I would argue even more importantly over the next ten years, China is going to be adding, give or take some, a new coal-fired power plant every week to ten days. And over the next ten years, a substantial share of their new incremental supply will be brought online, and that is not going to be things where we can get an end-of-pipe capture technology. Which means that if we wait for 10–15 years to have a technology penetrate the United States, we've committed ourselves to a substantially higher level of concentrations.

My guess is that that level of concentration is at least 550 p.p.m. and perhaps 650, given the going forward pathway. So I would make the suggestion that if we need to think about this in very specific ways, it's how do we move that and how do we accelerate that. How do we get it so it's not a 10–15 year pathway, but a 5–8 year pathway. What would it take in the way of capital investment, what would it take in the way of incentives, what would it take in the way of subsidies, what would it take in the way of regulation to move it both in the United States and internationally.

Rogers: I think that is a very powerful and important point. I just want to underscore my agreement with that.

Michael MacCracken: I would just say that I think the states are actually showing what to do, they are moving very hard on efficiency. I mean, California has worked very hard on that over the years. They do it both by incentive and by regulation to try to get appliances to get much better, to try to get buildings much better. I think if you look at what, for example, the American Institute of Architects is trying to do, they are trying to get a lot of the energy use out of buildings.

I mean, they want to go to zero carbon use in new and existing buildings in about 20–25 years, which would be a real change. They actually are suggesting ways to do it. And other states, such as, I believe, Delaware, are talking about or have a bond issue set to loan and try to upgrade, to sort of loan to homeowners to improve efficiency and paying it back with the savings in the electric bill. There are just tremendous amounts to do, and I guess in addition, I guess I would ask the question, in addition to these cap-and-trade parts of the bill, what are they saying about efficiency and getting demand down?

Grumet: No, that's — and Julian, do you want to jump in on this one, or should I?

Julian Braithwaite: I was going to make it a point comparing our experience in the United Kingdom.

Grumet: Why don't you go there and...

Real quick, let me touch on bringing this to the science real quick and then I want to get back to this exact point. In terms of the

science, there is a study that came out in the journal Science this week that basically questions whether we can carry this, our modelling, much farther in terms of trying to pin down the climate sensitivity. What is the role of science, the scientists here? What do they need to provide to add to this discussion to be able to get the policy-makers where they need to go? If you could address that, Mike.

MacCracken: Well, I think the first thing to say about the ranges that the IPCC generates on what will happen in the future is that about half of the range is a result of what's going to happen with respect to society. And so what choices society is going to make in the future about things, so that is a pretty important part. So don't attribute the entire range to uncertainties about how the climate system is going to work.

I guess the second thing I would say is indeed, it's going to be hard to get the range too narrow, but what has been happening is the lower bound has coming up. And where the major uncertainty is is on the upper end, the changes could be larger than we have been projecting in the past. And that's why what's happening in the Arctic for example, or what's happening in Greenland is so troubling, is because those are larger than we projected.

So when people talk about uncertainty in what's going to happen with respect to climate, it's not that it's going to do less than we think, it's that the potential is going to be larger than we have been stating. So that is just another argument for working as quickly as one can to do something. I mean, I think the climate is basically portraying to the developed countries, certainly which need to act first, that they have to go faster. And I think the other reason that they have to go faster is it's awfully hard to expect a developing country to do something that we haven't demonstrated is possible.

If we can't show a developed country can live on low carbon, it's awfully hard to go out on a moral basis and say — oh well, China, you should do that, even though we can't. So I guess I would not come back to the scientists and say you have to narrow it down. I don't think you can use the climate uncertainty as an excuse. I think what the scientists, as I say, are arguing about is can it be even larger?

Julian, on this very quickly, the European Union has said that it would set a target basically of limiting the effects of climate change to 2 °C, and that's based on the science, but obviously that's a policy decision. What are your thoughts?

Braithwaite: It's based on best available science at the moment, it's based on the Intergovernmental Panel on Climate Change, plus our own national modelling. We think the 2 degrees is linked to a sort of watershed really, in terms of the feedback in terms of what would happen with the accelerate change on climate change. It is the best available target at

the moment on the basis of the science.

I think that we then see that that links back to something that you can measure, which is about 450 to 550 parts per million in the atmosphere, which then allows you to start setting things that you can actually target, such as your caps on emissions nationally, regionally and in the European Union and hopefully globally that allow you to stabilize at that sort of a level by the middle of the century. I mean, just taking a step back and listening to this conversation, the United Kingdom has been following this very closely and we are as engaged as we can be as a foreign country.

But I think our lesson from Kyoto from what happened there is that it's clear that the United States is not going to be able to sign up to and implement something through an international treaty that it hasn't come to terms with domestically. And therefore the domestic critical process has to come first, and that's why what is going on now is so important.

We do believe in the United Kingdom and in Europe that a cap-and-trade system is essential public policy, it's the bedrock really of public policy that would deliver the sort of changes that we need. But coming back to the point about energy efficiency, it's actually the cap really that is the essential policy, a mandatory cap is what's essential. Then there's a whole range of public-policy tools that deliver that. And energy efficiency in the United Kingdom delivered well over a third of the country's savings in carbon dioxide emissions since 1990.

Since 1990, the UK economy has grown 45% and we've cut our emissions by about 15% and we've decoupled economic growth from growth and emissions. It can be done and we believe the United States can do it. But the United States is a swing voter on this internationally. I mean, the United States is not just one other country, the United States is 25% of the global carbon emissions. It's also, by some measure, 50% of all of the R&D invested in the world. If the United States switches on this, it will have a momentum that will bring the rest of the world along, and that's why this debate here is so important and that's why we're so engaged.

We are working with anyone who will work with us on these issues, we're working with the administration on technologies, where they are investing a great deal, particularly on clean coal and carbon sequestration where we support them absolutely — that's a key technology. We are working with the states, where they are developing cap-and-trade systems. We are talking to people in Congress, sharing our experience in Europe. But this is where the centre of the debate is. Once it shifts here, and if and when the United States does believe that a mandatory cap is key to going forward, then I think you'll have that impact internationally in China and elsewhere.

Rogers: Let me add a point here, because I thought that was a very articulate, powerful set of points about the role that the United States has to play. And it really reinforces, in

my mind, the importance to us acting in 2009. But I want to have a cautionary note here, because as I listen to political leaders talk in this country, they talk about us becoming a leader in the world.

I believe that we need a more thoughtful, humble approach to this because quite frankly, unlike the United Kingdom and other countries, we have not been leading the way on this. I think for us to be effective worldwide and drive this, because I think we have 192 countries and we'd like every country to participate, but we need to recognize every country will not be able to participate as countries in Europe and the United States can and we need to make accommodations for those other countries.

But as a tone of voice, our goal line should be to stand side by side with the United Kingdom, other countries and let that be our objective as we solve this rather than us beating our chests and saying we're going to lead the world. I think it's much more important to be effective in the international arena if we have that approach.

MacCracken: It's important, I think, to understand that when Julian says 2 degrees, it's 2 degrees above pre-industrial levels — not 2 degrees above present. And so as we're almost halfway there and committed to go another quarter of the way, we're very close and we need to act very soon. In fact, I think what the next argument or next issue coming up is going to be that we can't stay as high as people we're thinking we're going. We've got to come back down.

So this idea of stabilized atmosphere concentration, which is in the UN framework convention, you can't go up to this level, some high level that we end up going out to and not come back down. And that's for two reasons. First, on the CO₂ alone, the effect on the ocean is starting to appear with ocean acidification and a lot of the oceanographers are getting very worried about what's going to happen to marine life because of that. So that's a huge issue. So we've got to really work on CO₂.

Now a lot of it is talked about for the temperature, you are worried about CO₂ equivalent, so you're worried about the other gases. And you can certainly do a lot on that. In fact, it seems to me the deal to be made is that the developed countries have to work hard on everything, but that the developing countries actually can play a big role by controlling methane and soot and land-cover change, all of which are vital to improve their quality of life and reduce air pollution and improve health effects.

We can get methane way down if we really work at it and we had better do it fast enough before the sort of permafrost starts melting and put more up. But we can get it down by controlling sewage and other wastes and kinds of things, and China could commit to that, India could commit to that. Soot is an indication of inefficient kinds of combustion, and so improving that would help and would help health. Land-cover change is absolutely vital to get ecological services for water and other

things out of there.

So I think what ought to be encouraged is getting the developing countries to early on commit to methane, soot and land-cover change and some aspirational goal on CO₂ and the developed countries have to work very hard on all of these.

Let me go to Jason, and then I want to get Jonathan's view.

Grumet: I want to kind of reflect on the views that both Michael and Julian raised on the effect on Congress of the scientific community and also the international debate. Of course, it's always nice to recognize that it's a pleasure to be sitting with so many Nobel laureates, the IPCC has greatly enhanced the quality of my camaraderie here in town.

And then also note that I believe there is actually one scientist among all of our elected members of Congress, so this question of how science engages policy is obviously a very important one. I would start with the unfortunate reflection that I think there is a profound disconnect between ecological imperative and near-term political possibility.

And the problem that that creates as the science becomes ever more clear and the impact ever more chilling, is that the debate has shifted among those who are opposed to action from the question of science to now questioning the solution. We have kind of a nihilism that has invaded Congress and said essentially: 'yes, this looks pretty bad, but there's nothing we can do about it'. So I think that one of the roles that science needs to play more actively is to engage the important fact that regardless of whether you want one degree, two degrees, negative three degrees, what we need to do right now is basically the same.

That we have to get started and that the efforts to turn down the curve in the developed countries is essentially the same regardless of your endpoint, regardless of your expectations, your uncertainties. And then secondly what Dr MacCracken just talked about, about the opportunities for developing countries to take meaningful near-term actions is critical.

Because there is a very strong disbelief among many that the developing countries will ever do anything and there is also a rather surprising or strong questioning of the legitimacy of what the Europeans have been doing and sort of transfer now to the question of how international actions can inform the US discussion. I think Julian absolutely summarized US foreign policy in one sentence, which is that we tend to imagine ourselves as leaders and do not have a particular history of joining international agreements if they precede domestic action.

I think it's also appropriate as we look towards the post-2012 dynamic to really reflect on this reality that they are about 20 countries that are responsible for about 80% of all the emissions. And I believe that the recent summit that President Bush called was entirely con-

structive, but for the fact that we didn't show up with credibility or any money. It was almost as if we invited the world's leaders over for dinner and after about three hours, they realized we weren't serving any food. But my hope is that that does not undermine the legitimacy of the approach, because I think that we are going to be much more effective in that kind of negotiation than trying to re-enter a 160 country discussion.

Rogers: May I add a point here to really pick up on this? And this is really the broader question of developing countries around the world. I had an opportunity recently to address the UN plenary session on this issue. And in the course of my presentation, I had an opportunity to listen to environmental leaders, country leaders from around the world, different developing countries.

I think although the conventional wisdom about the United States has been they are not prepared to act until there are other actions around the world, every conversation that I heard recognized the devastation. Many of them would be the most affected in the early period and the recognition that they need to do something and to be acting on this, but recognizing they have limited economic capability to do this. And so I think what you're seeing is an emergence among developing countries with respect to this.

I put them in a fundamentally different category than the Indias and the Chinas of the world, although I would daresay that the old China hands in the United States have a little different view than the popular press in terms of the concerns that the Chinese have with respect to the ecological disaster that they are dealing with within the country. So I think worldwide, I think that you're seeing greater recognition, but with limited capabilities to address, which really gets to one key point that I would like to leave.

I think that's it critical that we expand the concept of all sets, because it's a cost mitigator on the one hand. And second, and this is probably a little more controversial, is I believe that we need to have a system of credit for avoiding deforestation. I think in certain countries such as Brazil, and I can name others, that this credit for avoiding deforestation would be an important add. I know that it was debated a lot in the Kyoto and rejected, but I think this is the type of the evolution in our thinking that is needed in order to engage all of the 192 countries in the UN and not just a few.

I want to get to you on this, Jonathan. The Environmental Protection Agency recently released its report basically saying that if you compare a lot of these bills that are up on the Hill right now on global CO₂ emissions, they don't make — there isn't a lot of difference among the bills in terms of the global impact without addressing the developing world, which is what we've been talking about here. What are your

thoughts? How do we actually engage the developing world, how do we bring them on board?

Pershing: Well, you start with two different things, the first one narrowly on that question. There is no issue in my mind that you cannot solve the problem unless you get global action. And by global action, I agree with Jason, give or take some 20 odd countries have to move. The United States is one of them, so is China.

Interestingly enough, China is actually way ahead of the United States in its movement. China has got a national, a renewable portfolio standard with an obligation. China has got an energy-efficiency standard with a legitimate and binding commitment. Chinese automobile efficiency standards are higher than those in California and higher than California is projected to be even over the next ten years.

So I look at those kinds of things and I think there is a significant gap between our perception of China and what it's doing, and even there it's falling behind and there is an implementation problem and there's a technology problem. And so ultimately how we figure that is going to be quite critical. It's in this context that you need to look at the EPA analysis, which basically says that if you were to cut off the entirety of developed country emissions, go from 100% down to zero, you would still require substantial action from developing countries to solve the problem.

And we can all be assured that we are not cutting off developed countries' emissions, because the electricity sector is contingent on those and currently transport is contingent on those. But what it also says to me is that the structure of what you do next in the United States matters hugely. If you would like to have developing countries engaged, you can't merely tell them we're going to make you do it.

You've got to demonstrate that you're going to do it yourself. You've got to demonstrate that with a per capita income 20 times as high as India, you really could act and it's not going to cost you so much. Because otherwise they will look at you and they say: 'I'm so sorry, I'm impoverished, I can't play', and they have a legitimate reason not to be able to do that. So if we can demonstrate technology potentials, if we can demonstrate the commercial viability of programmes, if we can demonstrate the profitability of these solutions, all of which I think are inherently realistic and plausible, then we can transfer that information.

I would suggest that as you look back at the science question, there are going to be two parts to the science. One part is the technical information, one part is the impacts and the physical science and the nature of the change that we're going through. I think that's what is driving China. That's why India is engaging in this conversation. I think the United States is, in some ways, behind in that curve.

I think the United States has turned away from science as a driver for action — the states could use it, the federal government has been very

slow in adopting it. But I note that in the statement made by Hu Jintao at the five-year annual meeting of the Communist Party, the environment was one of the three essential things that he raised and climate change was one of them and he cites the IPCC as evidence for change. So I think that's huge in terms of drivers.

MacCracken: They are very worried about the monsoons and what will happen. I mean, it's absolutely critical to them and they are worried about air pollution and other things, but they are worried about the monsoon and water. They've got lots of studies going on about it, they are worried about water resources coming from the Himalayas and the melting snow and the loss of snow, and they are very worried about — water is absolutely vital and you have to have it. So indeed, they are very, very concerned.

I wanted to come back to one comment about the EPA's finding when it says — I mean, if a developing country, if developed went to zero, developing would still have a problem. If developing went to zero, the developed countries going on the present course would have a problem sooner than that, actually, because our emissions right now are considerably higher. If we continue at the current rate, we'll do it. So even if developing went to zero, there's a huge issue — we both have to act, all of us have to act.

Pershing: The other thing, I just want to add one last point on this, which is that I think that the other piece that the Chinese are extremely focused on also has to do with the science, but it's the other side of the science, it's the technology, it's the engineering sciences. It's the sciences about how you can be profitable on things such as coal capture and storage, which they are going to develop at this rate before we do and they will sell it to us. And they will sell us a cheap car that will give five times the efficiency that we can produce because that is the direction that they are moving domestically and they will make a commercial success out of that deal. That's going to be a different part of the scientific conversation, which I think we're no longer ahead on if we're not aware of that.

Julian, I wanted to ask you. I mean, as long as we're talking about implementation here and trying to bring the developing world on board and trying to get legislation that will let that happen. What can the European Union teach us? I mean, what can the Kyoto Protocol and the framework that has been set up over there teach us here?

Braithwaite: Well, I think as you look to 2012, there are two visions of how we go forward being presented to the developing world, the large emerging economies. One is a voluntary system in effect based on international peer review, which doesn't offer the threat of the large emerging economies see it of binding cap amount emissions or targets on their emissions any time soon, or indeed as a principle going forward.

The other is one way you continue to develop the global carbon markets, you continue to develop principles of Kyoto where you have mandatory caps on emissions, you have common but differentiated commitments. Which does offer the prospect, in the longer term, that at some point China and India will have caps on their emissions. And we're not talking about that today, we're not talking about that over the next decade, probably.

But at some point, they are going to have to have caps to start really ratcheting down their emissions. But what we are talking about, which we think is attractive for them, is we're talking about a global carbon market, which will generate billions and billions and billions of dollars of financing for technology transfer and clean technology in the developing world that will help China build clean coal path stations instead of dirty coal path stations that will help them deal with waste and methane and the low-hanging fruit in the developing world for reducing greenhouse gases.

And that this is an attractive system for them and we believe that actually we can convince them that this is the way forward, that they do take it seriously as others around the table have said. But their energy-efficiency targets are extremely demanding and that actually you need to have these different types of pathways to achieving these goals and not try to say that unless China is prepared to sign up to the same cap that we're going to sign up to, we're not going to sign to it at all.

Grumet: The issue of the global linkage and China is one of the two or three kinds of profound challenges in achieving the consensus we need for the United States. I think it's worth reflecting on how the politics would be a little bit out of step with the technical substantive realities. I think any legislation will have a kind of tough love approach to China. The love will be some amount of resource going overseas for technology development.

The tough will be some type of contingency that says if China, India and others don't take certain steps by a date 10 or 15 years out, the United States is going to try to level the playing field with some kind of trade-related process.

The green-tariff issue.

Grumet: The green-tariff question or something like that. That's incredibly important to key constituencies such as organized labour, who have come forward now for the first time and boldly said they now support a mandatory programme that would cap domestic emissions. But they then say, you know, but come on folks, we're not going to commit to something out to 2050 as if Congress, in fact, could unless we see that, in fact, we can solve the problem, unless there is truly a global consensus.

So it suggests to me that the legislation, although we will all have a 2050 goal, people would appreciate that that's truly a goal and the actual legislation will try to get us to a pivot point in the 2020 or so timeframe. The other

aspect, and I just want to reflect on something Jim raised, emission offsets, which as Julian said, provide a wonderful opportunity if your goal is to transfer revenue to developing countries.

I am not convinced those are going to play very well early on in the domestic debate. I think Jim's reflection on the decade that we need for technology development applies equally to the development of procedures to make the offset programmes credible. And they have a very significant effect. A recent analysis that the EPA did on the McCain-Lieberman bill demonstrated that there be \$12 billion a year going overseas for offsets, and in fact, if domestic companies took full advantage of those offsets, we would not get below the 2005 emissions until 2030. So offsets can have a profound impact on the pace of technological progress in those demands.

And there is also, I think, a very real question about whether the offsets will have the environmental integrity that we ultimately need. The studies I've seen suggest that even in the CDM programme, there's a 20–30% fluff in the system, times that are either not real or not additional or not permanent. That's a real big deal.

So I'm quite concerned about efforts to use offsets as a means of cost containment, because I think it creates a bad, a collusive incentive between both sellers and buyers to assert that everything is real. So I think they have a role to play, but I think it has to be a role that is predicated upon a few years of learning our way through that.

Braithwaite: Coming back to the European experience, I mean, the European emission-striking scheme and what we've been doing through the CDM is probably the largest real world example of all of these policies and actions. I think it's fair to say that we've been the sort of global laboratory for these policies. And clearly, there are some things that we've learned and we can improve. I think your point about the quality of the offsets is a very important one and there's been a lot of experience now through the CDM as to how you might try to improve that.

And the other is being the structure of carbon markets and cap-and-trade, where again, the first phase of the European emissions trade scheme has thrown up a lot of lessons. But I think the point is that we still think in Europe that these systems that a global common market, cap-and-trade system in particular in the developed world with some system for offsets in the developing world to bring them in, to give them a stake in this global carbon market and also to harvest the low-hanging fruit there is an important sort of fundamental structure. We need to make it work and clearly there are ...

Grumet: Let me add that I agree entirely that it has to be a significant part of the solution. I'm just afraid people are over-selling its near term potential.

Rogers: May I weigh in on this, because I have an emerging point of view that the Euro-

pean community has done us a real favour by experimenting and expanding and deploying cap-and-trade, as well as the CDM. And as I have studied some of the issues that they have addressed, these are issues that are not insurmountable. We need to take advantage of the learning curve that they've experienced and allow that to give us the courage to build on what they've done going forward.

Jason, I think you made the point that maybe it won't go so fast in the United States, but I think it needs to go faster than those who are opposing it in trying to delay for a long period of time. Because there were some important learnings there and all of which, if we understand and adapt, would really allow us to do this in an important way. The second point I would make here is the danger of an off ramp — and this is the tricky political part about China — the danger of an off ramp is China is not playing in 2015 or 2020 carries with it the risk of undermining any cap-and-trade system going forward.

Because if there is an off ramp, it makes it difficult for the markets to really work and develop a proper price signal. Because what we need in this country and around the world is a price signal on the cost of carbon to go to work. If you look back to 1970 and you look at the study, our R&D investment in energy in this country has steadily declined since the 1970s. It's going to take a great act of political courage to turn that around so we can pour the money into the technology.

Very quickly, Jim, obviously we tend to talk about costs, but you're a businessman, there are also opportunities for profit out there. When you look at either the developing world or some of these new technologies that are coming out as a businessman, do you see costs or profits on the horizon, or both?

Rogers: I see it from two perspectives. I started my career as a consumer advocate fighting rate increases in utility companies. And coincidentally, today is my 19th anniversary as the chief executive of a utility company. I see this mainly because our company is so dependent on coal from a cost standpoint because 70% of the electricity our consumers use is predicated on coal and these were decisions that were made many decades ago. But that's on the one hand.

On the other hand, I see a great profit opportunity here for technology development, the conversation a moment ago about how the architectural community is really going and focusing on designing buildings. The buildings are probably one of the largest emitters of CO₂ in the country. The third thing on this in terms of making money even from my perspective, I don't know if you had a chance to see the Tom Friedman article on a proposal that we have pending called 'Save a Watt', which would fundamentally change the regulatory model and the business model for energy companies around the country like ours to basically com-

pensate us for delivering Save a Watts, which is a reduction of a megawatt.

If you think of it that way, that change in the business model would change our mission. So our job wouldn't just be building power plants to produce enough electricity to meet the load, but we would also go after and be compensated for reducing the load in the future. And I have one fundamental point of view. I have spent the past two years co-chairing the national action plan on energy efficiency.

I've looked at every state, I've looked at every programme and what I've recognized is two things. There has been a significant and unfortunate chronic under-investment in energy efficiency in this country. And although states like California have led the way, quite frankly, it's not enough. We need creativity and innovation from across the country and a constant reinvestment in this.

And if we can get the business model right for the utility industry and if we can start pouring billions of dollars into energy efficiency and developing those technologies, I think that offers the greatest hope in the short term as we wait for the development of carbon capture and storage, of battery technology and other technologies. And that's something we can do today and deliver real results for the environment and also for consumers across the country.

We're going to have to wrap this up here fairly quickly. I have a couple of last questions I want to just lay out on the table. The first is, I will put it to Mike and to the rest of you, actually, should scientists act as advocates on this issue? How far can scientists go to try to push this dialogue forward?

MacCracken: Well, I think we need to speak very clearly about what the implications are of what will happen if we don't act and what courses have to be taken, what steps have to be taken along the way. We tried doing this in the report to the United Nations Commission on Sustainable Development. They wanted scientists to say what we should do and scientists sort of say there are a lot of others who should be party to that discussion, but we can say the steps that need to be taken.

If you want to avoid dangerous or catastrophic kinds of consequences of the Greenland, you've to get on a path where developed country emissions are going down of order 80% by 2050. You have to do that. And we'll have to get developing countries to go along as they can and go down further after that. So I think we need to speak out very clearly on the exact details of what the policies are.

I think there are others who can say sort of better how to do that, but we can certainly push harder and more clearly on the urgency of it. The IPCC, you have to understand, in getting 150 or so countries to agree is necessarily a cautious body. It's not going to be at the cutting edge of what's happening. So there are a lot of debates going on in the scientific community about the

pace of sea-level rise and what's happening. Where the IPCC is probably lagging what science is pushing. So scientists certainly can be more clearly spoken on what's happened.

Pershing: Let's go back to the scientists to even a stronger point. I think that the scientific community has been under-represented in the dialogue and has taken a pass when it should have taken a step forward. It has basically proposed that others know better as to what should be done and that's not evident. If we take the past 20 years where there have been complete and total inaction.

The scientific community in the first IPCC assessment report laid out explicitly the nature of the problem and made proposals as to what ought to be done. Twenty years later, very little has happened. So I suggest the scientific community needs to be much more aggressive as opposed to much more passive.

Braithwaite: In an ideal world, scientists shouldn't have to be advocates. They should be listened to and if you are trying to make good public policy, on what basis can you make good public policy without basing it on the best available science. Any other form of policy-making is going to lead to poor results. So I think in an ideal world, they shouldn't have to be advocates; their voice should be heard anyway. When their voice isn't being heard, then that's a different situation. I'm not going to comment on the United States, but in the United Kingdom, I think if we tried to put together public policy without basing it on the best available science, we'd get ourselves in trouble very quickly.

Grumet: I would just add that if scientists are not actively involved, it would be left to us lawyers and politicians and you should all be very afraid. The one other point that I will make is that in our system, there is such a profound notion of there being two sides of every issue.

I think where the scientific community finally rose up with some outrage — and outrage among scientists is kind of modest annoyance — was when you'd have the real scientific community fully convinced that the basic root of this of the ecological reality and you'd have one or two folks out there pushing a different side. They would be consistently set up as, well, you know, one scientist thinks this and the other scientist thinks something different.

And finally I think about a year ago the scientific communities kind of got fed up with that and you heard a lot of people saying there may be some differences about impacts and timing, but there is not a scientific debate any more and that changed the discussion.

That sounds like it was a problem with the media.

Grumet: Well, of course it's a problem with the media, but sitting here in the National Press Club, I would not be so bold to suggest that.

Pershing: It's also a problem with the scientific community, which has been reluctant to ever come out on any side of any issue. That's not

the standard scientific process. There's always room for doubt and uncertainty. But in this particular instance, my sense is the scientific community has done itself a disservice.

MacCracken: I guess I would say that I think where the real problem has come is making sure there is an understanding of how scientists talk about levels of confidence or levels of uncertainty and some result. I mean, I think the scientists have been speaking strongly for quite some time consistently about what's going forward.

I mean, where I would put the problem in my view right now is with the US science adviser, who I think has done a terrible job in explaining this job of levels of confidence and how things work. It's something that when I give talks, I almost always explain right up at the front where I'm coming from, that basically the way scientists are, it's like saying we want odds of 20 to 1 when I go a horse track in my favour.

Plus, I want one more thing — I want 20 to 1 odds there's no other horse in the race. And we do that, we want that high level of confidence because you don't want to make mistakes like thalidomide. But that isn't how society works. Society has to make decisions based on sort of the best available evidence or likelihood. So in the IPCC second assessment they talked about balance of evidence suggesting things and scientists have been talking about this issue for some time.

The question is, how do you get public attention. And I'm not sure it would have helped if scientists had said: 'oh, I'm absolutely confident'. That any place along the way in getting that, I think it's probably more that the impacts are showing. I mean, it's taken until people can, actually the media, can go up to the Arctic and see melting ice and seeing things really changing that it's convinced people, it's given them an image of change.

On this question of public perception, I've got one last question and then I'll let you get on your way. Which is a better icon for global warming, Al Gore or the polar bear?

Grumet: Charismatic megafauna, and I think that describes both.

Rogers: I suspect we need all of the voices and all of the images to continue to keep this in the forefront of the public's mind. Because again, I think it's critical and I can't remember who made the point, it was a powerful point, is there is growing recognition of this as a serious issue that needs to be confronted immediately and we need all of the help we can get to keep people focused and increasingly educated.

Pershing: I have a different point. I think that these are the icons of failure. And I think to a certain extent, we've been plagued by not having the vision of success. If we could instead create an icon of a zero-emitting car or a zero-emitting building or a zero-emitting power plant, that would be a very powerful icon, because it would give you a positive framework as opposed to this failing framework.

Braithwaite: Perhaps the icon is the hybrid car, the GE wind turbine, the first zero-carbon coal-fired plant. Those will be the icons of a low-carbon world where advanced economies, prosperity and growth, employment and development are compatible with the low-carbon world.

MacCracken: I wholeheartedly agree. I think you sometimes can hear members of Congress say well, I don't understand how my friend Joe the farmer is going to plough the fields if

we don't have oil. Or I don't understand how something is going to happen, and we really do need some images of the future and about what the world can look like.

Excellent.

MacCracken: Because there are plenty of ones other than the polar bear around, whether it's the coastlines, about what happens, and it's not just the Gulf Coast. You fly over the Southern Chesapeake Bay or go to New York har-

bour or go to California and see the inland. It's water resources and it's fires and it's all of these things. These are huge issues, but we do need an image of what we can do.

Excellent. I think we will wrap it up there.

Thanks everybody, thank you Jim.

Rogers: Thank you all very much — I enjoyed being part of this. ■

Nature reporter Jeff Tollefson moderated this discussion in Washington DC.