

# TECHONOMY

TECHONOMY 2012 • NOVEMBER 11 – 13 • TUCSON, AZ

## Geo-engineering: Who Decides, and Who Benefits?

### Speakers:

David Keith, Harvard University  
Andrew Parker, Harvard Kennedy School

### Moderator:

Jeff Goodell, Rolling Stone

### Video:

<http://techonomy.com/2012/11/techonomy-2012-geo-engineering-who-decides-and-who-benefits>

**Kirkpatrick:** As you probably all know, Hurricane Sandy was a rather serious event the other day, which, as I said, even disrupted our little company quite dramatically. While there's plenty of things I wish we could have had on the program about that, the fact that we have a session on Geo-engineering led by Jeff Goodell of "Rolling Stone," who was such a great moderator for us last year, makes me very happy. We are clearly entering a new world so we have to figure out how to deal with it. So Jeff, take it away. Thanks so much. Hi.

**Goodell:** All right. So we're here to talk about geo-engineering, this idea of essentially building a kind of global thermostat for the planet. Yesterday Rick mentioned the idea of a kind of big data building and kind of global nervous system. And this is something analogous to that in a way.

Geo-engineering is a complicated idea, but we're going to focus this conversation on just kind of basically one technology or one idea which is essentially reflecting sunlight away from the planet to lower the Earth's temperature. There's other ideas about geo-engineering and other things you can do, but we're going to focus on that because that's what's the most pressing, most interesting, most dangerous, most politically complex and in a certain way the most do-able.

So let's just get started. Let me introduce the panelists. First is my friend David Keith, who is a professor at Harvard now who was at the University of Calgary for a long time. He's been thinking about geo-engineering probably longer than anyone, both on the engineering side of how it can be done and also on the ethical and political side of the complexities of this. And he's also, important to say, an entrepreneur who is starting a company, has started a company, called Carbon Engineering, which is essentially building devices that will pull CO2 out of the atmosphere. And we can talk a little bit about that.

And then we have Andy Parker, who just came to the States after working in the U.K. for some number of years. He was the lead staffer for the Royal Society Report on geo-engineering, which was the first report to really take seriously this idea of geo-engineering and to really look at the kind of governance issues related to that. That's sort of Andy's specialty. He's been traveling around the world, talking to various countries about this and about what they need to think about and how to get started on a governance structure.

So that's who we've got. I think we should start, David, by—why don't you just tell us really bluntly how we would do this. I know you have been thinking a lot about this. So let's just say Hurricane Sandy just hit. In two weeks Hurricane Sandy 2 comes and everyone says: Oh, my God, let's cool this off. We've got to do something now. What do we do?

**Keith:** Yeah, I'm happy to do that. I think the hard questions here really aren't technical. They're fundamentally political questions. But let's give you a sense of technically what you could do. I don't want to convince you necessarily that it's a good idea, but I want to convince you that it is very, very doable, kind of frighteningly doable.

So let's say you wanted to cut in half the rate of warming starting in 2020. So what you do is you start in 2020 with about two or three Gulfstream G650 aircraft re-engined with a military low bypass engine. That's a stock commercial airplane. You could get

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that from any number of companies. There's nothing magic about this. You could go to Boeing, but you could also go to Hindustan Aeronautics. So lots of people could supply you with the technology to do that.

You'd start with, as I said, about two aircraft. And they'd put about 20,000 tons of sulfur into the stratosphere, the upper atmosphere every year. And you'd need to do some work on that. And 20,000 tons may seem like a meaninglessly big or small number, but that's something like two or three hundred times less than the amount of sulfur we now pump into the lower atmosphere in pollution, which, by the way, kills something like a million people around the world a year. I didn't make that number up.

And of course you need to wrap this up. So the point is the rate of warming—warming is happening at a continuous pace because we're continuously building up the amount of carbon in the atmosphere. So our emissions of carbon add to the carbon stock in the atmosphere, the amount of carbon there is in the air. And every year there's a little bit more carbon in the air because we put a little bit more in there. If you want to cut the rate of warming in half, you have to each year put in a little more sulfur. You may see that there's some problems here in the long run, but let me just stick with what you do.

So 10 years out, in 2030, you'd be putting—have maybe 10 aircraft running. It would cost you a couple of hundred million a year, all up. And that's from real engineering companies' estimates that builds aircraft. You'd then be roughly 200,000 tons a year of sulfur. And after 50 years, in 2070, you'd probably switch to a different kind of aircraft and probably to a different kind of material that might be more efficient and have less environmental impact in various ways. But you'd still do that.

And this is a horrifyingly tiny amount of money. So we spent, the year before last, \$300 billion roughly. \$270 is what Bloomberg says globally, \$270 billion on clean tech.

The kind of numbers people talk about as the cost of climate impacts or the cost of managing problem are one percent of global GDP class numbers. So numbers at the level of a couple of hundred million are basically zero for this problem. So what that says is that you could—at a cost that's tiny, that essentially any country in the world, certainly any kind of G20 country could do, you could divide the rate of warming in half.

Now, is it perfect? No. Does it remove all climate problems? No. Does it cause its own risks?

Of course, it does. But whether you think this is a completely nutty idea or a perhaps good idea, what's clear is it is kind of frighteningly doable. All the hardware is essentially there so you could begin to do it. And a lot of the science is there now as well.

**Goodell:** So this whole global warming problem, we've got it fixed. Just a few airplanes, some sulfur in the sky, we're done, right? Don't have to worry about cutting emissions and all this. We're just—

**Keith:** Of course, if you go on forever, by adding more, you walk farther and farther along the plank, right.

**Goodell:** Right, right.

**Keith:** Because if you keep putting more carbon in the air and then keep putting more sulfur in the atmosphere, you keep walking yourself farther and farther away from the current climate and at the end something is going to break catastrophically.

In the long run, if you want to have a stable climate, you have to cut emissions basically to zero. It's like a stock and flow problem. If you want the level of water in your bathtub not to go up, you have to stop putting water in. So in the long run, the only way to have a stable climate is to stop emitting. That means stop the carbon emissions from the entire energy system. That means running on solar or nuclear power or what have you.

But the long run is a long way off. And it's important to say, and I think this may sound hyperbolic and salesmanish, but it is literally true: If you want to actually reduce the risks to many of the people who will suffer real climate impacts in the next

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decades, including some of the poorest people in the world, this is essentially the only thing you could do, because nothing you do to cut emissions has essentially any real impact over the next few decades because of this long inertia. Because the water in the bathtub has been built up from the last generations.

**Goodell:** So if someone says, you know, someone meaning a president or leader of a country says: We need to do something now, this is the only thing basically—this is what we can do.

**Keith:** If you—well, if you want to do something now to reduce the risk to our grandkids in climate change, what you should do is cut emissions.

**Goodell:** Of course.

**Keith:** But if you want to do something to reduce near-term climate risk other than just adaptation, you know, developing heat-resistant crops or putting dikes in or something, this is something you might really want to do.

But again, and I guess I should say one thing, I don't think we're actually quite ready to commit to do it in 2020. I would not advocate that, but I'd come pretty close. My sense is that a lot of the science to do that is pretty well understood and with a pretty limited amount of new science and broadening the science community in small tests, we know quite a lot more.

And there's one other important anchor. Nature does this at some level. So you might say: How could we possibly know by laboratory studies or just some eggheads writing papers what would happen if we put half a million tons of sulfur in the stratosphere. And the answer is nature does it. So, say the Pinatubo volcano in 1991 put 8 million tons of sulfur in the stratosphere in one year, it dropped global temperatures by half a degree C in one year, essentially instantly, and would have been much more if it had lasted for longer. And it had real impacts. Crop productivity actually went up globally, or ecosystem productivity. The ozone layer was slightly damaged. There were real impacts.

But the point is, the fact that nature does this periodically with big volcanos at a level tens of millions of tons, means that it's unlikely that some incredibly out-of-left-field unknown-unknown will bite us in the ass if we're only using half a million tons.

**Goodell:** Right. So, Andy, I want to ask you about that. So the obvious next—there's obviously lots of scary things we can talk about this Frankenplanet vision and there's the dark side of all this. But I want to talk about the—who will do it. I think that's a really interesting question. We were talking about this a little bit last night during dinner, I vaguely recall after a little too much wine last night.

But the conventional scenario is something like the United States would do this, would do some kind of a sort of well-run program. But you were talking about how it's equally likely or even more likely that the developing world could really push for this.

Talk a little bit about that and about why it is that it would be in the interest, say, of Africa, African nations, to take the lead on this kind of thing.

**Parker:** Sure. Well, you opened up by talking about Hurricane Sandy bringing a sense of immediacy to climate change policy. And of course underlying that is the idea that when people are suffering, they look for a quick way out, and solar geo-engineering might be perceived as offering a quick way out of the climate change problem.

Extrapolating by a few years—this is a very new idea that's only been really discussed in a few small expert circles in developed countries. Extrapolating by a few years, one could imagine—take, for example, the Pacific Islands or the African equatorial states projected to suffer climate change impacts far more keenly than Europe or the United States. And I don't see any reasons why they wouldn't be the ones demanding this to be done or doing it themselves. David says how terrifyingly cheap it might be to actually deploy solar geo-engineering.

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And I can see there's two large groups who might be interested in deployment in 15 years. Folks, perhaps the elites in the developed world who don't want to do anything about mitigation and see this as a way of stalling action on our emissions or people who are feeling the effects most keenly, those are the people in the developing world. What concerns me and what terrifies me most about this idea is probably more the political ramifications of that than the physical ramifications.

So if, for example, China decided that it was in its interest, it was suffering disproportionately from the effects of climate change, it teamed up with the African Union and deployed the technology, then let's say India suffered an extreme weather event, a cyclone, a failure of the monsoon, we'll not be able to tell whether the failure of the monsoon was caused by the geo-engineering or not. One could be fairly confident that quite a few people in India would perceive that the weather problems were caused by the geo-engineering. Then what do they do? Is there war across the Himalayas? Do they literally bomb the runways the jets are taking off from? So it's the political size of this that concerns me the most.

I think the challenge is trying to create a dialogue between all these desperate stakeholders around the world who might have different interests in promoting the technology or seeing it delayed. And exploring how on Earth we govern this. I don't think we have any models at the moment.

**Goodell:** Right. So that brings back this whole cold war idea of kind of weather warfare, right? You sent this hurricane or you, you know, using weather as a—

**Parker:** It's one amongst a host of terrifying possibilities if this goes wrong. Actually, interestingly weather warfare is about the only application of this technology which is currently not allowed under international treaty --

**Keith:** Because the U.S. did it during Vietnam and we then ended up with the ENMOD treaty that bans use of environmental modification for war.

**Parker:** So that at least offers some boundaries to the potential use of the technology. Unfortunately, when it comes to peaceful uses, i.e., trying to treat climate change, there's very little international regulation out there to stop us pooling our wealth and going out to do it tomorrow.

**Keith:** Neither of us has a billion dollars.

**Parker:** Well, at a conference of technology experts and funders I am kind of nervous to say that. But, yes, there are no regulations to stop us doing it tomorrow.

**Goodell:** Right. So there's obviously lots of political and environmental complexities. One of the things that doesn't get talked about this at all is, when we talk about who's going to do it, is, like, what are the business models? Is there ways of making money on this? Is there IP issues, things like that, which really no one has talked about yet? And I'm interested in both of your views on that.

David, I know you have started a company that is actually a startup that is based on this model of technology of pulling CO2 out of the atmosphere. And that's a pretty straightforward idea about how that would work in a carbon market and why that—the business model for that.

But talk about this question of who is going to develop this technology for solar radiation management. And are there sort of profit opportunities in this? Can you imagine a profit-driven model for this? And are there issues around IP that concern you?

**Keith:** Yeah, for sure. I think there are very real concerns that if people try to do it for profit—not that I think that's a bad thing. It's a fantastically powerful thing in lots of fields. But not in fields like this that are basically like military security. So we don't want for-profit companies developing nuclear weapons. And I think the analogy here is quite strong, and indeed we have patent law that manages that. So when you invent new technology for nuclear weapons, it's born classified and born government-owned, wherever you thought about it.

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And I think that we need to think about this in a similar way. So in the end, there might be some innovation around exactly how do you do it for sure. And it might be absolutely fine to have private companies do that. But what we don't want is private companies making the decisions about where to do it and how much to do it. I think it's crucial those decisions be public. I think in that way it's very, very different from things we do about reducing emissions or making low-carbon energy, where the industry system already a monster system, a system that is many-trillion-dollar global industry. And if we want to decarbonize the world, we have to really energize private innovation. There's no way government thought that innovation is going to do it because it's so expensive. We need bottom-up solutions for that sort of heterogeneity of the energy system.

But this is different. This is a thing where the—after all, the total size of the market, I just told you, is utterly tiny. And there are also huge liability issues.

So in practice, I can't really see private action here. And the reason is—private, for-profit action—if you were a company that could build those aircraft, lots of companies could, and you thought to yourself let's go into business of building these aircraft and putting sulfur in the air, you would be putting yourself at liability risk that was larger than any liability risk of any previous company in human history. And you would be crazy to do that. So I think in some ways, there's not that much chance of it happening in a direct way.

**Goodell:** Right, right, right.

**Keith:** But I still think we need to actively build, both by law and by custom, ways that encourage or search in this area to be as public and transparent as possible to avoid some of the international conflicts that arise when people—when countries do not trust each other and do not trust when information is public and not.

**Goodell:** Right. You made the analogy with nuclear weapons. But in fact, this—and I understand the similarities, but there are also big differences in the sense that this is, as you pointed out, cheap and relatively simple, right?

**Keith:** Right.

**Goodell:** So it's not like building a nuclear weapon in that sense, where you have to have incredibly complex technology, you have to have the materials, all that kind of thing, right?

**Keith:** Yeah, although you might say that compared to the other costs of warfare, nuclear weapons actually are an idea that is profoundly leveling, that allows poor countries to have more power than they otherwise would and change the balance of power in the world because they are fundamentally pretty cheap.

**Goodell:** At breakfast today you were talking about the idea of ransom. About—

**Keith:** That was a joke.

[LAUGHTER]

**Goodell:** It's a pretty fascinating idea and there are lots of ways this can go.

**Keith:** You can wonder whether if one country wants it one way and one the other, this kind of thing that Andy brought up where you imagine, you know, like two frat boys fighting in their apartment about where to set the thermostat. We have not even the beginning of a treaty of any international structure about how to resolve, say, this beef between India and China.

Let me reemphasize what Andy said. None of the current treaties, not the climate treaty, not other environmental treaties, even control doing this. So it is in principle legal to engineer the whole planet this way today, under international law, which is crazy. We, I think, quite urgently need to build up some set of international norms eventually backed up by some kind of law that allows some kind of decision rule for how we actually implement.

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**Parker:** Well, it wouldn't break any international laws. It would break international agreements. The CBD, the Convention on Biological Diversity, they met Nagoya in 2010, are the only international forum to really properly look at geo-engineering across the whole piece, so from carbon geo-engineering right through to solar.

They agreed, in typically meandering U.N. language, something that I think was basically sensible, which is if geo-engineering were to proceed on a scale that might threaten biodiversity around the world, then it needs to prove that it's scientifically necessary. It needs to be subject to international governance. They also agreed that if you wanted to go ahead with small-scale research indoors or out of doors, then that would be legitimate as long as it passed appropriate environmental impact assessment and so on and so on.

So there are some international agreements there. What those are worth is not clear in the light of—I'm not sure if everyone is familiar with the iron dumping case or Haida Gwaii in British Columbia. It took place this summer and came to light in the last couple of months.

But a Californian businessman working with a corporation owned by the Haida Gwaii village of Old Massett dumped roughly 100 tons of iron into the ocean, 200 miles I believe off Canada, with the hope of promoting a large algae bloom, which they ostensibly hoped would return fish stocks to the area, return salmon stocks. They certainly had heard reports of huge return of salmon and even whales to the area, which was held as a great success by the people who needed to portray it as a great success.

Of course, the dumping took place only in the summer of 2012. So you can be pretty confident that the salmon that swam to that area were already alive and swimming at the beginning of the summer.

**Keith:** Details.

**Parker:** Details, important details. And you can be equally confident those salmon that were redistributed from elsewhere, that came into the waters of Haida Gwaii, probably other people were hoping to catch them. There were probably other villages up and down the coast of B.C. and Alaska hoping to catch those salmon.

So that was a concerning alarm of where a potential profit motive operating on the international commons can have unintended consequences, particularly when it would—apparently it's not subject to the international agreements that exist. Canada is running a review at the moment to find out who knew what and when, find out if it was previously aware of this test.

**Goodell:** Well, I think the economics of this are really interesting and aren't talked about enough. When I first heard about geo-engineering, I thought this is a totally lunatic idea and people like David are completely crazy. And then as I have learned more and more about it, the more I see that it is not a crazy idea and I think now is going to happen in one way or another.

But the economic implications are huge, also for clean tech entrepreneurs, for fossil fuel industry. You can easily see that Big Coal would be very happy about launching a geo-engineering project and say: Oh, you know what, we don't have to cut back on coal really because coal is cheap and provides power for a lot of people. And yes, global warming is a big problem, so let's just build some airplanes and throw some sulfur into the atmosphere and we'll all be fine. And so when you think about it in that context, the economic implications of this idea are huge.

**Keith:** I think—we should probably throw it open to the audience, but I think that's the single biggest fear here. The biggest single fear is probably not some kind of technical gotcha, although that might happen. The biggest single fear is just the idea of this takes away the incentive to get serious about cutting emissions. That this provides a kind of technical fix, get out of jail free card or appears to provide one, and perhaps actually does not, that will then lead us further down a pathway where we put more carbon in the atmosphere and increase our risk without actually managing the kind of root problem which is the build-up of carbon.

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**Goodell:** Right, right. Are there any questions from the audience?

**Audience Member:** Fascinating. It's probably why we come to these conferences. I was just wondering, it seems like it's so relatively easy to do, to dump—what is it? Sulfur?

**Keith:** Yeah.

**Audience Member:** How easy would it be to do it covertly? And if we have to kind of say: You did it, is there somebody monitoring it? Who would be bold enough to say; you did it? Not just governments, but, you know, individuals and companies and so forth. I was just—is somebody looking at it?

**Keith:** Yeah, I have begun to be part of conversations about that. Certainly, people are beginning to think about that possibility. I think we actually don't do as good a job monitoring the stratosphere as we should. We have let some of the satellites that do that age.

But the bottom line is detecting that it was being done is relatively easy, if you do it in any scale, because you can detect the change in the amount of sunlight. We're talking in the end about fractions of a percent change up to a percent in the total sunlight. And there are instruments that can detect that very well.

But could you detect if a single country was actually running flights to put sulfur in the stratosphere? Not necessarily right away or easily. And with things other than sulfur, there might be room for covert action. I would say doing it at large scale it's pretty hard to see how you do it covertly.

But I think it's worth asking the question. And I think that there may be ways that one could do it that are more covert. And I think those are—these are where, as I said in the beginning, the hard problems here are not technology. They are all about governance and managing kind of asymmetric risk and threat.

**Goodell:** Yeah, yeah.

[INDISCERNIBLE]

**Arun Sundararajan:** So my question is about spillovers with this new technology. I mean, one of the—I guess the big challenge with the reason why we don't have these treaties is because there are externalities. I mean, what India does effects China. What China does effects India.

So I'm wondering if there are similar spillovers with the use of this sulfur in the atmosphere technology. I mean, if one country, say, overuses it, is that going to adversely affect its neighbors in terms of is it going to send some of their carbon, like, to the neighboring atmosphere? Is that a challenge that we should be worried about?

**Keith:** Absolutely. Maybe what we didn't say clearly enough here is that atmosphere is also connected. You can't do this just over one spot and just control the climate there. If you could, you might argue there's no governance problem. Each country just gets to set the thermostat where they want and you don't have to worry about it.

But that isn't the way the climate works. So in fact, if you do it for your country, you're really doing it for the whole world, pretty much. And so there are enormous spillovers. Both good and bad.

So one thing I can easily imagine happening is if one country begins to do it in a very sensible way—you could imagine people doing it in a non-sensible way. But if people did it slowly and with monitoring and gently, you might see that a bunch of other countries would do the following: They would publicly decry the action. They would say it's outrageous and lacked governance and lacked legitimacy and privately say, great, somebody else is doing it and that somebody else will then bear all the liability and heat.

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**Parker:** My concern is about the countries who publicly decry the action and privately mean it as well. So, again, you can imagine the equatorial countries in, say, South Asia might want the global thermostat to be set a degree or two below Canada and Russia, for example. And how we would ever come to agreement on a global temperature, well, I'm having trouble imagining.

**Keith:** Because some people benefit if it warms. And those people and those interests will not like it. I live partly in Calgary, Alberta. There are people that want to put billions of dollars into the Arctic Ocean to explore for gas. If they have done that and sunk tens of billions or hundred billion class capital and then somebody wants to regrow the Arctic ice, they're going to want compensation.

**Goodell:** Here in front.

**Lance Ulanoff:** Hi there. Thanks. Just by the way, I keep imagining, you talk about the global thermostat, like the arguments I have in my house. My wife, you know, 72, 68. How are we ever going to agree on that? But That's not my question. By the way, I'm Lance from Mashable.

So what about implications? I'm wondering if you have ever spoken to religious leaders about this idea, this whole concept of Mother Nature controlling the weather, man taking the place of God. What sort of reaction do you get when you talk to the people who believe that God controls everything?

**Goodell:** That's a great question.

**Keith:** That's a great question. I had a wonderful dinner with—I am forgetting her name—Katherine somebody or who is the pre-lay, the equivalent of the most powerful person in the Episcopal Church, at a National Academy Meeting, who was very, very thoughtful about it. And I don't think she had a—I certainly didn't hear from her any kind of simple answer yes or no.

But certainly coming at it from an ethical perspective that I think is crucial, I'm not myself a religious person, but I think engaging—I think these are ultimately ethical questions and questions about how to think about the planet as a whole, where ethical thought is necessary and religious thought is necessary.

I mean, I guess if you are somebody who really doesn't believe that humans can alter nature, this ought to shake that belief since it shows you for sure that you can. But that's separate from the question of believing that humans ought not to alter nature.

**Goodell:** One of the things that's often lost in discussions about this is the idea that this is not like this sort of atmospheric equivalent of building condos in a virgin redwood forest, right. We're already messing with things, right. We're already dumping stuff into the atmosphere, changing the planet in big ways.

The question this really brings up is: can we get better at it? Can we do it in an intelligent way? Can we actually learn what the control knobs are and things like that? So it makes that question about whose hand are we messing with here more complex from religious and spiritual—

**Parker:** Some people have argued some ethicists—and I don't want to prioritize religious ethics over secular ethics. But some ethicists have argued that you are crossing a crucial line, even though we are interfering with the atmosphere on so great a level. The moment you start to do it deliberately, something has changed and something fundamentally has changed to question whether we have the right ever to start doing it. Whatever the consequences may be.

So I think that's important argument to bear in mind, although people who hold that point of view have to then answer how they will deal with the suffering in the next 50, 60 years before mitigation really kicks in. How they will deal with the suffering of the people most vulnerable to climate change.

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**Goodell:** Right, right. Question?

**John Kao:** Hi. I'm John Kao. I just have a question about international cooperation. You talked I think mostly about international cooperation as a way to avoid some of the negative consequences, rogue action, etc.

But how about on the positive side of driving innovation, doing the necessary experiments, pursuing the kind of projects that maybe the private sector would be disinclined to do? If current institutions are kind of inadequate to have the collaborative impact on global civil society, what's the ideal outcome?

**Keith:** That's a great question. Let me say one interesting thing first. I hope is interesting. That your preconception might be that the U.S. is the country that loves to embrace tech fixes and so the U.S. would be the one actively doing this and Europe not. The opposite is the case, the precise opposite. Europe now has—you counted up about 22—

**Parker:** 22 million U.S. dollars worth of research programs, give or take, I guess.

**Keith:** Which is still tiny, but it's starting in Europe and not here. I think part of that is this interesting kind of double think that if you are perceived to be a country that's doing something about climate change, whether they really are or not is a little debatable, then you are sort of more politically able in political optics world to talk about this. Whereas the perception is the U.S. can't talk about it because they are perceived not to be doing anything on climate change.

But I think this is, in the grandest sense, a challenge for international institutions and innovation that we are not meeting.

And we keep saying this is a new idea. This idea actually goes back to the '60s. This idea is in the report that President Johnson got about climate change in 1965. So it's an old idea. And for a long time, there was a taboo that basically said in the sight of the community, agreed not to talk about it in public because of the fear of this kind of moral hazard that people wouldn't act.

Now only in the last five or six years have we seen kind of serious public debate about it and the beginning of a lot of scientific action in the science community. But we really lack the kind of institutions necessary to do the innovation and the governance. And we desperately need them. I mean, once again, this isn't a technical problem at the core, it is an institutional problem, and we are forced to innovate on institutions.

**Parker:** So one initiative I'm involved in—I don't know if it's going to provide any answers, it's certainly finding more questions than answers at the moment—it's called the SRM Governance Initiative, SRMGI. You'll hear some bad acronyms here over the next few days. SRMGI might well be the very worst. It's an international NGO-driven initiative for exploring the governance of these technologies. And it was set up by the Royal Society in the wake of the publication of the Big Red Report, Geo-engineering the Climate.

And essentially what it's trying to do is bring more people into the discussions who aren't involved already, particularly emerging economies, developing countries who haven't been involved already. And it's a question of going out there, explaining the technology and the science and some of the governance implications and then saying we've got no idea what to do with it.

And that's quite powerful, an august body such as the Royal Society going to developing countries, explaining the science, but then saying when it comes to the governance, they have no greater idea of what to do than anyone else.

So that process continues. We've got a meeting in South Africa in two weeks, trying to bring more people in.

**Keith:** I mean, Andy is sort of being modest in a way. It's like a classic example of bottom-out policy entrepreneurship when big governments weren't able to do anything. So The Royal Society of the U.K. isn't sort of ruled by its members. And really a few people, Andy among them, in that body realized they had a kind of moment to act. And they got in Environmental Defense, one

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of the biggest U.S. NGOs, and this thing called the Third World Academy of Science. I guess it's now called the Academy of Science for the Developing World, changed its name.

So it's a threesome, that academy, Environmental Defense and Royal Society. And they just kind of did it. And so now they—I have been part of some—they've had meetings around the world, beginning to engage some very senior officials. We were in the office of the lead—

**Parker:** Chief scientist.

**Keith:** Chief scientist of the Indian government, for example. And that's happening by kind of bottom-up entrepreneurship, not by governments actually making clear decisions. And I think we're seeing that on many topics around the world these days.

**Goodell:** All right. Well, that's great. So we've got to wrap this up. We're out of time. I think this is something we're obviously going to be talking about a lot more in the very near future. But thank you, David. Thanks, Andy. That was great.