

State of Play

JESSE REYNOLDS: Good afternoon. Welcome to the third panel of today's forum. The panel is on the state of play of politics and policy of solar geoengineering research in the US. I'm Jesse Reynolds from the University of Utrecht in the Netherlands. And I'd like to begin with a few words to provide some background leading up to the current state of play of the politics and policy of solar geoengineering.

Solar geoengineering, as an idea, is not new. It has, essentially, always been a concept within the climate change discourse as a potential response measure to the risks of climate change. But it's always been at the fringe of the discourse. And in fact, was initially a taboo topic.

But what we can see is in the last decade or so there's been increased attention to solar geoengineering. But backing up a step in time I'm going to put some milestones in the ground and in the chronology, particularly of how US policy relates to solar geoengineering.

In 1992 the National Academies issued a major report on climate change with a chapter on geoengineering that called for federal research. The topic remained distant. Really, in 2006 was a turning point when Nobel Laureate, Paul Crutzen published an academic article, an opinion piece, where he said, it's time to seriously consider solar geoengineering research in the face of insufficient cuts in greenhouse gas emissions.

And thereafter, interest has been gradually picking up. Here in the US there were hearings in the House Science Committee in 2009 or 2010. And related to that there was a report from the Government Accountability Office on geoengineering, again, calling for a research program.

2015 Was another pair of reports on geoengineering, focused on geoengineering from the US National Academies, again, that, once again, called for research. And then, earlier this year, in the update to the global change research program there were some ideas about how research might begin to look.

But where does that put the state of research right now? So a couple of numbers. Worldwide, ever, there's been, maybe, 1,000, approaching 1,000, scientific articles and chapters on geoengineering. And a lot of this includes carbon removal. And these outputs include both social sciences and natural sciences, roughly half and half. And also worldwide, to date, there's been a few tens of millions of dollars of research funding for solar geoengineering research. And once again, much of that is mixed up with carbon removal.

And this has come from mostly from a couple of dozen research groups in the world. Most of the output has been coming from the United Kingdom, Germany, and the US, where, as we've heard today, the sources have been a mix of public and private funding.

But this is still a topic that is a small slice of attention to climate change. For example, if you measure output by the number of papers, you measure output by the dollars of funding, it's something like a few percent of 1% of the attention given to climate change as a whole. A very small fraction.

In terms of politics, I get into more detail in my brief written contribution to the booklet that's provided. But overall, I see three primary constituencies in the political discourse around solar climate engineering research. The advocates for such research, many of whom are in this room, they call for research out of

pessimism and concern. The concern is for the impacts and risks of climate change. And the pessimism is the prospect of emissions reductions being sufficient. So there's a sense that they are making these calls somewhat reluctantly.

The second cohort or constituency are critics of research who raise a range of concerns, many of which we've heard about today, such as, the so-called moral hazard of hindering emissions cuts, governance issues, physical risks, and uncertainties, matters of justice, hubris of messing with nature in this way, slippery slope, public acceptability.

And the third constituency is something that I don't think we've talked about to date much. And that's the traditional opponents of climate change action, most of whom come from the political right. They've been mostly silent on the issue of solar geoengineering for a variety of reasons. And so a lingering question is, as we go into the future, as the attention given to solar geoengineering might increase—it looks like it will continue to do so—how they will respond, these conservatives who have been silent on solar geoengineering, I believe, is a big, big question.

So here we are with a state of play that appears to be rapidly changing. One obvious recent change is a new presidential administration that seems to be intent on charting a different path, with respect to climate change. But I'd like to also call attention to a proposal that we have entered into a new geologic epoch, the anthropocene, in which it would be the epoch of humans, in which we recognize ourselves as a dominant force influencing Earth's systems.

So having provided that background I'll turn the floor over to the speakers, whom I will introduce one at a time as they provide their comments. We're going to start with Joseph Majkut of the Niskanen Center. He's the director of climate science there. He's an expert on climate, the global carbon cycle, on risk and uncertainty in decision making.

Before joining the Niskanen Center he worked on climate change policy in Congress as a congressional science fellow supported by the American Association for the Advancement of Science, and the American Geoscience Institute. And I'll ask for his thoughts about how he sees the political landscape of solar geoengineering research in America. Joseph.

JOSEPH MAJKUT: Thank you, Jesse. It's a real pleasure and an honor to be here, especially on an issue that I'm learning a lot more about, but there is clearly a lot of thought that's going to be in most of the people in this room. So I've been learning a lot already today, and thank you. I wanted to start my comments by echoing what Dan said in the last panel, that the urgency of climate change, and the, kind of, the climatology of the last year really makes clear that decades hence we're going to find ourselves wanting to act, I believe.

And what we've seen recently boosted by, El Nino, other things, are going to be normal conditions within the lifetime of my career. And you know, my wife and I just had a baby. And so I'm only one or two generations distant from a leadership class that is going to potentially want to use these technologies, right?

I think it would be a huge disservice to those future leaders to leave them in ignorance about the potential for solar radiation management, or any other thing that will allow them to reduce the risks of

climate change for the people that they are serving at that time. Never mind how they're going to deal with the risks that are felt by people in their own futures.

There's also the idea that somebody else may just go about doing this. And so if we think, in the context of US research program, for a technical solution or a technical means of reducing climate risk they can be carried out, sort of, unilaterally we want to be prepared to see, observe, understand, or potentially interrupt whatever another nation may do in the coming decades. We'll get to that, I think, a little bit later in the discussion. And eventually the US may want to participate in some deployment. And we should know what we're doing.

In terms of the present political context there's almost no political context for solar geoengineering in the United States. Almost none. Political actors, by and large, don't really think about it. And within the policy circles here in DC where I work there's also very little discussion about how solar bioengineering research would be carried out, who would support it, what its goals should be.

And the secondary question of, would we ever deploying this? Or how does a research program relate to deployment? There very little discussion. In fact, the discussion always seems to jump there, as we saw this morning, rather than sort of the more minute questions of, what are we going to do over the next five to 10 years? And how might we channel another 10 million dollars into a research program. I don't have the expertise in this exact field to judge how we should, but I think its an interesting question.

To speak to the sort of what we do at Niskanen, when we introduce ourselves we are a libertarian policy advocacy organization that, unlike some of our colleagues who defend free markets and liberty, also happen to think climate risk is a very compelling issue for public policy. And because of that we work primarily with congressional Republicans who are also uncomfortable with the denialism and the policy resistance on their side of the aisle to come up to build a coalition for a conservative climate action.

And one of the things we've seen in that community over the two years that we've existed, and I've been there for a year, is that abject denialism of climate risk is increasingly untenable. If you are a Republican representative from the district on the eastern seaboard climate risk is arriving, and coming quickly. And it's something that you need to be able to satisfy your constituent demand for response.

Those people face limited policy options. Part of that is political inertia. There's carbon pricing. There are favoring support toward forms of energy that could be deemed conservative, or anti-environmental, like nuclear power, or other things. But there's really been no policy movement in that direction. And likewise there is the sort of Star Trek fantasies about advanced R and D Funding programs, but again, not responsive to the scale of climate risk face now or in the near future.

Geoengineering research could provide a mechanism by which somebody who operates in a political context where massive mitigation projects are going to be a challenge, right now, could talk about climate, and develop a vocabulary for climate in a way that is actually responsive to the scales of climate risk. I think that's an important thing to consider.

On the other hand, solar geoengineering has this frustrating thing that people most concerned about climate risks, traditionally the environmental community, are also the most wary of where research may lead. And there has been some cartoon examples here in the, sort of, policy community, kind of, from

the last 10 years that show that, right? There's a Bickel and Lane paper from 2008 or 2009 that uses a basic cost benefit analysis to show, if you're concerned about climate change you should do nothing else but fund research into solar geoengineering, because it's the easiest way to solve this problem,

I understand how that result, or echoing David's comments from earlier about, well, could this be used as an excuse by political leaders who are wary of mitigation policy to do nothing? Can be frightening. However, I think the context in which we find ourselves now where we have huge warming, but also the Paris agreement, state and now delayed federal policy in the United States, and increasingly favorable economics for clean energy may actually relieve some of those concerns more rapidly than we expect. I think I'll conclude there. The Trump administration I have absolutely no idea what to do with.

[LAUGHING]

JESSE REYNOLDS: Thank you, Joseph. Next up, Steven Hamburg, who's chief scientist at the Environmental Defense Fund, EDF. There he oversees and insures the Scientific Integrity of EDF's positions and programs. And he facilitates collaborations with researchers from a diversity of institutions and countries.

He also helps identify emerging science that is relevant to EDF's mission. He's been actively involved in biogeochemistry, and forest ecology research for more than 35 years having published more than 100 scientific papers. And EDF is an interesting group that's been involved with the solar geoengineering discourse in some degree for a few years now. And I'd like Steve to share with us some of the key lessons that he's drawn from that experience.

STEVEN P. HAMBURG: Thanks, Jesse. I think that the last two panels set up the conversation in a great way, talking about the social context in the science context. It really took the title The State of Play to heart.

One thing just to sort of note is, just to show you the immaturity of this conversation. Today we're calling it solar geoengineering. I was recently on an NAS report that called it albedo modification. And I'm part of a group that I'll describe in a minute that talks do it as solar radiation management. So we don't even have a common vocabulary of what the thing we're talking about is.

So one of the things I just want to start with, similarly, is to look around in this room and who's here. The issue of inclusiveness is really critical to this issue. We're talking about the global climate. And the people who are having this conversation represent a very, very small fraction of that community. And I think that is an issue that this community has to think a lot about. It comes back to some of the social science panel issues, relative. But I'll come back to that in a minute. But I think it's not something we should treat lightly.

Similarly the issues of transparency. It's got mentioned a few times, but I want to bring it to the fore. If this community, as we think about, and I'm including myself in it, because I've been involved in thinking about it for more than six years, if we're not being transparent so that we really can say, look, you can look everywhere, it's all out there, once again, this will become an incredibly polarized and not constructive conversation.

EDF is unusual in that we have been, as an environmental organization, involved in this issue for quite a while. It started with a science day that David and Scott participated in. I think it was over six years ago where we brought our board together with our senior staff, and [INAUDIBLE] Frank was there as a trustee, and had a conversation for six hours about this issue.

That led to involvement in the solar radiation government's governance initiative, which is a joint effort of the Royal Society, The World Academy of Sciences, and EDF. And John Shepherd from the Royal Society, Qasim Jan from TWAS. And he's from Pakistan. And myself co-chair that. And that effort was at the beginning to create this inclusive, transparent conversation about these issues, about the governance of research, and how to make it—I like to refer to it as an ever expanding spiral.

How do we get more and more people involved so that, in fact, we do have some kind of social license to begin to think about these problems, because we won't do it in rooms like this. That's not to say this conversation isn't important, but it's necessary but certainly not sufficient.

And so what we've done over the last six years is we've had more than a dozen conversations around the globe at capitals everywhere. We have a meeting coming up in May in China, another one in June in Kenya. And then we're bringing all the people who have been involved, or a good subset of them, together in Berlin for the meeting in October.

And that conversation is really not about presenting. It involves bringing only two or three Europeans and North Americans with a community of scientists and interest groups in each of these locations to say, your voice matters, and to initiate that conversation.

In most of the places we go that's the first time that conversation has taken place in that country, or in that area. It's expanding that spiral, which I would argue is incredibly important. And it's done very deliberately by having science, global science, and NGO involved in that.

Now, EDF itself has taken a position on these issues. We developed that a couple of years ago. It has four parts. It's fairly straightforward, and not probably very surprising, but you can go on our web site and it's posted right there. Mitigation first. You could say first, second, third, fourth whatever. But it's not a substitute, as all of the Royal Society study, the NAS study, the Asilomar, I think most meetings I've talked about.

Deployment for the foreseeable future is off the table. That small scale research to understand both the climate, it was talked about, the dual need of, how do we take apart our ignorance, whatever it is, for both understanding climate, as well as, SRM is prudent. And that, as was talked about, CDR research is also critically important.

That position puts us in a place where we think that, bottom line, I sum it up, ignorance is our enemy. We have to engage in these topics. We have to understand them. We talked about it. These are not straightforward. Those first two panels, I think, teed up very effectively, the conversation. I won't claim that I have answers to those. We've been part of it. But it's really, I think, important to bring those issues together.

So bottom line is I have four words that I think matter here, which is inclusiveness, transparency, governance, and research. And that's sort of the metric by which we have to look at these. Thanks very much.

JESSE REYNOLDS: Thanks, Steven. I do want to just add one detail to what he said about meeting in Berlin in October. That will be the second climate engineering conference in Berlin, October 14th through 17th, I believe. So if you're interested in these issues that promises to be a very interesting and exciting meeting.

Next is Jamie Thompson, immediately to my left. She's vice president at Cassidy and Associates where she works on issues related to alternative energy development, environmental compliance, climate change, public lands, energy tax, and technology innovation. She earlier served in the Obama administration as a congressional affairs liaison for the Department of Energy.

Prior to that she served on the staff of the House Committee on science and technology, which held the hearings in six or seven years ago that I mentioned earlier. So Janie, I'll turn it over to you and see what you can tell us about how these issues can and do interface with the federal government.

JANIE WISE THOMPSON: Thanks, Jesse. It's good to see so many familiar people here. Those hearings were actually eight and nine years ago now. But many of you were our witnesses during those hearings. And actually, I was just sort of hearkening back to those days where I was trying to unpack this as a junior staffer on The Hill, and I had a lot less experience in climate change than I do now. And I like to think I was a good student. But I wasn't as conversant as everybody else in the room here is today on the topics, and on geoengineering.

And it was my job to unpack this very complicated topic, and explain it to my bosses. I had to write a memo. You really need the memo to be six pages. And then you need to rewrite it so it's only one page. And then you need to write their talking points. And they prefer their speeches to be maybe six words per sentence or less. And so this is a good analogy for what we have to do with our lawmakers and our policy makers in Washington, generally.

And you know, it was an illustration of the challenge that we all face where climate itself, even though we've all been working in this space for a long time now, and we're very comfortable with the acronyms, and the actors, and what is two degrees all about, or whatever, this is not readily available to most people. It's not readily available to most smart people. But consider how we use carbon and carbon dioxide interchangeably. Nobody even notices that anymore, among, probably this audience. But that is really confounding to a normal person.

So that's the kind of things that I've been trying to spend time on. And I hope that the rest of the group will acknowledge we try to unpack these very complicated questions of what you could need for some very complicated, threatening, future scenarios in the way of governance. What could you need in the way of research to support potential outcomes you're trying to achieve? I mean there's a lot of assumptions baked in. We're just the gloss over when we're communicating with people.

In general I think that's, sort of, a mission that I would like to spread among all of the smart climate scientists, and academics in the room is, we need to try to think more about how to break down this

subject into bite sized chunks. And that is partly something that you should do to be respectful of your lawmakers when you talk to them and their staff.

All of these staffers are very smart. But they have about 400 other subjects that they're trying to manage that may be equally complex. And they're trying to juggle their bosses, you know, constituent interests, and so on. So it's incumbent on us, the folks who are sort of plugged in, to potentially develop a common vocabulary. That would probably be helpful if we started using a single term of art to talk about this. And then boil down your asks and your concerns into more tangible things.

And I think that's something that would be useful in the broader climate debate, as well. Putting yourself in the staffer's shoes, or the administration's shoes, quite scary when somebody shows up and says, I'm here to sound the alarm. This is calamitous. Please fix it. OK. Fix it, how? They've got a lot of other responsibilities. And there's a good chance your meeting is 25 minutes long, or less.

So we have opportunities, if we can figure out how to break down this enormous problem into smaller outcome based challenges where, OK, we don't understand the research well enough. What's happening in the clouds? Well, OK, we can point to a place in the latest working group theory report. It says we don't know the cloud aerosol effect. Let's talk about the cloud aerosol effect.

What does it mean to not know this well enough? What are the instruments, the LIDAR instruments that's being supported by NASA that are helping us unpack this today? Could you have better instruments that would enhance our ability to understand those things? Could you asked for a specific new instrument to be built by a very specific location?

So that's a little bit more finite. That gives people something to work with. So that's kind of the call to action to consider how you present your problem to other people. It needs to be very finite. And I think that's, when you talk to your lawmakers, and when you talk to just other folks about your work.

I'd also encourage folks to, sort of, appreciate the environment that you're in. I don't know if, maybe, the whole world, or just the policy geeks observed the release last week of the president's skin budget, which is sort of the very incomplete blueprint for what he'd like to see in budgets. Now, Congress holds the purse strings. That's not gospel. But that's what the president would like to see. And the numbers for climate research generally are not good.

So what you do first is you hold the line. We think about defending the resources that we have now in a very specific way. Not, be good to climate. That's not actionable. Don't shut down NASA earth sciences, and the levels need to stay here for the Goddard Center. That's actionable. People can work with that.

So holding the line first. Communicating clearly about what tools, resources, capabilities that the federal government brings to bear are already important to the work you're doing now is job number one. And job number two is articulating the very finite obligations that you would like to see pursued in the near term. So giving folks something to work with is the name of the game.

JESSE REYNOLDS: Thanks, Janie. We'll move on now to Peter Frumhoff, who is director of science and policy, and chief scientist of the climate campaign at the Union of Concerned Scientists, where he ensures that UCS brings robust science to bear on our efforts to strengthen public policies with a particular focus on climate change.

A global change ecologist, Dr. Frumhoff has published and lectured widely on topics including climate change impacts, climate science and policy, tropical forest conservation and management, and biological diversity. With that, I'll turn the floor over to you to share your perspectives and those of your group on solar geoengineering.

PETER C. FRUMHOFF: Thank you, Jesse. It's a pleasure to be here. Let me frame my comments at the outset in the context of the original intent of this forum. That is to say, to explore the conditions under which the US government should fund solar geoengineering research. And I just want to be really clear that if a proposal were coming forward to the Trump administration in Congress, if it would be taken up in some serious way—I don't expect this to be the case, but just to note the plausibility of it, it's not off the table—UCS would actively oppose it.

And we would do so not because we're opposed to solar geoengineering field research, quite contrary. But to the point that others have made earlier in the morning sessions, because we believe, I believe, that it's essential to really think through carefully about how to build out a well-designed, appropriately governed, appropriately scaled solar geoengineering field research in a way that builds and sustains legitimacy, social license that we talked about earlier.

And you know, if I were to try to design a strategy that would be intended to undermine legitimacy I would do it by seeking funding from the Trump administration. In this context, in this moment, in the context of an administration that is so clearly bent on defunding climate change science, diminishing funding for clean energy research and deployment, and basically, in many respects, denying the risks of climate change, that would be the worst possible outcome.

And I have to say that I don't know to the point about philanthropic, independently funded field research, the sort that David was mentioning earlier. This is a relatively new issue for us to wrestle with. This hasn't been on my radar screen. And I actually don't know what our institutional position would be on the work that David's considering, and colleagues over the next year or two.

We have to really think through, carefully, notwithstanding the high probability, if not near certainty, that the work itself would not pose significant risks, as you've described it. But recognizing that, again, the issue of legitimacy is really fundamental here. And transparency, inclusivity, kind of a notion of what the right kind of consultative process would be before that research would take place, seems really essential to establish the legitimacy not just of that work but of the work that would be implied to be further beyond it.

And it's really important to do this right, lest we find that we end up creating a system that has—which I think is quite plausible—solar geoengineering field work be seen as fracking is, by so many actors, inherently negative, notwithstanding that under some conditions it might less so. Or the perceived health risks of GMOs, notwithstanding that those risks are not established as a fundamental scientific premise. But perceptions matter.

In this moment, a relatively small number of scientists and thought leaders are wrestling with the trade of risks associated with climate risks going well above two degrees, and the potential risks, and the both intended, and unintended consequences of solar geoengineering deployments, potentially, as well, research, depending on its scale.

But most others, most people aren't, including people within my organization, and a broad set of stakeholders, and thought leaders in the climate science, and policy, and NGO community really are not wrestling with this in a significant way. I think that's going to change. It has to change. It's worth noting, of course, that the Paris agreement focuses on achieving the two degree target, or well below two degree target in the context of reductions in emissions from sources, and uptake from sink's. The notion of radiation management, albedo modification doesn't exist formally, in the context of that agreement.

And of course the IPCC special report on 1.5, motivated by the Paris agreement, is also, at least in its draft outline, silent on whether this issue will be taken up. I know there were lot of lead authors and developers of the report outlining that were really loathe to consider solar geoengineering, the published research already, in the context of the 1.5 special report.

And that speaks to the fact that, I think, as we all recognize, there's, for many, an inherent many who are evolved in climate policy and climate advocacy, an inherent distaste for even going to the idea of wrestling with it. And much credit to EDF for having really stepped forward, and began to wrestle with this as an NGO.

That's necessary, but not sufficient. We need much broader inclusivity, and participation in thinking about this. I do think that in 2018, when IPC special report is released, when there'll be a consultative process in the international post-Paris agreement discussions among governments, the what is highly likely to be an IPCC report that points out just how difficult, if not nearly impossible, to conceive of achieving the Paris targets with the tools at the disposal of the special report. That is to say, mitigation, and carbon monoxide removal, that is, and should be seen as an important teachable moment within the broader stakeholder community to wrestle with the trade off of risks and consequences. And the notion of research and appropriate research governance, in a way that's very difficult to do today. I think we really should be mindful of taking advantage of that opportunity.

Since we're in the US, and we're thinking about US leadership, whether it be philanthropic approaches, or US government funding, or both certainly us researchers who are actively involved in this, I just want to—drawing on my own work in the tropical forest world—remind myself as I was thinking about this of the lessons that I've taken away from not entirely a parallel effort, but nonetheless, one that I think has some insights to offer, which was around the leadership of the United States originally coming out of the Kyoto process in trying to incorporate tropical forests in their protection slowly deforestation in the context of what was then the clean development mechanism.

I hear this was an issue that was intended to support developing countries in protecting biological diversity in those countries. It was a US primarily, and other industrialized country led effort. US NGOs, prominently EDF, and UCS were active in the Nature Conservancy, actively involved in supporting this. And the science was evolving, but nonetheless, robust and reasonably clear that we would know how to do this, and do it relatively well from a technical perspective.

And really, much to my surprise, and this was back in the early 2000s, the whole notion of this was met with intense opposition. Just intense opposition. Not only from international NGOs but from developing countries who came at this with the frame that this was an effort by northern countries, and particularly the United States, to essentially get off the hook, get out of our own commitments to potentially cheat offsets and benefits in the context of tropical forest offsets with the CDM. It was basically de-legitimatized and highly unsuccessful.

But it was only after developing countries, led by Papua New Guinea, with funding support from Norway, a perceived independent and credible actor, unlike the United States, in that context, that the whole notion of the role of tropical forests and climate mitigation turned around. There are a lot of other pieces to this, but this is just the shorthand. Ultimately it's now seen as a legitimate, and indeed, central part of the Paris agreement.

So representation really matters. There are a lot of bad ways to do this. And I'm deeply concerned that if we don't set up a research funding initiative that is inclusive of developing countries, particularly the vulnerable developing countries who we see as the purported beneficiaries, or considerable beneficiaries of this kind of effort, recognizing that they are among the least resilient and capable of responding to climate impacts—we're not designing this in a way that gives them a seat at the table, making this salient to developing country actors.

Not NGO representatives of them, but in a meaningful way. That the legitimacy of, not just deployment, but research, would be highly questioned. And the goals that I think most of us share of building out an appropriately designed, and well-governed, and sustained, research initiative will be very much at risk. I'll stop there.

JESSE REYNOLDS: Thank you. Thank you, Peter. Finally, Janos Pasztor, who is currently senior fellow and executive director of the Carnegie Climate Geoengineering Governance Initiative at the Carnegie Council for ethics and international affairs. And he has over 35 years of work experience in the areas of energy, environment, climate change, and sustainable development. And before taking up this current assignment he was UN Assistant Secretary General for climate change in New York, Under Secretary General Ban Ki Moon. And he will tell us a bit more about his new project. Janos, please.

JANOS PASZTOR: Thank you, Jesse. Good afternoon, colleagues and friends. Yes, I will say a few words about this new initiative. But I will do that by first sharing with you a few ideas. A few key, sort of, messages that are, I think, important for this discussion. And they are very important in the way we set up our initiatives.

I think the first point I was going to make was made the whole morning about the importance of governance. There is an issue there. It's complicated. It's challenging. A lot of work still needs to be done on that. And we've set up our initiative precisely to try to contribute to filling feeling that governance gap.

The second point is that our initiative, and we have to say this very clearly up front, is we're not promoting any kind of geoengineering. We're not necessarily against its use. That's not our purpose. Our purpose is not to make decisions whether or not they should be used. Our purpose is to understand, in particular, the governance requirements and try to advance the debate.

But we are also very clear that the number one thing to do, as many of us have said here before, is that we need to bring emissions down to zero. And it doesn't matter what kind of geoengineering option we talk about. Whether it's carbon removal, solar radiation management, all of those require, in any case to bring down our emissions. And yes, the issue might arise that we may still need to do something more than that, because all of that will not be enough, and we've seen some very interesting graphs.

But if that is the case, then if the existing mitigation, and other strategies that we have are not able to bring us down to below the temperature targets of the Paris agreement then we will overshoot. And we will overshoot by maybe a few degrees, maybe a few decades. And that is something that we may be able to avoid if we make use of some of these technologies, maybe.

But then the question is, can we ignore those technologies now? Or can we do some more serious studies, assessments, trying to understand them, and then make a decision whether they're viable? And if they're viable, under what conditions can we make use of them? So it is this approach that we have tried to take into the Carnegie initiative.

Now, this implies what I just said is we need to do more research. We do need to do more research. And yes, as it was said before, we need to do, not just research about governance, research about the technologies, but we also need to look at the governance for research itself. How will that work? And there was some discussion of that.

Now, the last point that is actually very important is also the question of, can we just look at geoengineering in its vacuum, in its silo? Or do we have to look at it in totality with, not just the other options that we have to reduce climate risk, like adaptation, mitigation, but, in fact, the broader sustainable development agenda?

And we believe strongly that it has to be done that way. That's the only way the world community will be able to make good decisions about it. Our initiative may only address a certain slice of that problem, but we're still doing it in that bigger context.

And that brings us to the first real objective of our initiative, and that is, really, to enable dialogue so that eventually the policy people will also be able to, not just understand what this issue is all about, but that they will be able to make policy decisions, because right now most of the discussion is by the scientists. That's where it's happening. And that's fine. We need to base on that.

And I very much appreciate, Janie, your comments for the policymakers—it's the same for the public, for the civil society organizations. They don't know what this is all about. They don't understand it yet. And the communication requirements of that is quite substantial.

So number one is the dialogue so that people in government, but also non-state actors, will be in a position to make policy decisions about that. And for us that's very important. We're not just talking about governments. We're talking about governments and non-state actors, as well.

What we hope after a few years of work is that the result of our work, not the direct outputs, but the result of our work will be that, in fact, you will begin to see, after a few years, inter-governmental action of different kinds, that it will appear on the agenda of intergovernmental processes, that there will be some discussion, maybe beginning of some work toward an agreement. But of course, at the national level, at the domestic level also, that there will be that kind of understanding.

Now, our strategy to get there, it's a fairly simple strategy, but it's a very challenging one, of course. What we will try to do is try to engage systematically over the next few years with a set of international organizations, intergovernmentals, but also international NGOs that are working on these issues, treaty

buddies, private sector organizations, scientific groups, and so on. And hope that we can work together in partnership with them.

And the engagement means that we would try to make sure that each of these different entities pick up the issue, if they haven't yet done so. If they've already done it, enhance their work. And what can they do? Well, different organizations can do different things. But if some of them can do assessments of the technologies then we'll get some authoritative assessments on the environmental and social impact.

If some of them, like the World Meteorological Organization can address this issue of monitoring, that we've talked about earlier, in a more systematic way. If some of them can simply engage different policymakers in an outreach program to better explain what the issues are, and so on, and so forth. What we hope is that after a few years of work what will appear is a whole series of visible information products that by themselves will be useful.

But what's even more important is that behind those information products there will be a network of people working on these issues in those organizations, but also in the governments that link to those organizations who begin to understand the issue, and begin to understand the policy aspects, and will be able to start thinking policy, and thinking, and preparing, for eventually, policy decisions. And that is really the essence of our project. We hope that over the next few years we will be able to achieve that.

Now, briefly we are hosted by the Carnegie Council for Ethics and International Affairs, based in New York. Our team, we have a small team that is virtual in the sense that we're not linked to any particular physical location. I have two colleagues here in the back, Cynthia and Kai. They are each located in different parts of this country. I'm in Switzerland. And others should be working somewhere else. So we are setting this up like that.

We're working in partnership with a number of entities. Some of them are here. Some are even on this panel, like SRMGI, like the FCA, and so on and so forth. So we're trying to also, first of all, learn from what's out there, and also connect the dots as much as possible, because many dots have to be connected. And we are also setting up an advisory group that will be providing substantive advice to our group. And since January, we're in operation, and you'll hear from us again. Thank you.

JESSE REYNOLDS: Thank you. Thank you, Janos. Thanks to all of our speakers for sharing their thoughts. What I'd like to do now is give each of our speakers the opportunity to respond in whatever way they wish to the comments they've heard, provide comment or questions. Let's keep it short, around a couple of minutes or so, so that we have plenty of time to get questions from the attendees, audience.

We'll just proceed in the same order that we began with. Let's start with Joseph.

JOSEPH MAJKUT: Thanks everybody. That was really interesting. Peter, I have a question for you. You said that if a research program were to be funded under the Trump administration that's not something that much UCS would be happy with. Is that independent of the characteristics of the program, how it may be carried out by the administration, or administered by the administration itself?

The reason I ask is, if you had a good faith effort coming out of Congress for a transparent, inclusive, progressive, in the sense of moving acceptably from smaller to larger implementation of research, but it carried with the authority of the US government and political backing, why wait four years or a decade?

PETER C. FRUMHOFF: Fair question. So we're seeing, although a lot of it is still yet to come, this administration in Congress, leadership in Congress, pulling back on our commitments under the Paris agreement, on seeking to achieve—whether through the Clean Power Plan, or another approach—pulling back on research funding, pulling back on Earth system monitoring through NOAA, and NASA satellite infrastructure that's essential for so many reasons, including being able to detect the impacts intent or non-intent to do of the field research.

And so the very premise, that I would hope most of us share, of this being a supplement to, if ever deployed, not a substitute for commitments to achieve and go beyond the current Paris agreement commitments, would be at odds with the assumptions of this administration, that I think it would be seen, I think probably appropriately so, by a broad range of actors as part of an effort to substitute rather than supplement.

And in that context, the legitimacy of it, whatever UCS thinks as an organization would put the legitimacy of the research at great risk. I think that the number of civil society organizations who would oppose it would be very strong. And we'd end up with a highly contentious debate over it in a way that it would be unhelpful to the goals that we all share about a fundamentally sustained, and an appropriately scaled research initiative.

JESSE REYNOLDS: Steven.

STEVEN P. HAMBURG: Well, I really don't have a question for my panelists. But I do want to highlight something that Peter raised that I didn't talk about. But I think the funding sources issue is one that we really need to grapple with using the sort of frame that I said. And I didn't have time. It's something we think about an ETF broadly, a lot, since we do a lot of work with the corporate sector. We do work on a lot of issues that may not be always within the mainstream of our own, sort of, sister organizations.

So I think that I see three, sort of, broad strokes, three different areas. They're corporate funding, philanthropic, and public. And I think we need to think about those three in the context of this. And I agree with Peter, certainly in the context. I mean, we would certainly never be able to endorse funding if it were in the context of cutting in the way that it's been proposed for all these basic research, and then say, we're going to fund this. Well, of course, that would be totally antithetical to our position, which says, we have to mitigate first.

But I think we need to think a bit about the funding issue. We need to think about what the implications are. I think that has to happen jointly with the government's conversation, even on small scale research, even on modeling. So even not going on the field, just sort of, what does it mean?

And again, I don't have a preconceived notion, other than our own position is, certainly, corporate funding—again, we work with a lot of people collaboratively that bring corporate money. But we don't take it. So there's no question about motive for us. So I don't know quite how this interplays, but as far as I know, we've not had, as a community, that conversation. And that's a conversation we need to have soon, and we need to have it in a broad way.

JESSE REYNOLDS: Thanks. Janie.

JANIE WISE THOMPSON: Steven, when we were talking about transparency concerns, actually several people mentioned transparency concerns. One thing I didn't get around to but I meant to point out is that, you sort of want to pursue specific research requirements.

But we also might want to consider really specific governance requirements in more of a finite way, and even map the most mature proposals that we know about, against the federal policies that we have today, and how these unfold.

I've wondered, and I wonder if you've considered, how NEPA, National Environmental Policy Act, and the EIS process, provide for transparency? Because I keep trying to imagine a field study of some scale that could potentially exert some influence on a local climate condition that wouldn't trigger NEPA. It's a hair trigger. You get NEPA pretty easy. And then you have to write a long EIS, and you have to tell everybody, and everybody's paying attention.

And that process, I think, gives you a great opportunity to appreciate, what are the risks that we're talking about here? And to make sure that the world knows that the civil society organizations are tuned in. People can sue you when they think your EIS is inadequate. So I just wonder if that's something that you'd considered before. I'm sure you wouldn't consider it complete, but maybe that's a tool.

STEVEN P. HAMBURG: Well, it's a real element. And there have been conversations. The National Academy Report dealt with that, to some degree, and with conversations. Certainly existing rules and laws are—absolutely, we've got to apply them. But this question is, they're necessary but not sufficient.

And I think that's where we need the roadmap of, when are they necessary? We've had this conversation about what's de minimis? In many forums. And where's the threshold? And when does it get invoked? And even if it isn't invoked, what are the requirements for transparency, because the nature of the topic, even if it wouldn't involve NEPA, or some other mechanism?

So again, I think, absolutely, those are issues. But again, we need to put the time and effort into trying to create those. There have been various efforts to begin to think about it. Jane Long chaired one many of us in the room have participated in. And we need to take it to the next step, and actually creating a, kind of, proposed roadmap, or at least alternatives, and then vet them in a very open and transparent way with a wide range of people.

PETER C. FRUMHOFF: I have a question for Janos. I just want to ask you to say a little bit about research governance, and in particular, how it relates to the kind of small scale research that we're seeing on the table. And in particular, I wanted just to call attention to another domain, which is the history of human subjects research, in the context of medical, biomedical, and psychological research, where, as I understand, that history over the past 40, 50 years, the development of research governance was prompted by small scale, essentially, research in the 50s and 60s that was seen by a variety of actors as problematic. And that didn't de-legitimize human subjects research.

It prompted, in a kind of bootstrapped way, to use David's frame, the motivation for the development of a governance regime that was iterative and developed over time, and included an important dimension of informed consent, that I think is important dimension of this work that needs to be fleshed out.

So I'm wondering whether you think that that's a useful analogy? And whether it's OK, from—not to take a position—but how you think small scale research, in the absence of governance might both, inform and motivate, research governance of the sort you're trying to put forward?

JANOS PASZTOR: Well, thank you. First of all, I think, one can, and one should, learn from different histories in areas which have nothing to do with geoengineering. But the governance of those processes, there are maybe things we can learn from that. And if that works, and if it's helpful, let's look into it. And let's look at it. And maybe we'll learn a few things.

Janie, I also liked your comment about, let's look at specific governance issues. So one thing is to say we need governance. The other one is to say, what are the governance issues that are important? And you can imagine, based on my earlier question, that I look at the small scale experiment type of situation quite differently than the very large scale.

And I'm not sure where the boundary is in between the two. So let's leave that for now. We can work on it. But certainly, when it comes to this small scale one can come up with some reasonably concrete ideas of what is probably necessary.

One thing, it's probably necessary to have a clear, transparent engagement with the public, which includes civil society organizations so at least there is an understanding of what is being planned, how it's going to happen, and then the mechanisms we can work on it. But the basic idea of transparent engagement with the public.

The second one, it's also reasonably clear to me, is that if there is such an experiment, yes there will be some things that have to be done based on the existing laws. But the existing laws may not cover some of these things, because it's different. And so one has to be a little bit open to going beyond the box.

Therefore, in this kind of situation, bringing together a good group of people, experts, in some kind of independent body to look at what you're doing and give you advice. So that's another thing. These are concrete things that one can do.

And there was discussion about the funding. Funding is very important to be clear about the funding, because all of this together, maybe not just these things, but these together, and other things, will provide, or not, the legitimacy that is so important.

I also totally agree with you, the legitimacy can throw you off in the wrong direction for years. You will have to fight very, very hard to get back to some legitimacy if you've taken the wrong steps. If you take the right steps, then maybe it's going to go a lot easier.

JESSE REYNOLDS: Would you like to add anything? Comments or observations from your co-panelists?

JANOS PASZTOR: Well, some of them have come up in this, but I think there was the issue of the legitimacy. I think that's really, really key. And then this idea of, most people, whether it's policy makers, or the public, and their accessibility to what this is. What is this technology? What are the implications? I think we have a lot of work to do there, collectively.

And I think part of that consultation process that might happen, for example, around an experiment, is part of that process. It's part of the educational process. This is something. And it's happening for a certain reason. And I think you can use that in a very serious way for educational purposes.

And there was just one more thing about the terminology issue. We are all speaking English here. And there are a few other languages there. But even in English we have a problem of geoengineering, climate engineering, and all that stuff. And many of us have felt that maybe some of these terminologies are not very helpful, anyway. But maybe that's part of what can evolve through these different conversations, to come up with better words, and better expression for someone who uses the technology.

JANIE WISE THOMPSON: I might offer up the notion that, perhaps, we talk about solar geoengineering as geoengineering. And the carbon dioxide removal—it's very confusing to say, there's two categories, and they're got nothing to do with each other.

One of them is kind of like adaptation. The other one is kind of like mitigation. And then each of them need research and they need governance, sure, but they couldn't be possibly any more different. And the longer we talk about it, the more you realize it's different researchers doing the work. You would have different nuts to crack. So for your consideration, I think we jettison carbon removal and put that in its own bucket. And now we have four options.

JESSE REYNOLDS: On that note, I'd like to open the floor for short, relevant questions from the audience. I'm going to take three at first, and see what the responses are, and more if we have more time.

MIKE: I wanted to pick up again from the last one, and just say, given the course we're on, heading past irreversible thresholds, it just seems to me that this discussion that we're going to do this in series rather than in parallel really bothers me, because I just don't think we really have the time to wait for all that.

I mean, it's really great to do social sciences, I will just speak for my time when we were in the US Global Change Research Program about how long it has taken to get social science research really done in an organized way, and in a mission focused way. It's hard to do. It takes a long time. And I guess, I think if you wait to get it done we're going to be way past a time when you can do something reasonable.

AUDIENCE: Thanks, I have more a comment than a question responding to Peter Frumhoff. And I would say from the point of view of us, running experiments, we are absolutely clear that under the condition where this administration cuts research deeply on climate science, and cuts action on mitigation, then we think that our response, and the correct response of the community that wants to build a sustainable effort on solar geoengineering is not to take the money, and to offer active resistance.

So from my point of view, to build a sustainable effort you have to tie this to mitigation policy. And so I think what Peter said is completely sensible, and in no way do I disagree. In fact, I really strongly agree. And so from my point of view, what we need to do is focus more on international funding, and focus on working internationally, and focus on raising funds in a way that's transparent, and from organizations with a long track record of funding environmental work. And that's what we've been doing.

And finally, Peter mentioned that it was crucial that if these things are to benefit people in the developing world that we work closely with that world. And we, again, strongly agree, and in different ways are trying to do that. And even to join.

JESSE REYNOLDS: Great. There was a woman back there with her hand high up in the air. I'll add in two more, because of the presence of comments, and not questions.

SARAH GONZALEZ-ROTHI: I'll be brief. I'm Sarah Gonzalez Rothe, with the democratic staff of the Senate Committee on Commerce Science and Transportation. I have two questions. Both are brief. If, as we've heard, the United States maybe isn't in a position right now, politically, to lead on research governance, then who is? And then, secondarily, Scott talked earlier, on the first panel, about incidental masking with sulfur dioxide. In recognizing that, and in recognizing our current pollution framework for Clean Air Act, or Clean Water Act discharges, how would a deployment governance system work, as it relates to the incidental masking and discharge of sulfur dioxide?

KELLY WANSEER: Hi, I'm Kelly Wanser. I'm with the Marine Club Writing Project. I'm going to toss out a little bit of a contrarian point of view on federal research funding in the current climate. In a very tactical way, from my understanding of being engaged with field research proposals in geoengineering, and others can argue the percentage, but a good majority of the work is very synergistic, if not identical, with a detailed understanding of the climate.

And there are three components. There are the platforms for observing climate. There are the models for interpreting climate. And there are other people. And right now we have proposals on the table to decommission those things inside the government.

And if there is a framework for a Republican climate policy that allows the maintenance of that infrastructure in the United States for understanding climate, which is—and when we talk about geoengineering research, I think it's just important to consider that much of what we're talking about is very fine grained understanding of climate and feedbacks. And so I just wanted to put that out there, in the context of this particular emphasis.

JESSE REYNOLDS: Oliver?

OLIVER MOORE: Hi, Oliver Moore. Under the rubric of state of play I just wondered if any of the panel had any feeling about what the prevalence of Chemtrail conspiracies means for geoengineering policy, in this event.

STEVEN P. HAMBURG: Great.

[LAUGHING]

JESSE REYNOLDS: I'm going to go in reverse order, with Janos. Any responses to the questions that were scattered among the comments?

JANOS PASZTOR: Sure. So I've been receiving more and more followers from the Chemtrails category. So this is great. We talked earlier, a lot, about attribution. Oliver, you were the one who actually brought this up in an interesting way. And we're not going to get away with it that easy about that issue. And the

perception of what is happening is just so important. And whether it has anything to do with reality, or a little bit to do with reality, or a lot to do with reality, something we will need to deal with. But, anyway.

But I wanted to come back to the first question about series or parallel. And I would strongly believe that in this kind of situation going parallel is the way to go, particularly when it comes to research and governance, because neither side do we know exactly yet what we're looking for.

And we're learning from each other so. I think it makes a lot of sense to go ahead, do some experiments that spur others to think about governance issues, and then we do some governance, that spurs some of the research people to do things differently. And if we are all transparent about this, then we can learn from it. And that is the way to move forward.

STEVEN P. HAMBURG: Can I just comment on that one.

JESSE REYNOLDS: Yes, please. Go ahead.

STEVEN P. HAMBURG: So I heard Mike say something different. So Mike can correct which one it is. So I 100% agree. Our position statement at EDF says that explicitly. What I heard, though, is the parallelism of Mike was deployment, or beginning to actually go into the field.

That I will push back very hard against, and let me explain why. Even if you didn't say it, I'll push back.

[LAUGHING]

[AUDIO OUT]

STEVEN P. HAMBURG: Well, a large scale field—

MIKE: How large?

STEVEN P. HAMBURG: Yes. How large? I mean, large scale enough that it's not—

JANOS PASZTOR: [INAUDIBLE].

STEVEN P. HAMBURG: Right. I mean, something that will have more than a de minimis impact, was your parallel. No? Yes?

MIKE: I want [INAUDIBLE].

STEVEN P. HAMBURG: Parallel with what? Governance? Well, I think we're all in agreement with that. So I don't think there's any question. Or at least, certainly, we are, and the community that I know of. At least, initially, you can't figure out the governance well unless you're doing some research so you can bounce it off. Doesn't mean you start the research then think about the governance. You do them in truly and parallel.

JESSE REYNOLDS: All right. Peter.

PETER C. FRUMHOFF: So I'm a little confused about what the conversation's about, but—

[LAUGHING]

Fundamentally, I don't think we need a fully fledged governance system, whatever fully fledged looks like, in order to initiate small scale research of the sort we're talking about here today. I think it's appropriate to think about them as co-evolving as Ted Parsons has talked about in other contexts.

But scale matters, and perception, and legitimacy matters a lot. And so I think I'm worried about the emergence of things that will be perceived as risky or large scale by others, and how we perceive it probably doesn't really matter. It's how others perceive it that matters. And we just need to be mindful of doing this in a way that doesn't step into the minefields of pushing back on the goals that we all share. Exactly where the boundaries are, and what appropriate scale looks like, and what the level of governance is needed for research of different scales, is well beyond my ability to characterize today.

But I do think that as we do small scale research some clear understanding of where the governance process is heading, what it's intended to look like, and the fact that it's being done in a way that has legitimacy, with the right set of stakeholders, and inclusiveness, and transparency, is going to be essential so we don't trip over those many minefields that will be in front of those. I'm not sure if that really gets to your question or not, Mike. So yes, in parallel. I'm sorry, in parallel rather than series, but with some care to ensure that we don't undermine our fundamental goals.

JESSE REYNOLDS: Let's see if I can get Janie, and Joseph, in here, and then I'll circle back around to Janos.

JANIE WISE THOMPSON: So I really liked Sarah and Kelly's comments. Both kind of fit in together, which was sort of unpacking the science questions, and geoen지니어ing helps you unpack a lot of other great things about the climate, including understanding the sulfur masking, which I mean, if it's sulfates in the troposphere we're talking about things that harm human health.

So for me, that makes me think about, this is something that comes home to people's constituency's. If you don't have one person in your district that understands climate science you definitely have people that understand asthma.

So it's a good question to, sort of, think about, how would you address sulfur masking from the governance perspective? But also sort of marrying these two concepts to draw out the need for research and to build that support. And also Sarah's question about, who ought lead on research governance, if not the US, if we're not in a position to do that?

The very question makes me think, well, it must be the US. I mean, despite all our misgivings, and maybe, lack of faith in the United States government today I do believe we've got the tools to do a good job with this, and to take a good faith effort. And you know, it's telling me, yes we should you know get cracking.

JOSEPH MAJKUT: Yes. Actually, I agree. And I think likewise, I'm worried by the idea that we're waiting for the right political context, or the right preconditions from political actors before moving ahead, or supporting research. The enemy is ignorance, right? What we're trying to do is give people in the future tools to better understand, and perhaps, better respond to the risks from climate change.

If the vessel or the funder that will marshal the war against ignorance doesn't like mitigation policy all that much, I don't necessarily agree that that's going to be a problem for the governance issues, because we're so far from deployment. We're decades from tenth of [INAUDIBLE], which is an experiment, right? That's not even a deployment statement.

I really question the hesitancy because—I tried to get at this in my comments—if it's not those who are concerned about climate risk pushing for this research it'll never come about. And if the conditions for the preconditions are too strong then it'll never be an option.

JANOS PASZTOR: So two issues. I mean, following this line, that's not why I asked for the mic. But I do tend to agree that, on the one hand, refusing money from a government that is against mitigation, that's one thing. But there is other things in this world, including in this country, than the federal government.

There are states, there are cities, there are lots of different entities that can do useful things in this area. And I hope they will do that. So let's work on that.

STEVEN P. HAMBURG: I was just going to jump in. One thing is there was sort of a presumption, and maybe not by everybody, but governance doesn't mean government.

JOSEPH MAJKUT: Yes.

STEVEN P. HAMBURG: And I think we have to be really careful. There are lots of governance institutions. And in this space. I think the initial ones are not going to be government but they may evolve into government. And so I think we need to spend some time figuring that out. Or it may be government governance outside and within government. If you do NEPA, obviously, that's government. But if it's pre-NEPA you may still have governance.

JANOS PASZTOR: I remembered another point. So that relates to the question I asked David. And it's not that I'm pushing for an answer. And I'm just flagging it, because I think we will need to work on this. Between the small scale, that I think is fairly clear what we're talking about, small scale, and the very large scale deployment, there must be stages. And we need to be able to define that so that we can be clear about when one becomes the other, as part of this evolution of our work.

JESSE REYNOLDS: I will give the last word to Peter.

PETER C. FRUMHOFF: I just wanted to say that whatever I think, and perhaps most of us in the room think, about the advisability of beyond small scale research in the direction of larger scale work, and ultimately the feasibility of deployment, it's not my decision. And I don't think it's our decision.

I think we have to be careful to distinguish our interest in understanding the risks and tradeoffs, and communicating them, and promoting an outcome that really is an outcome to be decided in a consultative process that's inclusive and transparent by a much broader range of stakeholders than are in the room today.

So it's easy to get those entwined. I know, and I do it all the time. And I just want to make sure that we're—even though I might want to see work move forward aggressively, that might not be an [INAUDIBLE] where society wants to take us.

JESSE REYNOLDS: I get the sense we could go on all day. But we'll wrap it up here. Thank you for your comments, and your questions, and your attention. And please join me in thanking the panel.

[APPLAUSE]