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MIKE LIVERMORE: Welcome to the Free Range Podcast. I'm your host Mike Livermore. This episode is sponsored by the Program on Law Communities and the Environment at the University of Virginia School of Law.

With me today is Michael Greenstone, who is the Milton Friedman Distinguished Service Professor in Economics, and the director of the Energy Policy Institute at the University of Chicago. He served as the chief economist for President Obama's Council of Economic Advisers. And he's been working for decades, engaged in research and policy development on environmental issues. Michael, thanks for joining me today.

MICHAEL GREENSTONE: My pleasure. Thank you for having me.

MIKE LIVERMORE: So I thought we might begin by talking about a really important recent climate development. Development in the world of climate policy has been just over a month as of the time of this recording that we're making, which is the Inflation Reduction Act, a really major piece of legislation. So there's a lot to it, but just the really small thumbnail is the bill's-- basically, the climate provisions of the bill are a big pot of money. A lot of funding, mostly in the form of tax subsidies for various kind of suite of decarbonization efforts. Roughly, to the tune of \$400 billion.

We've got tax credits for certain types of energy projects. There's the electric vehicle tax credit, there's money for homeowners who are going to make improvements like installing heating pumps. There's a provision establishing a Green bank to provide funds for clean energy projects. This is a really complex piece of legislation. There's requirements around many of these subsidies, including labor standards, US content standards, and so on. There are provisions to promote fossil fuel easing on top of that.

And as we record, we're in the middle of a debate about what's being referred to as the side deal, which is an effort to reform the process of environmental review to make it more developer friendly. So I guess just the big picture question, I know there's a lot of moving parts, obviously, as you know as well. But what's your general impression of the legislation? Is it a good thing? Are we in a better place now than we were six months ago on climate policy in the US?

MICHAEL GREENSTONE: So I think the short answer to that question is the period of American exceptionalism around climate policy, and that was not to have a policy, has finally come to an end. And so I think we-- in terms of confronting the climate crisis, we're in a totally different place than we were six months ago. And that's a great achievement. As you list it, there's many, many details about the IRA.

And probably, it's too hard to sum them all up into one grade, but there are certainly some elements of it that are-- look quite terrific. Some of the tax incentives look like they're going to get reductions in CO2 at relatively inexpensive cost.

MIKE LIVERMORE: Yeah, I'd seen the report that you were part of on that. And so which of those provisions have you have you taken a look at, that you think are kind of most promising in that regard?

MICHAEL Yeah, it's primarily the tax incentives for a generation of low-carbon electricity. And those look like-- compared to
GREENSTONE: their benefits where their benefits are the reduction in climate damages that they're going to unlock, their benefits look maybe three times larger than the cost.

MIKE Pretty good, as these things go.
LIVERMORE:

MICHAEL Yeah. And, I mean, I'll just add like, for those of your listeners who aren't in the depths of cost-benefit land. Like,
GREENSTONE: normally, economists get pretty excited when a policy is like 1.2 times the benefits or 1.2 times the cost. Like we don't get policies that are-- where the benefits are three times the cost. And it's really remarkable.

I think it is also a reflection of an important outside event, and that has been the reduction in the costs of low-carbon energy sources. And so these same tax incentives would not have produced such large carbon reductions three years ago, five years ago, or 10 years ago. It's these guys, these energy sources are much closer to being in the money. And these tax incentives are now pushing them across the line.

MIKE Yeah, and that's an interesting story itself, and how the technology has come along. But maybe just one general
LIVERMORE: question is kind of an almost an interpretive question that's come up in the wake of this bill, and the political success it realizes, right? I mean, we've been working-- and the United States, in general, has been, as you said, the kind of exception to the rule here, in terms of its lack of climate policy, especially legislative climate policy.

And there's been efforts for decades to get something done. And now we finally have something. But one of the interpretations that I've seen, I'd be curious your take on, is that the fact that this is what got over the finish line, some are reading as kind of a rebuke to economists, and the role of economists in debates over climate policy.

The thinking or the argument goes something along the lines of, economists have been urging carbon pricing, things like a carbon tax or a cap and trade for decades. And that's not the policy that we ultimately got. We got something that was subsidy based. It's much less technologically neutral than other approaches, as there's a lot of provisions in the bill that are targeted to specific technologies.

And there's been a kind of consistent concern amongst some economists that that's a bad idea, because you're picking-- the government's not very good at picking winners and losers, as the saying goes. And so that's been an interpretation that I've seen. There was a piece in the times by Lydia Depillis, kind of recording some of this and some chatter on Twitter. Yeah, I was curious, if you read the politics this way, if you read the legislation this way, or if you had a different take on that?

MICHAEL Yeah, I find this kind of navel-gazing and the conclusions that have emerged from it really bizarre. So yeah, the
GREENSTONE: bill got across it got across a 50/50 Senate. The vice president casting the first vote. And it is true that the period of American exceptionalism with respect to having no climate policy has come to an end. But we still are the standout in the sense that of the seven G7 countries, we're the only one that is not using carbon pricing in a systematic way. And I think it's really a kind of a strange, like getting the microscope all the way against a piece of paper to reach the kind of conclusions that you listed.

And again, I celebrate, at least, some of the features of the IRA that I understand. But it doesn't change the fact that we are picking some winners and losers. And probably, we're going to miss out on some innovation that would have happened if they'd been more neutral. Although, this is more neutral than other policies have been in the past-- proposals in the past. And this isn't doing anything really about the economy-wide problem. There's emissions all over the place.

And there's not an economist was like, what common sense would say is, like getting the entire economy incentivized on carbon is the way to go. So I find it kind of a very strange, possibly self-serving interpretation. And one that also does not account for, really, the rest of the world. The US is-- I guess, we're about 5 billion tons of CO2-- metric tons of CO2 now. The world is 40 billion tons. And the world seems to be-- most of the rest of the world seems capable of buying less expensive abatement than we do. Or sorry. I want to be clear. Most of the rest of the G7-- or the rest of the G7, yeah.

MIKE Right, and which accounts for a good chunk of global emissions.

LIVERMORE:

MICHAEL Of course.

GREENSTONE:

MIKE Right. Yeah, I think this raises an interesting question. One that kind of is coming up, I think, now even just with respect to what we've seen with gasoline prices over the last, I guess, year or six months, and how that relates to the kind of political fortunes of folks in Congress. We have a midterm election kind of on the horizon. It really does seem that gas prices are a huge input into-- and energy prices are a huge input into the political process. And that's globally true, I think, to some extent. But it does seem really salient in the US.

LIVERMORE:

And I was wondering-- and that-- obviously, that relates to carbon pricing. And so, whenever proposals to price carbon have gotten serious at the national level, there's always an easy kind of opportunity for political opponents to shoot it down as something that's going to affect energy prices. And that really does seem like something that motivates voters.

I wonder if you have-- you've been in this debate for a long time-- if you have theories about why energy prices seem to have such an impact on elections? I mean, one possibility is that that's just an impression, and that's wrong, I guess, right? It's just perceived to have a big effect, and it doesn't, actually. But there seems to be alternative pathways through which concern about energy prices could kind of feed into politics, yeah? I'm just wondering if you had any thoughts on this as an observer over the years?

MICHAEL Yeah, so I'd say a couple of things. What we take away from the swift increase in gas prices around the initiation of the Ukraine war, and now the decline, as of late. But what we take away from that, I think, is not relevant.

GREENSTONE:

It's not the same thing as what a methodical and forceful carbon pricing would look like. There you would have the price appear, not overnight, when people are stuck driving a particular kind of car, but rather people would have a chance to adjust an expectation of what was coming, and maybe you would phase it in over time.

And the other thing, the reason I think it's kind of a false comparison is it is a design feature of carbon pricing as to how you distribute the pain, I guess, of the higher cost, it's like. And you could take the money, you could burn it, you could dump it in the ocean, you could put it in the general revenues of the treasury. Or it does not take like superpowers to come up with a plan to redistribute it in a very progressive way.

And so there's plenty of proposals out there that have at their core the idea of introducing carbon pricing which, as you said, would lead to higher gas prices and higher other prices. But then having some rebate as part of it, which is heavily tilted towards people who are going to face the highest cost.

But I want to add, like if the idea is, can you name a carbon pricing policy where there's not a single American out of the 330 million Americans who's not hurt, then, of course, there's going to be people who will be hurt, but you have to add up the people who'll be harmed versus the larger benefits, and I think it's not hard to devise policies where especially lower-income Americans are protected, and unleashing all kinds of climate benefits.

There's one other point I want to make here, which is, sometimes, I think it's not fully appreciated. Why does the United States want to cut its emissions? It wants to cut its emissions-- I'm going to try and take a pretty narrow view of the US interest here.

And suppose that all we cared about was the United States. That may or may not be right for some people. That's going to be true for some people. It's not. But even for the people who all you cared about was the United States, there is plenty of reason to look for carbon policies or climate policies, particularly those that will unlock reductions in other countries.

Because when a ton gets reduced in Detroit, it produces benefits for all Americans. But it also produces benefits for this world. Similarly, when a ton gets reduced in Mumbai, or doesn't get emitted, or in London or even in Moscow, it's going to produce benefits for Americans. So the benefit of having clear carbon policy, carbon pricing is a really good example of it, not the only one, is that can go be leveraged in international negotiations for reductions elsewhere.

And those aren't abstract things, those are things that are going to produce benefits for Americans. And I just I want to get that out because sometimes I worry we get so focused on US emissions kind of as an end and of itself. And kind of there's this larger playing field out there.

MIKE LIVERMORE: Yeah, it's a really interesting point because I think, in a way, there's maybe an irony to this. So I take one of your - an element of the point you were just making, that one of the advantages of a carbon tax, or even, maybe even more specifically a cap, that would involve a cap and trade program, is that you can then go to international negotiations and say, look, we have a mandatory cap. It's very clear, like, what our emissions profile is going to look like.

But same thing with the carbon price. We're putting a carbon price of X per unit of emissions. And what we want to see is you guys do something like that. And it's very clear as opposed to what, maybe, something like the IRA looks like is, we're putting a bunch of money into clean energy development. We project its going to reduce our emissions by a certain amount. But that lacks that clarity when you're on the international stage. so what--

MICHAEL GREENSTONE: Yeah, and we sure hope that like, by the way, that there's adjacent permitting law that would actually unlock all of those production of clean energy, Which--

MIKE LIVERMORE: Exactly. Which is very different than a cap.

MICHAEL GREENSTONE: Yeah, very different.

MIKE So then-- but I wonder if that's also-- it's kind of a feature, but it's also a bug, in the sense that part of what is attractive about something like the IRA, from a political perspective, or part of the liability of a pricing mechanism is that a pricing mechanism is very clear. And that's part of what makes it politically difficult, is we can say like, look, this is what we're doing.

We know what the consequences are going to be. Energy prices are going to go up. The mix of energy is going to change. Conservation efficiency efforts are going to make sense. So people are going to invest in those. And it's actually, in a sense, that clarity that makes it more politically difficult. I'm not sure about that, but I wonder I wonder if that might be partially the case.

MICHAEL Yeah, I think the transparency is both a feature and a bug. There's another thread that cuts through all of this that I think is just worth touching upon for a second. And I think the United States is viewed as a kind of a free market place, at least, internationally. What is strange in the environmental and climate and energy space is I kind of feel like our instinct is to be engineers, and not to be free market people. And what do I mean by engineers?

People want to put their hands on the machine that's going to stop the emissions. And really feel-- are, I think, quite uncomfortable with letting market forces sort that out. And I don't why that's more true here than in some other places or why that's even true at all. But I think the tangibility of, yes, I am subsidizing water heaters, or I am subsidizing windmills, and then so I I'm going to get more of those things, that people feel comfortable about that.

But what is lost in that is the goal is not more windows, the goal is not more efficient water heaters, or whatever it is. The goal is less carbon. And time and time again, we have found that when you go for these bank shot policies and the bank shot is not directly targeting the enemy-- the enemy here is carbon. The enemy is not enough windmills, it's too much carbon-- not always, but often, we can end up in places we didn't expect, with outcomes that we don't like so much.

And you, I have made myself no friends in energy environment land with-- one thing I've done has written a couple of papers on what are the returns to energy efficiency investments in the residential sector. and those have not-- and when you name them, it's hard to dislike them. I want more insulation in my attic, or better windows, or whatever it is. It turns out, just because the world is a complicated and messy place, when you test this with real randomized controlled trials, that, yeah, you can get less energy consumption when you do that.

But it turns out that on a cost-per-ton basis, so there are a lot more attractive options out there. And I view that as kind of the fault line on the engineering approach, which is, if you're going to insist on putting your hands on it, then you may-- on the technology rather than on the CO2, then you might end up with something that is not doing so great on bang for the buck.

MIKE Yeah, and I actually want to dig into this, because I think it's a really interesting fault line. But just a little anecdote, kind of, along these lines is a reporter was asking me the other day. It was kind of about this bill. Like what do you think about hydrogen, or carbon capture and storage, and different technologies. And I said like, I don't know. I don't want to ever have to try to know.

This is what the tricky thing is, like. Nobody knows the answer to these questions. And if you get the incentives straight, then the people will make bets. It's not like the market. I mean, that's the thing people-- not to go on a tangent too much, but people think when folks talk about the market knowing, that doesn't mean that anybody knows in the market. It's just that people are going to make bets, and then eventually the right people, or the correct people, their bets are going to be borne out, and other folks that bets are not.

MICHAEL GREENSTONE: Yeah, but hold on. You should define what do you mean by the right people or the correct people? Because it's a really important point.

MIKE LIVERMORE: Yes. The ones who make better bets, you make good predictions about what technologies are going to be the lowest cost technologies and most viable, that's right. Not the right people in the-- right-thinking people, that's-- yeah, that's true. That's a good point. But I guess the question that I wanted to just delve into a little bit is, I think there is this fault line that you described. I totally agree with that. I like the idea that they can adjust the market approach, the free market approach, versus, kind of, an engineering, more centrally directed approach.

And there certainly has always been that within the environment and energy community. But on climate, really, I do think there was a period of time where a lot of folks were bought into more of a free market approach, more of a price mechanism, cap and trade-type system. And there was always going to be some elements of central directed, kind of, layered on top of the pricing mechanism, subsidies for this, or clean energy efficiency standards, or whatever. And putting those asides, the centerpiece of just going back to the Waxman-Markey bill was always the cap and trade.

MICHAEL GREENSTONE: So let's just stipulate. You're talking about the halcyon days of, let's call them, a two-year window, 2007 to 2009.

MIKE LIVERMORE: That's right. That's what I'm talking about.

MICHAEL GREENSTONE: Yeah, OK. So there was a presidential election, both people were saying. Yeah, and then there was an effort to get it to Congress, made it to the house, and died in the Senate.

MIKE LIVERMORE: Right. And I guess what's interesting here is comparing that, that moment with the moment that we just had, in a sense, where the IRA is able to get over the finish line. And in principle, it's hard to explain this, I think. Because if market mechanisms are the lowest cost approach, which I think there is a very good reason to think that's true, what is it about the political coalition?

So I guess that's a question for you, if you have any insight into this, is what makes-- because the cap and dividend that you were describing earlier just seems like a superior policy. But it does seem to be very hard to get off the ground in the United States, where we're, as you said, supposedly culturally predisposed to market mechanisms.

I guess the question I have is, do you think it's more of an inside-game story, where there are just certain factions in the Democratic party that prefer the engineering approach? And so, if the prospect of bipartisanship, a bipartisan approach is off the table, then the engineering people kind of just have more sway within their own party?

Or is it something about broad perceptions about these bills, and the opportunity to go out and demagogue a little bit is less obvious with the subsidies approach? Even though you might think it would be easier if folks in the US had a very pro-market orientation, and opponents of this kind of policy could go out and say, look, this is like a government takeover of the energy sector. Look at this, this seems bad.

MICHAEL Yeah, so there's a lot to unpack there. Let me just make a couple of points. First, I said this before. I want to say it
GREENSTONE: again. The delta that is the difference between the clean energy-- cost of clean energy sources, and the fossils, has shrunk a lot. And so now something is possible with these kinds of policies to achieve meaningful carbon reduction. That was not true, as I said three years, five, or 10 years ago.

The second thing is, I can't fully articulate why this happen. But there is now, my read is, an increasing awareness of that climate change is having impacts today. It's the wildfires, whatever it is. And so I think there's a much greater sense of urgency.

And so I think all of that, both of those things push towards doing something. And then now, you're asking-- in a way that wasn't true a couple of years ago. Now you're asking why did it tilt more towards the technology policies? Or why didn't it tilt towards carbon pricing? I don't know. I think people will be writing books about this for a long time.

I will say, though, that one thing that I was really struck by is the Green New Deal and Greta and it's really galvanized people's interest-- I think, helped galvanize people's interest in climate change in ways that I was surprised by. And they were very successful at that.

And I think they deserve a lot of credit for that. It is also true that that faction of the environmental movement, part of the environmental movement, is, I think, has historically not been very comfortable with markets. And so maybe because they were the ones who got the ball rolling, their ideas took more of the centerpiece. I'm not quite sure.

MIKE Yeah, yeah, that's interesting.

LIVERMORE:

MICHAEL But it's a great question. I think we'll be writing dissertations and books about it for a long time. And I'm not sure
GREENSTONE: there will ever be a definitive answer.

MIKE Yeah. Yeah, and that seems totally right. And maybe we can shift gears a little bit just because we probably
LIVERMORE: aren't going to get this fully settled. It's just it's a fascinating set of questions. But thinking-- kind of shifting gears, maybe.

One of the points that you raised a couple of times is the fact that technology has gotten so much cheaper in the last few years. And that really does change everything. It changes how far our subsidies go. It actually changes how much of a price you would have to put on. It changes the effects of the price, whatever the price you put on. You're going to get more emissions reductions if the substitute technologies are cheaper.

So what are your thoughts on how that came about is it because again, it was an anticipation of a change in policy, or is it just normal technological development, and we all just kind of get the benefit of waiting a few years, and now the technology is in a better place?

MICHAEL Yeah, that is another great question that I don't think we have definitive answers to. I think there are some facts
GREENSTONE: that seem directionally to have contributed to it. Germany and Spain, and some other parts of the EU's focus on building out these technologies, to get them down their cost curves, I think that certainly played a role.

China's massive investment in these technologies and subsidizing them, their development, has surely played a role. I think, importantly, and I was in the Obama administration, but some of the things the Obama administration did to help quicken the pace of understanding about these technologies probably also helped.

I think state renewable portfolio standards, probably, also helped the United States. I think there were a mix of things that caused some, what economists like to think of as, non-appropriable learning, that is I learned something about how to build better windmills, and the Michael Livermore competing company, some of that spills over on them and they benefit from that as well. And so I think there was a lot of that going on. And there were probably a mix of factors that reducing it.

But I think we should stand back in awe of the reduction in solar prices and the reduction in batteries. I think, really, only a tiny minority of people would have predicted, or were predicting them a decade ago. We got lucky.

MIKE It turns out, there's a variety of different environmental experiences that we had in the environmental space,
LIVERMORE: where with some pushing from policy, whether it's a pricing mechanism, or it's a regulatory approach, or it's a subsidies approach, you do get these really important, profound effects, in part because technology just kind of leaps forward in unexpected ways. So, of course, I'm thinking of the sulfur dioxide program in the United States, where we just get these incredible reductions that we're kind of at low-cost, that we're just not anticipated at the time of the 1990 Clean Air Act amendments.

MICHAEL Yep. So I think that's a validation of hanging prices, and letting people sort it out. I want to step back for one
GREENSTONE: second. There are two basic market failures with respect to climate change. The first is just that you get to pollute and largely don't have to pay for it.

And the second is on basic R&D. And I would even say, basic R&D and demonstration, which are really considered part of basic R&D. And that is this idea that there's a whole bunch of learning that has to take place. No company has it in their interest to do it all, because some of it, they'll do less of it in a [INAUDIBLE] because some of it will spill over, as I described a minute ago. And there's just such a strong case for government support of that.

And so, if I were king of the world, I would be shooting tons of money at the wall on all kinds of things that might reduce-- might develop new technologies that are in the early stages, or demonstrate kind of maturing technologies about how we can build them at scale and things like that. And when you turn over those cards, a couple of them are going to-- I think we have a long history-- a couple of them will turn out to be great. Many will turn out crappy, but that's totally fine.

MIKE That's expected in some ways, right?
LIVERMORE:

MICHAEL Yeah.
GREENSTONE:

MIKE LIVERMORE: As we're kind of thinking about the role of economics in this policy debate. One of the things that also kind of struck me in this domain is the importance of economic forecasting here. And actually, the predicting technology kind of relates to this, because that's part of one of the most-- that's probably the most difficult, or it's certainly one of the most difficult pieces of say, predicting what the effects of this bill are going to be.

The Rhodium Group, which you're familiar with, of course, did a lot of very influential, I think, predictions on what the emissions consequences are going to be. And Technology is an inherent or making guesses about technologies as an inherent part of that enterprise. So I wonder two things, I think, are interesting about this. So one is just your thoughts on the role of economic forecasting, and the difficulty of that as it relates to emissions, and so on, in the policy domain.

And its influence, the fact that it seems to be really, really influential even if the tools that economists might recommend, like carbon pricing, are not-- weren't carrying the day. The economic forecasts were certainly used as an input into the policy-making process, a really important input.

MICHAEL GREENSTONE: Yes. I think it's awesome to choose policy when you're not blindfolded. And I think there was a lot of good work done to kind of assess what these policies could produce in terms of carbon reductions. And the Rhodium Group has been at the absolute forefront of providing thoughtful, clear, fair, totally level analysis. And they deserve a lot of credit in my book.

Another area where there's like forecasting going on is probably trying to understand what the impacts of climate change are going to be that can damage us from climate change. And that's I think-- I know that space much better than the economic forecasting of which technologies are going to win. And in that space, I think we are totally at the dawn of a new era. A very, very exciting time.

And I think the intellectual lineage is that Bill Nordhaus, who won the Nobel Prize at Yale, kind of laid out this foundation for how to think about the problem. But he was stuck in a period where there were like crappy computers, and there wasn't a lot of access to data. And so he did like totally reasonable things. like he made-- to put data was available and made some assumptions and extrapolated them. And kind of went with it and laid this foundation for how to think about everything.

Now, you could think of that as laying out a body, and now we're like have all this data and these great big computers, and we can do all kinds of amazing things. And it's like we're taking that body, and we're putting muscles in it and bones, and like turning it into a much more nuanced and rich understanding of what the impacts of climate change will be. And a lot of that work is-- I have to admit, it's like being done by this group that I helped set up with Trevor Houser, and Sol Hsiang, and Bob Kopp called the Climate Impact Lab, where we're really trying to take what was kind of mathematical best guesses, and flesh it out with data and evidence.

MIKE LIVERMORE: Yeah. Well, yeah, let's talk about that next generation of-- maybe, broadly, we can talk about social cost of carbon and climate forecasting. Maybe one thing to kind of get on the table. I think, folks are sometimes unclear about is the difference between, say, what folks associated with the climate impact Center, and even Nordhaus, and more broadly, the way that economists go about the business of doing this modeling, versus what you see at the Intergovernmental Panel on Climate Change, the IPCC models, those types of forecasts.

I see those as being like, really, two fundamentally different enterprises. And maybe you could kind of explain how the work that you does kind of fits into, or differs from, the climate models that, I think, a lot of people who are outside of the, really, the inside game of policy analysis might see these as all being kind of similar to each other. And the IPCC, of course, gets a lot of general attention.

MICHAEL Yeah, so I kind of-- and I've never been on an IPCC panel. I guess, you'd say by choice. But they're very large
GREENSTONE: groups of people, who I don't I don't think they're based-- largely, my understanding is they're not doing original analysis, or kind of trying to summarize a bunch of articles that are out there. And with very large teams and people with very different opinions and kind of really excellent review pieces.

What the climate Impact Lab is trying to do is actually say, you know what? We can do better than what has been done in the past in understanding what the impacts of climate change will be. And kind of build up from scratch, an empirically founded estimates of what climate damages will be. And then with a special focus on the social cost of carbon, which are the damages associated with the release of an additional ton of CO2.

MIKE
LIVERMORE: So one question I have for-- so when you say, from the ground up, this is in a sense the distinctiveness of a lot of this project. Because in, as you were describing the Nordhaus methodology, and a lot of the Premier models, peer-reviewed, very useful, first-generation models, are taking a lot-- are really building the estimate of climate damages from a top-down, right? And so when you talk about building it from the ground up, like what does that mean in practice, if you're not making just a general assumption about a relationship between temperature change and global GDP damages?

MICHAEL
GREENSTONE: Yeah, so what does it mean in practice? First of all, it means spending a couple of years collecting data. And so, it is not the most glamorous part of this, but we spent a couple of years gathering data on electricity and energy consumption. for 95% of the-- it ended up being available for about 95% of the world. Collecting data on mortality from about 60%, data sets that cover about 60% of the world. And doing similar things for agriculture, and all the other sectors. We looked at--

And I think one way to really highlight why it's so important to do that is a finding that comes out of our results is, before we started working on this, the assumption was that the relationship between temperature and human mortality was-- sorry-- the climate change impact on temperature would basically have a zero impact on human mortality. Now why was that? that was effectively saying reductions in very cold days would be almost equally balanced by increases in the number of hot days. And that was the right conclusion from the available data.

It turned out, though, that most of that data came from rich places with temperate climates. Maybe like Chicago or London, or places that are northern European cities. And so like, yeah, getting rid of cold days in Chicago is really good. It's going to cause less death. And it's not a hot enough place that you get to really high temperatures that cause really large increases in mortality.

So when you actually have data from the whole world, it turns out that that relation that kind of balancing that applies in these rich northern places is not true globally. And there are locations in the world that are very poorly positioned for climate change, both because they're poor to begin with, and they're hot to begin with. And there, you're not getting the counterbalancing or the reduction. Cold days you just get an increase in hot days.

And when you add it all up, it turns out we were understating climate change impact on mortality due to temperature change, probably, by a factor of 20. And so I think that is like an illustration of why I kind of think we're at the dawn of a new era. And another thing that's really, really important about it is the way we have largely, up until recently, been talking about climate change is, well, global GDP will change by 2 or 3%, and global temperatures will go up by 2 degrees C on average.

The problem is, nobody lives at the average. And what we're finding is just massive inequality in the impacts of climate change. And what is true is that if a 2% loss in GDP, just to be very extreme, is like, we would feel very differently about a 2% loss of GDP if it was generated by everyone on the planet losing 2%, than if 90% of the people had some massive loss-- or sorry, 10% of the people had some massive loss and 90% of people had no loss. And that's what we're uncovering, is like the losses are very unequally distributed.

MIKE LIVERMORE: Yeah, and so, I think that's a really interesting point right there, is I think there's two things I wanted to touch on, as in this question of next-generation social carbon issues. So one is-- so adaptation, I'm curious how what you think the best approach to dealing with adaptation. Because it raises some of the same difficult questions around forecasting, generally. We were talking about the difficulty of predicting technological change.

Adaptation is something that, at least in principle, could involve a substantial amount of technological change in agriculture, agricultural practices, new varieties of agricultural crops, even, potentially, genetic engineering, here. So yeah, building materials or building practices. There's a lot of potential things that would affect how temperature change actually translates to effects on human well-being.

So I'm curious, is that something that you just have to make the best assumptions you have? Or are there ways to try to validate the predictions that you kind of have in these models? And just, generally, your thoughts on the best way to deal with the question of adaptation in the social cost of carbon.

MICHAEL GREENSTONE: Yeah, so the first thing is, I think you have to have the social cost of carbon, or any estimate of climate damages. Social cost of carbon is just one particular calculation about climate damages. You have to include both the benefits and the costs of adaptation. And the kind of granular local projections that we're able to make in the Climate Impact Lab kind of unlock that.

And so there's a really good example, I think, that comes out of this, which is, you take the cities of Houston and Seattle. They are both very, very rich by global standards. And, obviously, both belong to the United States, and have lots of similarities. Maybe there're some differences in state government but, by and large, a lot of differences are like, they're way more similar than Houston and Mumbai, why don't we say.

And so what we got out of the data is that when a very hot day arrives, like the average temperature, that is the average of the high and the low is maybe 95 or something, in Houston, basically, nobody dies. But when that arrives in Seattle, there's quite elevated rates of mortality. And why is that? that reflects adaptations. Those kinds of days arrive in Houston all the time. Or maybe not all the time, but with some frequency.

And so people in Houston have adapted their lives, adapted their buildings, purchased air conditioning, a whole series of things to protect themselves when those days come. In Seattle, it's not worth it, because those days don't-- currently, don't come very often. And in some sense, they're-- it's a nasty way that economists talk-- choosing to spend their money on something else, which is, when those days arrive, leads to elevated mortality there.

And what we put at the center of our efforts at the Climate Impact Lab is to measure both the benefits, that is the reduction in mortality when a hot day arrives from adaptation, as well as accounting for the costs. And it's absolutely critical. The cost of those adaptation. It's absolutely critical to do that in order to get an accurate estimate of what climate damages will be. So that's one point I want to make.

I just want to make a second point, which I think is related to your question, which is, if you are going to unleash companies, Monsanto, to figure out what seeds are needed, and things like that. It is not OK to just know what's going to happen, either globally or at the country level, in response to climate change. You have to have local estimates. So in the corn counties, what's going to happen to crop yields? And so to get the adaptation we need, we have to have visibility at a much more granular level than has been the case with the climate impacts literature today.

MIKE LIVERMORE: Yes, certainly in terms of informing as an important point, informing adaptations, is that what you're talking about? There's someone out there thinking like, what should I be doing to adapt to climate change? And if all you get is, well, climate change is going to result in a 2% decrease in global GDP, that doesn't really tell you what you're supposed to do in response.

MICHAEL GREENSTONE: It doesn't tell. So to be snarky, like knowing what's going to happen, on average, in the US is not going to help Miami prepare for higher sea levels.

MIKE LIVERMORE: Right. So on that distribution, so there's a couple of points that you're kind of making about distribution. So one is just that one that you made, that the impacts are going to be different in different places. And planning and adapting has to account for those differences. It sounds like you're relatively optimistic.

I mean, one of the points I make is the difficulty of making fine-grain analysis. There's a reason why it's easier to make a prediction about global effects than there is local effects in Miami because, in some sense, you've got the benefit of aggregation. And your errors can point-- as long as they're uncorrelated, you can take advantage of that. And so it's really tricky. But it does sound like are optimistic that we can make sensible predictions, that are at least useful enough for policy-making at a more fine-grain level.

MICHAEL GREENSTONE: Absolutely. I really believe, and I said this at the outset, we're at the dawn of a new era on understanding what the consequences of climate change are going to be. And that has as its foundation the use of data, and accounting for adaptations costs and benefits. And doing this at a very-- I don't want to hesitate but almost hyper-local level.

MIKE LIVERMORE: So then, another feature of distribution, so there's what we're talking about right now, which is just differences, essentially, on the ground. There's also how we should be thinking, generally, about the unfairness of distribution. As you said earlier, if we all take a 2% haircut, that's not that big of a deal. If--

MICHAEL GREENSTONE: To be extreme, if 2% of the people died.

MIKE LIVERMORE: Exactly. Right, take 100%, exactly.

MICHAEL Yeah.

GREENSTONE:

MIKE So how do you think this should inform something like the social cost of carbon or policy? So, obviously, there's a
LIVERMORE: long debate, that you're familiar with, about a practice like equity weighting in the social cost of carbon, where effects on people who are less well-off are counted more because of the diminishing marginal utility of consumption, or just unfairness, in general. We've largely not gone that way in the US, with respect to the social cost of carbon.

I'm curious. Is it something that you think should just be in the background of our deliberations as we think about climate change? And that's that. Or is it something we should incorporate formally into the social cost of carbon through something like equity weighting? Or something in the middle? Yeah, just to take a stand on any of that stuff. But how do you think about those kinds of questions when thinking about distribution and this type of analysis?

MICHAEL Yeah, it's a terrific question. So let's start with first principles. First principles is, it appears to me that the world
GREENSTONE: cares much more about a poor person losing \$1 than Jeff Bezos losing \$1. And that's because \$1 doesn't mean so much to him. The marginal utility of consumption, as you said, is very low for Jeff Bezos than it is for a poor person. And so, if you set aside politics and you said it's like governing, that basic insight should inform how we think about climate damages. And I don't think that's a controversial view.

I think what is more complicated is how you bring that into the federal policymaking apparatus. And if you were to do that, is climate special? Or should you be doing that more broadly? Does it spill over to all kinds of other policies? And those are difficult and thorny questions. And I think political-- those are much more political judgments than what would a benign social planner, not that there is one in the world, but we're there a benign-- what would a benign social planner want to do?

And so they're just-- I think, how you think about it is, it depends very much on which hat do you have on. Like am I Joe Biden, President Joe Biden, who is running the American government? Or am I kind of a social planner for the world?

MIKE And so ultimately, then it sounds like for the economists then, what do you think the role of the economist then is
LIVERMORE: [INAUDIBLE]

MICHAEL Oh, I think the role of the economists is to articulate very clearly what the impacts of climate change look like
GREENSTONE: from these different perspectives. And I think, ultimately, they're going to turn on very complicated and thorny things like values, and do we really care as a society about poor people more-- losses to poor people more than the rich people? I personally do. But it's a democracy and that kind of has to be sorted out through all the messiness of democracy.

I should also add, by the way, if you were to do a full accounting, you got to do it on the other side of the ledger, too. Suppose it was carbon pricing that was unlocking carbon reductions. You would then want to track, very carefully, who was bearing the costs of that carbon pricing, and how you felt about that.

MIKE Right. Good, since we're in the weeds a little bit on the social cost of carbon--
LIVERMORE:

MICHAEL I mean, you've managed to avoid saying the verboten circular A4 which will drive your listenership to zero, so.
GREENSTONE:

MIKE So some credit for that, right? But one alternative that's been getting, at least, a little bit of attention, both, I
LIVERMORE: believe within the Biden administration, but also in the broader debate within the economics and policy community, is this notion that the project that you're describing, actually, that you have a lot of optimism about, is the wrong project, in a sense, when we're talking about valuing greenhouse gas reductions.

And what we should be doing instead? Usually, the term that's used is a marginal abatement cost, kind of analysis, where the idea is, you know what? We enough to know that we need to decarbonize. We've selected these dates and certain goals, that's happened at the state level, that's happened at-- lots of countries have decarbonization goals.

And we really don't need to know too much about the exact details of damages to set policy at this point. Maybe for adaptation purposes, but we've already set our goals of decarbonization by 2050, or 2030, or whatever it happens to be.

And all we need to know is how much is it going to cost so that we can-- on a marginal basis. So that we can decide which policies to pursue. Is it subsidies for that industry, or this industry? Is it energy efficiency? Is it clean energy? Is it this? Is it that? Is it the other thing?

And all we need to do is have, essentially, a projection around what the marginal abatement-- what marginal abatement costs do we need to impose in order to get to our goals? And everything else is kind of besides the point, or useful, but shouldn't be core to how we're implementing policy. So Nicholas Stern and Joe Stiglitz have written something to this effect. Yeah, I'm curious, what your thoughts are on this notion of this kind of alternative to the social cost of carbon?

MICHAEL Yeah, so I think it depends. I was just with Nick Stern last week in London, and it depends what you think the goal
GREENSTONE: is. Is climate change beyond cost-benefit analysis? And that is, is there no amount that we should pay-- that we should be unwilling to pay? Then, I guess, I think that's probably right. Then their view is right, which is that we should just line up the lowest cost options to get to 0 by whatever year.

My own view is that that's not correct. And that climate change is a complicated version of an economic problem. The damages go out a couple of centuries, when you release a ton today. But those don't add conceptual problems, they just add complications and calculation. And so I think knowing what the damages are should give you a sense of how much you're willing to spend.

And if it costs \$5,000 to get rid of a ton of CO₂, and getting rid of a ton of CO₂ only produces \$200 of benefits. I don't think that's such a great idea. And so I basically disagree with the assertion that climate change must be brought to its knees at any cost.

MIKE Right. And there is a flip side to this, of course, which is, we might not have sufficiently ambitious goals. And
LIVERMORE: information about the social cost of carbon can tell us that, because if we're not squeezing out enough carbon on a fast enough timeline, then just looking at marginal abatement costs isn't going to tell us whether that's the case or not.

MICHAEL Yeah, there's another thing that I find a little bizarre about that approach, is like, there's this "we" that is like
GREENSTONE: lurking here. The we sometimes takes the form of-- I'll start parochially. I think sometimes in the United States, we think, well if we could just decarbonize California, then everything would be fine. We can start worrying about the climate change problem.

Now that's not true. Emissions from anywhere in the world have the same impact. And then sometimes there's like a "we," like, well if the United States would just do it, then that would be fine. But in truth, I think we can-- it's a mistake to, even for one second, take our eyes off the ball that is global emissions that matter.

And there, I want to come back to the fundamentals. What are the fundamentals? The fundamentals are the delta, and the delta is a difference between the costs of low-carbon technologies, and the fossils. And we need that delta to shrink, not just in California, or not just in the United States or the IRA, but we need to make it so that the countries that are really going to be the big drivers of increases in emissions in the coming decades, it's in their own interest as well to reduce their carbon emissions.

And so there's this kind of implicit-- I don't know. Is Nick Stern and Joe Stiglitz, are they like in charge of global emissions? No, nobody is in charge of global emissions. And each country is going to decide it on their own, what's good for them. And ultimately, a lot of that's going to turn on what that delta looks like.

MIKE Yeah, and maybe just the last question with respect to that, and I'm not sure if you have thoughts on this. But it
LIVERMORE: does seem like we're in a weird place with respect to global negotiations on climate change. I mean. There is the Paris Accord and follow-ups to that. But there's not really a clear-- there was a clear picture of what the goal was in terms of international treaty caps that would be allocated in some way. And now it's a very unclear pathway forward.

So I'm just curious if you had any broad thoughts on, ideally, what would we be shooting for in terms of, is it just kind of hope that everybody coordinates in some general way? Or do you have other thoughts on what we might hope for in terms of global cooperation on this issue going forward? Because, as you know, it is fundamentally, and will always be, a global problem in its nature.

MICHAEL Yeah, so I'm not a religious person, but I do find the serenity prayer to be super insightful on many things, I think,
GREENSTONE: even on climate policy, which is, the essence of it is, grant me the wisdom to know the difference between the thing I can control and things I can't. And I think that's where our focus should be.

So where our focus should be is driving down that delta, that. again, just repeating myself, the difference between the cost of the low-carbon energy sources and the fossils, to as small or even negative as humanly possible. And we should be putting our policy through that test. Is this helpful for that?

And then the second thing is, I think we should be looking for opportunities to leverage our policies for reductions elsewhere in the world. Because those reductions elsewhere in the world are going to provide benefits for Americans. And, of course, other people as well.

MIKE All right, great. Well, thanks so much for taking the time to chat with me, Michael. It's been a broad-ranging
LIVERMORE: conversation. And super, super interesting.

MICHAEL Thank you for the opportunity. Always fun to talk.

GREENSTONE:

[MUSIC PLAYING]