Richard Muller: Skeptical Climate Science

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Greg Dalton: This is Climate One, I'm Greg Dalton. Today we'll look in to the complex and contentious realm of climate science. The effective gases that trap the sun's heat on the earth's atmosphere were discovered in 1824 by Joseph Fourier, then investigated and validated by scientists over the next hundred years. In the 1950s, United States military conducted tests to understand how the greenhouse gas effect impacted missile navigation systems. In recent decades, climate science has become a highly visible and politicized field of inquiry. The vast majority of climate scientists who published peer reviewed articles agreed that the rising temperatures are disrupting the earth's life support system and burning fossil fuels is a major cause. But science trades improbabilities rather than absolute certainties, and there's a lot that scientists don't know. For the next hour, we'll talk about scientific understanding of the earth's disruptive climate with our live audience here at the Commonwealth Club in San Francisco. Our featured guest is Richard Muller, professor of Physics at UC Berkeley, and founder of a research effort called Berkeley Earth Surface Temperature or BEST. He's the recipient of a MacArthur genius prize and author of the new book "Energy for Future Presidents: The Science Behind the Headlines". Please welcome Richard Muller to Climate One.

[Applause]

Richard Muller: Thank you.

Greg Dalton: Richard Muller, welcome. Thanks for coming.

Richard Muller: Delighted to be here.

Greg Dalton: So, you did your PhD in particle physics. Tell us how you kind of got from there into earth sciences and into the climate realm.

Richard Muller: I think I have somewhat of a reputation working on one disaster after another. I started in particle physics but I quickly moved into astrophysics. I started out several cosmology projects, one, to measure the cosmic microwave background, and another, to look at supernovas for the expansion of the universe. I was fascinated though and intrigued by what Luis and Walter Alvarez were doing on what killed the dinosaurs, and I did some work on that. After that work, I began working on other natural disasters, things that had big effects on the earth, volcanic eruptions, climate change. What's going on with the ice ages? Were they caused by impacts? What was the story there? So I wound up spending 10 years of my life doing research on the cycles of the ice ages. Now, I would go and give talks on this at various scientific meetings. Invariably, all the questions at the end came on global warming, that the people were interested in climate, that was their concern.

Greg Dalton: What time frame was this?

Richard Muller: I guess I finished my work around 2001. And that -- because of that, I was really -- felt I had to do research on -- in global warming. I began reading the papers. I didn't get seriously involved in it until just three years ago.

Greg Dalton: But in 2004, you wrote critically about the famous hockey stick, the idea that the

temperatures are rising exponentially. For people who saw “An Inconvenient Truth”, that’s when Al Gore gets on the cherry picker and goes up. And there’s an article by Michael Mann, a professor back East. Tell us about your concern about the hockey stick ‘cause that was quite of a [crosstalk].

Richard Muller: Well, when I wrote my book in year 2000, I wrote a technical book on the ice ages. Plot number one, I put in Michael Mann’s plot of a hockey stick.

And then before -- when I was doing the proofs, I looked over to my book and I said, “I need to put it. I don’t want anything in this book that I won’t believe in 10 years. Let me look hard at this.” And I looked at his original papers and realized, now these aren’t convincing. I wound up pulling that plot and then putting in a plot of my own where I had used my own data to show that temperatures were rising. When the Climategate scandal broke, I was horrified to learn how these plots had been manipulated and changed with the goal of convincing the public that the conclusions they had drawn should be clear and incontrovertible.

Greg Dalton: But the hockey stick, you had some issues with the shapes of the handle or some statistical methods for defining the contours of the stick. But isn’t it true that there are 12 studies subsequently concluded that the warmest decade in a thousand years was probably at the end of the 20th century, that the hockey stick has been validated by the National Research Council [crosstalk]--

Richard Muller: No, no, no. I was on that National Research Council panel; I was a referee for their paper. I agree with everything they said, but they didn’t validate it. What they were referring to there, the hockey -- what they said about the Michael Mann hockey stick was that he could not go back more than 300 years because the error bars were so large. Now, we already knew back 300 years that the temperature had gone up like that, there was nothing new there. The -- what was compelling about what he had done was that he had argued that the signal went back a thousand years, that was shown invalid by the National Academy study, and that it was evident in a wide range of world data. In fact, what had been discovered was that the hockey stick that Michael Mann did was derived almost entirely from a few tree ring data sets that were from North America.

So, basically, the end of the National Academy study, although it was kind on Mr. Mann, it said that none of the new things that he had come up with in his papers in 1998, 1999, none of them proved out to be correct.

Greg Dalton: But Roger Pielke, who’s a critic of the IPCC and a professor in Colorado, said that the National Research Council was, quote, “a near-complete vindication of Michael Mann”, so it sounds like--

Richard Muller: I think he misread the report. I think some people have characterized it that way and it certainly wasn’t. I think if you read the report, you’ll see that although the report is very polite to Mr. Mann, it does not -- nothing that he came out with, none of the key conclusions that he drew in his 1998, 1999 work really held up once the National Academy reviewed it.

Greg Dalton: But is it true that other reports have validated the basic premise which is that warming is increasing?

Richard Muller: Oh, that wasn’t the premise of the Mann work, that wasn’t what the National Academy was about. The National Academy said nothing about global warming. I know that because I was the referee. The Mann work, based on what are called proxies -- a proxy is an indirect measure of temperature. What made that so striking was that it showed that the current era is unusual over the past thousand years, and it turned out not to be true. What we do believe is that we have had warming. My own work substantiates that we have had warming over the past 50, 100,

150 years. That's not new and that's not what the National Academy report was about.

Greg Dalton: Is it true that the warmest decade in a thousand years was probably at the end of the 20th century?

Richard Muller: No. No scientist -- the National Academy said -- would say the following. Now, the report was done a few years ago, but they would say that the recent decade was the warmest it's been on record for the past 300 years.

Greg Dalton: Okay. So, 300, not a thousand, okay. So, the warmest decade--

Richard Muller: But that was known back in 1980.

Greg Dalton: Okay, so--

Richard Muller: So, that was still warmer. Even in 1980, it was still warmer than it had been for 300 years, nothing new there.

Greg Dalton: In 2000 -- then you moved on the Berkeley Earth Surface Temperature project. There's three main groups around the world that collect earth surface temperatures in different ways, using different methodologies, different measurements and stations, and you decided to test or validate that. Why did you think that was necessary?

Richard Muller: Well, the temperature measurements are made by thousands of people all around the world using different criteria and different kinds of thermometers. These data are then gathered together, primarily by the NOAA group, although--

Greg Dalton: The National Oceanic and Atmospheric Administration?

Richard Muller: Yeah, yeah. And that's their job. They collected raw data which is virtually unusable, then they analyzed it, and much of their data is then used also by the NASA group, and there's some independent work done in the UK. What -- but in the process of doing this analysis on the data, all three groups were doing a lot of adjustments to the data. And the data have to be adjusted. We see records in which it's clear the temperature jumps from zero degrees all the way up to 32 in one hour. Well, no, someone just started to switch from Celsius to Fahrenheit. So you have to go look at the data and make those adjustments.

But there were problems with this. There were undocumented station location changes. There were -- only a small fraction of the data were being used. Of the stations that were available -- of the nearly 40,000 stations that are available, the group, the NOAA group was using only 8,000 of them. The group in the UK was only using 2,000. There were issues of how they were selecting these. If they were selecting them because they had long records, which was the method that they said they were using, then there's a danger that records with long records were once rural. If they are 200 years old, they almost certainly were once rural. But now they may be deeply buried inside of the city and there's the urban heat island effect. So there are all of these questions, and when I read the papers, I could not find adequate answers to these questions that bothered me. I wanted to know whether global warming was real and whether it's caused by humans. And I could not convince myself when I carefully scrutinized the data.

Greg Dalton: That was a couple years ago. Last fall, you came out and said you have scrutinized the data. And what was the conclusion?

Richard Muller: That the global warming of the past 50 years was very close to what the prior

groups had claimed it was.

Greg Dalton: So they were right?

Richard Muller: On this issue they were right. That's right. And I -- my reaction was that the issues that they did not answer, that they didn't answer in their papers and that they didn't answer publicly were issues that they had put a great deal of careful scientific thought into. And they were able to answer it to the standards necessary. Now, there's a difference between being able to come to a conclusion and being able to convince every skeptic that you've come to that conclusion. The details of this get so complex, that their failing was not in the work they had done. Their failing, I felt at the end, was in their ability to address openly all of the issues that had been addressed in such way that an unbiased outside observer coming in would be compelled to accept their conclusions.

Greg Dalton: Which is you're talking about a communication issue and scientists are often not--

Richard Muller: That's right.

Greg Dalton: --the best communicators, they agree with what they don't know rather than what [crosstalk].

Richard Muller: So they were right.

Greg Dalton: There's a whole set of issue there.

Richard Muller: On the measurement of the temperature change, they were right.

Greg Dalton: And what was the reaction to your report? You previously were known as a climate skeptic or a denier, and there were some pretty strong words for you. Among some people, you were called a media whore; some people thought you were, you know, a convert. So what was the reaction?

Richard Muller: Well, actually, if these had all happened 15 years ago, you wouldn't have such quotes. These days we have the internet--

Greg Dalton: Thank God for blogs.

Richard Muller: And anybody can use the strongest language that they want and put it on. And then even if they retracted, it's there.

Greg Dalton: Yeah, that was -- so--

Richard Muller: So, yeah, a lot of people misunderstood. They -- people still today confuse media reports of what, let's say, I have done with what I have done. And it's like this famous painting, "This is Not a Pipe", it's a painting of a pipe. So people would respond to what people had said I had said, not to what our group, our Berkeley Surface Temperature group had actually said. To try to avoid this, we -- our goal was not just to test the conclusions of the prior groups, but to do it in a far more transparent and open way. So even though they had not yet been accepted for publication, we put them online -- Jim Hanson [crosstalk]--

Greg Dalton: And you were criticized for putting out non-peer-reviewed literature by people saying, "Hey, this is--

Richard Muller: Despite the fact that that's the longest tradition in science. People have done this; we used to call them preprints. And it was -- traditionally I was raised in by Nobel laureate, Luis Alvarez. You send your papers out and you get peer review--

Greg Dalton: Right.

Richard Muller: --before you even submit them to the journal.

And this was what I learned was peer review. And now, some people have decided, no, that's not peer review. Now, it's only the journals who decide what's peer review.

Greg Dalton: And what was the response of some of the funders? The funders of this include Charles Koch with the Koch Industries, Bill Gates, Ann and Gordon Getty. How did they respond to the results?

Richard Muller: I haven't had anything other than expressions of pleasure that we were able to do what we proposed to do.

Greg Dalton: And so you validated the basic measurement of the earth's surface temperature is warming.

Richard Muller: That's right. That's right.

Greg Dalton: That's right.

Richard Muller: And we were able to measure with greater accuracy. We were able to address what we felt in an open and clear way the objections that had prevented me from reaching this conclusion in the past. This included the fact that we were able to use all the stations. I have a -- my -- person we hired to do much of the math and computing named Robert Rohde, who is one of the few geniuses I've ever met in my life. And he did a superb job on the statistical analysis on the data -- data work. And we were able to show that the station -- we were able to use all the stations which previous groups couldn't do. We were able to directly look at -- because we could use all the stations, we could pick a subset of the stations that were all rural, none of them in cities. And we could get the global temperature solely from the rural stations. This is the most direct way to address the urban heat island effect. We got the same answer. We can do this because we're using all the stations.

Greg Dalton: So the science is sound -- you've written about -- there's skeptics, which all scientists should be skeptics, and there's closed-minded deniers. So, talk about the difference then. Did you convince anyone -- did your work convince anyone who's like, "Uh, okay, well, if this guy says it, it must be true."

Richard Muller: Well, it's hard to know, but there are deniers on both sides. I mean, they are -- I call the deniers the people who pay no attention to the science.

They don't care -- they start with the assumption that there's a great conspiracy, and that whatever's happening in the climate is good.

Greg Dalton: If Al Gore says it, it's got to be wrong.

Richard Muller: That's right. Now, on the other side, there are the exaggerators who are just as bad as the deniers.

Greg Dalton: The doomsdayers of the world is going to end and – right. Okay.

Richard Muller: Yeah, that includes Al Gore. And so he's on the other extreme, he doesn't pay any attention to the science on one side, and the deniers don't pay it on the -- in the middle. There are -- and even close to the middle, there are the skeptics who've done a really wonderful job of pointing out the flaws in the science. They are what I call the warmists. The warmists are people who have – actually, many of them have done really good work, but have convinced themselves that this is now a really dangerous thing and they become political activists. But there are -- I see the symmetric, I see that there are equally -- equal denier -- in my book, I refer to Al Gore as a skeptic. I should have called him a denier because he doesn't even accept what the IPCC says. He thinks it's wrong, it's too cautious. He goes way beyond. If you watch his movie "An Inconvenient Truth", you'll discover he has many, many things in that that are not in the IPCC report, but you wouldn't know that by watching the movie.

Greg Dalton: Our guest at Climate One today is Richard Muller, professor of Physics at UC Berkeley. So, on the IPCC, the Intergovernmental Panel on Climate Change which won the Nobel Peace Prize a few years ago, many people say that that's a consensus driven organization, that every sentence in their synthesis reports are reviewed by committees. And if a number of people disagree with a sentence, they form a committee and they go outside and they hammer it out. It's a tedious, laborious process. So, everything that gets into those reports has gone through by many scientists from around the world which leads to naturally kind of consensus--

Richard Muller: Yeah, I wish that were true.

Greg Dalton: No comment on that--

Richard Muller: I wish that were true.

I mean, we take the outstanding case of the melting of the Himalayas, which was in their 2007 report.

Greg Dalton: A non-peer-reviewed work that got in there that--

Richard Muller: Well, it was an--

Greg Dalton: Advocacy organization?

Richard Muller: The fact is that the reviewer for the IPCC stated that this cannot be put in the report because it is not based on scientific study; moreover, it's certainly wrong. This is what the referee for the IPCC report said.

Greg Dalton: So that's one piece of data--

Richard Muller: But wait a minute. I'm not finished.

Greg Dalton: --a one flaw in -- that's one typo in Moby Dick.

Richard Muller: Well, wait a second, wait a second. I was addressing the process. The author of that section overrode the referee. Now, if you have a report in which referees are only advisory, it's not really a refereed report.

Greg Dalton: And has the IPCC acknowledged they messed up on this one?

Richard Muller: Yes.

Greg Dalton: That's one of the celebrated cases of -- they--

Richard Muller: Now, you say that this is just one little fact, that's been their response too. The trouble is that one little fact was absolutely key. This was the thing that made the newspaper headlines. This is the thing that got the public attention.

Greg Dalton: But in most cases, does the IPCC go through and sentence by sentence, word by word, people--

Richard Muller: No, not at all. Not at all.

Greg Dalton: --go through that. Because I've talked to people who are -- have you been part of the IPCC?

Richard Muller: I'm just from the outside. But I've talked to many people who've been on the IPCC.

Greg Dalton: And so have I, and it's -- it sounds torturous and painful.

Richard Muller: It is torturous and painful but it's not science. And they don't claim it science. If they want to know, for example, what confidence level to put on a certain claim, now a scientist would do this through a calculation, through mathematics, and he'll be able to show it to you. They did it by vote. How many people are in favor of a 90% confidence level, how many people want 95, how many people want 67? So they voted on it. This isn't science and they don't claim it's science. It's not meant to be science, it's meant to be policy and with -- affected by science.

Greg Dalton: So there's a -- the IPCC doesn't do original science, they synthesize the literature--

Richard Muller: That's not what I said.

Greg Dalton: That's part of it, and they do policy recommendations, and that's what you're talking about.

Richard Muller: When you said they don't do original science, you threw in a word that was unnecessary. They don't do science and they don't claim they do.

Greg Dalton: They aggregate science and [crosstalk]--

Richard Muller: They read science and they try to reach conclusions based on this but they don't consist of scientists. Most of their sections are written by a group of policy and specialists. People don't sign off on the entire report, not the scientists, they can't. They haven't -- they can't verify most of what's in that report, this is a policy report affected by science, and it doesn't follow the standards of peer review. It's a great thing that they do.

Greg Dalton: But there are many scientists who participate in the IPCC.

Richard Muller: Oh, yeah.

Greg Dalton: Not all of them are.

Richard Muller: Yeah.

Greg Dalton: But many--

Richard Muller: They participate.

Greg Dalton: And – okay. So, the general consensus is you agree that the earth is warming.

Richard Muller: Earth is warming.

Greg Dalton: How big a risk is this to civilization as we--

Richard Muller: Now, you're outside of my area of expertise, but I will talk about it anyway, once I had that -- once I say I'm no longer speaking as a scientist now but as a concerned human. I think it's a big risk, a big danger. I think -- let's assume for the moment that the IPCC conclusion is right, that most of the warming is caused by humans. Then, we're -- if that's the case, then the increase in carbon dioxide that we project for the future will cause several degrees of global warming which will be unprecedented, it will be warmer. Right now, I don't think it's the warmest it's ever been in a thousand years. My own guess is that a thousand years ago was equally warm, but we will surpass that.

Greg Dalton: But you acknowledge it's the warmest it's been in 300 years?

Richard Muller: Oh, yeah, yeah, yeah.

Greg Dalton: Okay.

Richard Muller: But we -- some issue of it is at the end of natural causes, there are lots of fluctuations that takes place. Let's assume for the sake of discussion that it's caused by humans.

In that case, it will keep on going up. I think that's plausible just from a theoretical point of view, carbon dioxide is a greenhouse gas, I have no doubts about it being a greenhouse gas. How much it affects the climate depends on some feedback mechanisms about which I do have some doubts. But let's assume it's going to go up. If it does go up, if the carbon -- carbon dioxide will go up unless we do something really drastic. And it's not we, we can't do it on our own, we have to get China involved. If China continues to add one new gigawatt of coal every week as they have been doing now for the last decade, if they continue doing that, whatever we do in the United States is irrelevant. The greenhouse gases will go up, and under our assumption, we will have several -- we will have an unprecedented degree of global warming. We haven't had it yet. We've only had two-thirds of one degree Celsius of global warming, that's according to the IPCC, two-thirds of one degree.

Greg Dalton: And is there a delay of fact that is that what we put up there today stays up there a very long time and will continue to warm the atmosphere, so that there -- so, you know, it's like a tanker--

Richard Muller: Yeah.

Greg Dalton: --it takes a long time to slow or to--

Richard Muller: Yeah, there's so much misinformation on that subject that it'll be a whole another discussion. Like in the carbon dioxide, there are statements from scientists who should know better saying it stays up there for hundreds of years. The fact is if you dump carbon dioxide into the atmosphere, half of it disappears in the first year, and the rest will probably get mixed out over the next 20 to 25 years.

Greg Dalton: So you're saying we could reduce it quickly and sharply--

Richard Muller: We could reduce it.

Greg Dalton: Okay.

Richard Muller: But we can't, not you and me, it has to be China.

Greg Dalton: So most of the future emissions will be in the developing world.

Richard Muller: That's right.

Greg Dalton: Most of the current emissions are red, white and blue.

Richard Muller: No. No.

Greg Dalton: Because the historic emissions, Britain and the United States have contributed most of the historic emissions--

Richard Muller: But you're assuming that those emissions have stayed up there for so long. Yeah, let me just accept that for the -- just for the sake of argument. Let's say that best testament is one quarter to one-fifth of the warming is due to the United States so far. Of that, the warming, according to the IPCC, is .6 degree Celsius. So let's say, .15 degree Celsius is due to the US. So one-eighth -- one-sixth of one degree Celsius is due to US. Yes, US has done that. Of the three or four or five as -- well, it's -- I'm switching between Celsius.

Greg Dalton: Yeah, stick in Fahrenheit because that's what Americans understand.

Richard Muller: Oh, okay. Well, of what Dianne Feinstein said in that clip, virtually all of that is going to come from the developing world. So you can compare that to the fraction of a degree that we have already done, and say we are to blame, we are guilty for two-tenths of a degree -- well .15 Celsius.

Greg Dalton: So what to do about future missions from developing economies who say, "Look, we're not going to pay for the sins of your grandfathers. We have an equal right to economic developments. Why should we pay more than you did. You grew dirty, so why should we pay more to grow clean?"

Richard Muller: The fact that we happen to be so much more populist than you means we will put a lot more in. By the way, by 2025, at the current rate of growth, China will be emitting more emissions per person than the US.

Greg Dalton: Right now there are -- in your book you have their measure as a percentage of GDP is this much higher, but per person in the US is still much higher than Europe and some--

Richard Muller: So higher -- it's much -- but you have to recognize, we are a small country, and we can take unilateral action but it won't solve the problem.

Greg Dalton: But does that mean we shouldn't do anything?

Richard Muller: Of course not. We want to do something that means -- makes a difference, not something that's meaningless. What really bothers me is there are so many meaningless things out there. People say let's get all electric automobiles.

The US is responsible for .15 degree Celsius. Of that, US automobiles are responsible for one quarter of that which is .05 degree -- .04. So, US automobiles have contributed almost nothing to global warming, and they will contribute almost nothing in the future. And if we think the thing for us to do is to make electric automobiles -- well, electric automobiles in China produce more carbon dioxide than gasoline automobiles in China because they are based on coal.

Greg Dalton: Right. The Economist did a story on that recently--

Richard Muller: Yeah, and I was delighted at that.

Greg Dalton: So -- but the transportation sector is accounting for 30, 40% of greenhouse gases in the United States. There's trucks, there's a lot of things, so--

Richard Muller: I know, but you keep on mentioning United States. United States is not the problem.

Greg Dalton: Is there a point in leadership?

Richard Muller: Yes, and we have to show -- we have to show leadership, we have to take actions that will be meaningful in China. Building Tesla automobiles is not a leadership step. They will never be adopted in China. China is a poor country; they cannot afford $100,000 automobiles.

Greg Dalton: Well, they got one that's coming out now that's 50 and sexy and beautiful but--

Richard Muller: They can't afford that either. And it is not sexy and beautiful when you realize--

Greg Dalton: The first time I saw a Maybach, $100,000 Mercedes was in Beijing. So there's a lot of money in China, lot of our money in China right now.

Richard Muller: Well, there's -- there are wealthy people in China, that's true. But this is not addressing the issue of the danger of global warming.

Greg Dalton: So, point taken about scale. New things need to happen at scale, so you believe that switching China from coal to natural gas will be--

Richard Muller: It's the only thing. The only thing on the horizon that has any realistic chance of making a big difference is to get them to switch their economy from one new gigawatt of coal every week, 50 gigawatts a year. I mean, it makes their solar program miniscule. The actual solar delivered power that they're adding every year is a tenth of a gigawatt.

And they're adding one -- they're adding 50 gigawatts of coal, that's the big thing. And if you think somehow, solar is going to catch up, well, it's so--

Greg Dalton: So let's get to coal, but solar -- China has done a tremendous -- created a public good by driving down the price of photovoltaic solar, makes it much more affordable for people for -- maybe it's not for climate change but it's because they want cheaper or more reliable electricity in California or elsewhere. They've had a tremendous market impact by driving down the price of a PV solar. Now, there's a trade spat going on between the US and China right now, but they can have tremendous impact, that's not a bad thing.

Richard Muller: Well, not completely bad. They say -- US says they're subsidizing theirs, they say we're subsidizing ours.

Greg Dalton: Right.

Richard Muller: I don't expect that solar photovoltaic will really be centrally important in the United States for the following reasons. I think the cost of the solar cells is getting so low and will soon be even lower that they'll be basically free.

Greg Dalton: And -- well, now they're price competitive with traditional electricity.

Richard Muller: Well, actually they're not, not yet.

Greg Dalton: Getting close?

Richard Muller: No, no. You're confusing again the peak power with the average power they deliver. So you can -- yes, you can install a new gas burning plant or a dollar for watt. Yes, you can install a solar cell for 75 cents a watt. But that's peak watt. And that delivers it only in midday, when the sun is out and overhead. In fact, you lose typically a fact -- in China, they're finding about a loss of 90% of that.

Greg Dalton: Because they got so much air pollution. So, solar, you don't see as a--

Richard Muller: Actually, air pollution, of course, is due to the coal.

Greg Dalton: Right, yeah.

Richard Muller: And that's not the problem. The problem is the sun isn't out during the night and it's often cloudy.

Greg Dalton: So you're not a big fan of solar even though the price has come down?

Richard Muller: Oh, no, no, no, no. I am a big fan of solar. I think solar has a great future particularly in China.

Because part of the expense of solar is going to be the installation cost, it's a lot cheaper to do that there, the maintenance cost. I mean, they can brush off the dust at a much lower cost than we have. And there are also large areas that you can build the solar and you don't require the infrastructure to get it there. So I think solar is going to have a big impact in China. I think it will have niche market in the United States. I think it'll be very important in the United States. It's just not going to really solve the global warming problem.

Greg Dalton: Well, nothing -- no single thing is going to solve the global warming problem. There has to be some--

Richard Muller: No, but there are big things and there are little things.

Greg Dalton: Right. And there's big -- there's Silver Buckshot, No Silver Bullets, and there's these different size wedges which people at Princeton and other places has written about, so--

Richard Muller: The wedges thing, I think, is misleading because it seems to imply that anything you do will be a big help. I regard that as misleading because it says, "Hey, what I'm going to do is I'm going to buy a Tesla Roadster and I'm doing my part." The wedges thing, I think, can be misinterpreted by the public. It's saying, "Let's just do our part." In fact, what we need is a big program that can really address the big issue or it's just not going to happen. It's not going to add up.

Greg Dalton: So, what you seem to be saying is individual action doesn't matter, it requires policy.

Richard Muller: Yes, exactly. Unless that individual action sets an example. But the examples that we're setting with electric automobiles are -- and overly expensive and nonworking solar arrays like Solyndra, those examples don't set an example that will be useful for stopping global warming.

Greg Dalton: So I have an electric car, I'm paying much less now for power that I use to--

Richard Muller: But you don't. Let me correct you on that--

Greg Dalton: People love to come up and say, "Ooh, no gas, that's cool."

Richard Muller: Yeah. When you include in the cost of the battery replacements, the expense per mile--

Greg Dalton: I'm not planning on owning it until the battery needs to be replaced.

Richard Muller: Are you going to sell it as used car?

Greg Dalton: Yeah.

Richard Muller: Well, you're not going to get much money for it because the battery will need to be replaced.

Electric cars -- I go to the numbers in my book here. A typical automobile in the United States cost 10 cents per mile to drive, mostly gasoline. The electric cars, the Volt -- the Chevrolet Volt, the Nissan Leaf, they cost between 50 cents and 70 cents per mile to drive when you include the fact that the batteries are only good for 500 recharges. So you're not saving money. You may be doing something good for the environment. Assuming you're not charging it from coal, you're doing something good for the environment, but you're probably burning it in California, most of it is natural gas.

Greg Dalton: Yeah. I don't think it's fair to include the cost of a replace battery that will be borne by a subsequent owner of that car, but let's--

Richard Muller: Oh, I would let every one of our listeners decide that on their own. I mean, your battery, after 500 recharges, will have to be replaced, that's typically after 30,000 miles.

Greg Dalton: Five hundred recharges, that could be 500 days.

Richard Muller: That's -- it could be -- yeah, it's like a refill. It's 500 refills, that's a -- and then you have to replace it. To think that this is way off in the future, you're going to keep your car for how long? I mean, I keep my car for 10, 15 years, you will need several battery replacements during that period, and that will drive up the cost. These batteries, these are lithium ion batteries. Replace your battery in your computer and it will cost you a $100 per pound. The Tesla Roadster has a half ton, a thousand pounds of these things in it.

Greg Dalton: The little guy's got --

Richard Muller: Well, yeah, on a discount, of course. So--

Greg Dalton: No, they're not -- let's come back and we'll drive my car around and see how much it costs.

Richard Muller: When you replace the battery.

Greg Dalton: The – okay. I might ask you for a loan. Then, you said that we need big policy. So, what big policy do you think will be needed to actually address the big policy?

Richard Muller: I think the only hope is to kick-start the conversion in China and the rest of the developing world, India, into natural gas.

They have enormous reserves, they can be exploited, we have enormous knowhow. I've talked at length with one of our great oil and gas experts in the United States, Marlan Downey, and he and I are working together. What we would like to see is to share freely with China -- I talked about this in China when I was there just a few weeks ago -- freely share our knowhow on the new gas technologies with China, so they can begin the conversion at a rapid rate from coal to natural gas. Whether or not you believe in global warming, this is worth doing, because China, as you pointed out, is choking from the soot and the sulfur dioxides and the other pollutions from coal. It -- just for humanitarian reasons alone, they should switch. We should help them switch to natural gas, but I think this is the most important thing we can do. And I think it's so much larger than anything else I've heard suggested that I'm hoping it has some chance of going ahead.

Greg Dalton: And natural gas is quite cheap right now at least in the United States. It's much more expensive in Asia and other places. So you're talking about exporting hydraulic fracturing technology that's happening along the Marcellus Shale in Pennsylvania, elsewhere in New York to China, so they can get these unconventional deposits of natural gas and get off coal.

Richard Muller: Exactly right.

Greg Dalton: And the policy or the market mechanisms that would enable that are--

Richard Muller: I think we need the President of the United States to talk to our industry and say, "This is in our national best interest. What we would like you to do is to invite -- we will invite a hundred Chinese engineers, their best oil and gas engineers to come to the United States to work with you. I want you to hold no secrets back. We have to show them how do to this and get them -- when they go back, they'll be able to jumpstart their industry in natural gas." But the problem isn't the patents; we don't have special patents on this.

I've discussed this at some length with the experts. The problem is what do you do when you're drilling and suddenly something doesn't work? And we had that worked out. We've worked it out over the last 30 years.

Greg Dalton: But surely lots of US energy companies would love to get into that business in China. They don't need the President to say that there's a market there that--

Richard Muller: China won't allow that. China does not want US companies to come in and own the fields of China. So there's -- I mean, they regard that as a new form of technological colonialism. And I can understand that point of view.

Greg Dalton: Let's talk about oil. We haven't talked a lot about oil. In your previous book, "Physics for Future Presidents", you wrote on page 91 about the end of oil, and I'd like to read you a quote from Fatih Birol, who's the chief economist of the International Energy Agency, one of the world's foremost authorities on energy. And he says, quote, "One day we will run out of oil. It is not today or tomorrow, but one day, we will run out of oil and we will have to leave oil before oil leaves us. And we have to prepare ourselves for that today. The earlier we start, the better." Do you disagree or agree with that?

Richard Muller: No. I agree. I mean, the issue now, what its timeline is. My current feeling in the new book -- "Physics for Future Presidents" was written four years ago. This book, I've learned a lot about the new things that can happen to oil. Back then I talked about converting coal to oil, which is a well known technology. If we do that, we're not going to run out of oil for several hundred years.

Greg Dalton: And then there's shale oil, which is in the process for doing that--

Richard Muller: And then there's shale oil which is relatively recent, still not a big deal. It's the most -- for people -- there are people who simply oppose fossil fuels because they're fossil fuels and because they invariably will -- they don't believe in clean coal, they don't believe that we can stop emitting carbon dioxide. But in my mind, I draw a distinction between power generation and locomotion.

Greg Dalton: Transportation.

Richard Muller: In the United States -- we have a crisis in the United States of oil, of gasoline, not of coal, we have plenty of coal, we have -- and that can be addressed by manufacturing coal -- rather manufacturing gasoline out of coal. But there's this new-

Greg Dalton: So that's how we're going to get our oils by making coal into oil?

Richard Muller: That's what I thought four years ago. Now, what's happening is that several companies have developed remarkably good methods for extracting oil from shale. And this is a revolution that is currently taking place.

Greg Dalton: In Canada and elsewhere and--

Richard Muller: No, no. That's the -- the Canadian work are the oil sands, sometimes called tar sands. But in the United States, these are in shale rock, and they're in the same kind of formations in which we have the gas. And the techniques that are used are similar to the tracking technology that we use for gas. But Shell, for example, has developed a remarkable way of heating the shale oil under the ground, leaving it there for three years, in which case the long complex carbon chains break up and become short ones. They turn from heavy oil to sweet oil underground, and then they can extract those out. So this is a rapidly breaking technology now.

Greg Dalton: So, you see that as the future domestic sources rather than Saudi Arabian or Venezuelan oil with different kinds of American oil, that's the kind of oil that we ought to be using.

Richard Muller: Our oil imports have actually dropped for the first time and--

Greg Dalton: Domestic production is up.

Richard Muller: Domestic production is up partly -- most of it is not due to this new technology; most of it is simply due to what's called enhanced oil recovery. But I think we -- the Hubbert's peak, this peak in oil is something that we may get beyond by using advanced oil extraction methods.

Greg Dalton: But you agree that we need to get away from foreign oil, that seems to be what you're saying.

Richard Muller: Oh, I'm not opposed to using foreign oil. I'd much rather use foreign oil and keep our own reserves for as long as possible. The problem is that half of our balance of payments deficit is coming from importing oil. And that's something -- it's better this week because the price of

foreign oil has dropped. If we start a large production of our own oil, then the price of the world oil will go down at that point and we'd say "Import as much as possible."

Greg Dalton: Our guest today at Climate One is Richard Muller, a professor of Physics at UC Berkeley. I'm Greg Dalton. You also wrote in your previous book that the average automobile at that point got about 25 miles per gallon. The US Senate proposed a bill in 2007 that require automakers to sell cars with an average fuel consumption of 35 miles per gallon by 2020. Seems like a reasonable approach but it's the kind of -- to take if you feel there's no crisis, we feel it were more -- if we felt that were more important, we could soon be doing much better. Well, that in fact happened, now there's 56 miles. Do you think that's enough, the 56 miles?

Richard Muller: No, no. We should go up – well, I would like to go up to 100. I think we can get 100 miles per gallon.

Greg Dalton: So, that was done by President Obama. How do you think he's done on energy efficiency? That was one of the signature achievements--

Richard Muller: Oh, yeah, one of the best things he's done has been on energy efficiency. I think energy efficiency is just not mentioned enough. I think energy conservation got a bad name because--

Greg Dalton: Of Jimmy Carter's sweater.

Richard Muller: -- because of Jimmy Carter saying, "Hey, let me invade your home and have you turn down the thermostat in winter." He never should have done that. It was really unfortunate -- he gave energy efficiency -- he should have said, "Hey, let me subsidize some insulation in your walls, then you could turn your thermostat up wherever you want." That would have been really smart. Energy efficiency is one of the big things that doesn't get enough attention. And I think in the future, it's the only thing that is order of magnitude the same size as switching China from coal to natural gas.

It could have that big of an effect.

Greg Dalton: Our guest is Richard Muller, professor of Physics at UC Berkeley. We're going to go put a microphone up here and invite your participation -- invite your participation with one-on-one part question or comment, and I'll be here to help you if you need some help with that one-on-one part and brief. And while we're getting that set up, I'm going to ask one more question about the insurance industry. Here's a quote from an executive of the insurance industry. He says, "From our industry perspective, the foot prints of climate change are around us and the trend of increasing damage to property and threat to lives is clear." That's Franklin Nutter, President of the Reinsurance Industry Association of America in March of this year. So, insurance industry is seeing more damages--

Richard Muller: Now, he says that. I would be interested in knowing what their scientific analysis of that really is. I learned years ago, when I had automobile insurance that -- back when I was -- when I was just young, that automobile insurance companies didn't pay up. It was hard, you had a dent on your car and they don't want to pay. Then they learned something--

Greg Dalton: Shocking. Yeah.

Richard Muller: They learned something. They discovered – now, they'll pay up real fast because then their rates can go up. And now, they're all, "We'll pay you right away." But you wind up paying much, much higher rates than we used to. So, insurance companies are in the business of

wanting people to insure things that are in danger. If you say he doesn't have a conflict of interest in trying to encourage people to get insurance, then maybe I would take his statement more at face value.

Greg Dalton: So you're saying climate change is good for the insurance industry--

Richard Muller: Of course.

Greg Dalton: --because they get to create new products--

Richard Muller: No, no, no, no. No, no.

Greg Dalton: --and raise rates?

Richard Muller: Not that the climate change is good but that the perception of climate change is good. You get people to insure against climate change and then they make more money.

That's certainly true, whether or not -- if the climate actually does change, they'll make more money anyway because they have more things to insure. And if it doesn't change, they make a whole lot more money.

Greg Dalton: Let's go to our -- let's have our audience questions. Yes, sir.

Male Speaker 1: Yeah, I just had a quick question about the electric car thing. We had a program here a couple of weeks ago, and they were talking about how it's not really -- we don't know yet enough how long batteries are going to last because electric cars haven't really been around that long. So I'm just wondering if, you know, you're not taking into account the fact that technology is advancing for batteries and maybe that will be surpassed, gas will be surpassed by that.

Richard Muller: In fact, the optimism for electric cars depends completely on having batteries that will recharge 5,000 times instead of 500 times. Even investors in the Tesla Motors are doing that on the basis of this kind of optimism. So as a result, I looked into that with some care. We have a battery research group at the Lawrence Berkeley Laboratory who study this. And the problem with batteries is simply that the hard thing is to get them to recharge many, many times. There are batteries that can be recharged many times. The sodium -- ion sodium or the sulfur batteries can go up to 5,000 times. These were in static environments at high temperatures. Automobile was really tough. So I've talked to battery experts, and the progress has been very slow. Five years ago, there's a battery called the A123 battery that was claiming it could be recharged many, many, many times. It's now on the market. Now it's being limited by five to 700 times. It hasn't improved over that time. The trouble is when you're recharging a battery, what you're doing is moving molecules back and forth across the electrolyte, and they have to go back to the same place or a similar place where they were.

They start growing little dendrites, and that eventually shorts out the battery, and that's been a really difficult problem. So what they do is they put in -- they use nanotechnology to try to prevent those dendrites from growing. It's really difficult. And my guess, based on the experts in the field that I've talked to, is that this is not going to happen in the next 10 years. We all saw a rapid battery development with our personal computers. In fact, there wasn't that much rapid battery development. What happened was that once we had personal computers and cell phones for the first time, people are willing to spend $100 for a pound of battery. And so technologies that existed that were well known to the battery industry suddenly became commercially viable. But there really aren't any new chemistries available; they're all listed in the battery handbook. What are needed are ways to be able to recharge them many, many, more times. That's not an exponentially growing

technology. That tends to be linear. It's not a Moore's Law.

Greg Dalton: Let's have our next question for Richard Muller.

Male Speaker 2: Professor Muller, I wonder if you could help me, as a ordinary citizen not a scientist, sort of understand how we get to the concept of global warming. I was a pilot, and I studied meteorology a little bit, and it just appears that there is -- there are so many data points. For example, if you, you know, attribute the atmosphere of 10 miles, most of the atmosphere, the water surface which is the largest part of the earth, and the land mass, and think of the whole thing, there are so many data points that it's hard for me to imagine that, in fact, we can measure very many of them. And so we must be making assumptions about what we cannot measure. And so, can you tell me how then we can ultimately conclude, and also over a relatively brief period of time, like you say 50 years--

Richard Muller: Yeah.

Male Speaker 2: --that is a very short period of time and climate. For weather, that's a big period of time, but for climate, it's a small period of time. And so, how do we actually reach those conclusions and what assumptions could we make?

Richard Muller: What makes it so difficult; one of the things we have in our papers is a plot of the United States. And of these, we took all the stations that have had temperature measurements extending over 70 years. If you look at this plot, we marked the ones that have warmed, two-thirds of the stations have warmed over 70 years, one-third of them have cooled. People are shocked at this because they say, "Hey, global warming, you just got to walk outside and you see global warming." No, no, no, no. No human can sense global warming. Global warming is so much variation from year to year, from month to month, from hour to hour that it's impossible to sense it. But just as scientists can measure the number of molecules in a pint of water, if you get enough data -- and we love data, when there's lots of data, you do lots and lots of averages -- then we can actually get down to an accuracy of a tenth of degree Celsius. And we have done this by doing lots of averages. You take advantage of the fact stations that are several miles apart aren't that different on average. They go up and down and storms go by, but you really have to take all that into account and do an average. And only when you do that average can you see it. Nobody can sense global warming. Nobody in this room has sensed it. And if you know someone who has, they are fooling themselves. The global warming we're seeing is two-thirds of one degree Celsius, and the average between day and night may be 20 degree Celsius or 10. You can't see things like that. And California, the local climate of California is -- the hurricanes, they're determined by El Niño, and by the Gulf Stream, not by global warming. So you -- the trick is to be able to measure thousands of points, see how correlated they are with each other, just count that correlation where it's inappropriate and do the mathematics of it.

But it's actually the fact that we have so much data that enables us to see this relatively small change. I can't adequately answer that question in under four hours.

Greg Dalton: And the global warming suggests that it's all one direction, and that it's gradual, whereas other people use the term climate disruption or climate change because some places warm, some places cool, pattern changes not all in one direction.

Richard Muller: Well, even the global warming, only if you average it over 10 years, is it moving in the same direction. Even then, there was a period in the 1940s and '50s when it was going down. So what we see is a pattern that's going up like this and then goes down a little bit and then it goes up. And even if we assume global warming is smooth, there's still the ups and downs which may be

related to variability in the ocean currents.

Greg Dalton: Right. So, just like the stock market goes up and down everyday but it's the monthly or the long term pattern--

Richard Muller: That's a good comparison.

Greg Dalton: --that matters. Let's have our next audience question for Richard Muller.

Sarah: Hi. My name is Sarah. I'm actually an intern here at Climate One. And my question is, so, you say policy is the answer to global warming, but what do you suggest the average person do to alleviate, is there anything we can do or--

Richard Muller: Raise the issue of global warming as a more important criterion for who you vote for. Let that be -- let that -- in the end, no, you can't do anything. I'm sorry, you can't. I mean, I own a Prius, and I get up before my class, and they applaud me for owning a Prius. And I groan, they don't understand, I own a Prius because I love the technology, but I can't do anything. What I can do for global warming is come to groups like this and try to talk about it. I can go to Washington DC and talk about it. I can help clarify the issues so that if there had been valid questions raised about global warming such as urban heat islands, if I can go and talk to people who are bothered by that and say, "I believe we've answered this. Let me show you how."

Science is that one realm of knowledge that we can agree on. Things -- there are lots of realms of knowledge. There's literature, there's history. There's always going to be disagreement on those things, but science is -- can almost be defined as that realm of knowledge over which everybody can agree. So let's agree on the science, but we don't do that by consensus, we don't do this by vote; we do this by addressing the issues raised by other people. And when you address those issues, I find myself remarkably capable of convincing skeptics that global warming is real. Then they say, "Well, okay, I've always accepted that. The question is how much is caused by humans." And you asked me earlier, how many people we convinced. I can't -- and anybody who says, Well, we always accepted global warming. The question is how much is human," as, you know, a success in my part.

Greg Dalton: And there -- that's movement but it's not movement fast enough. I mean, that could have been said 20, 30 years ago. In fact--

Richard Muller: My approach in the meantime -- I've written with Marlan Downey, an op-ed piece was submitted to a major newspaper, we hope that it'll get -- on this fracking issue. And our argument is I don't care whether you believe in global warming or not. What we need to introduce and kick start fracking in China. If you believe in global warming, then this is obviously a good thing to do. You have -- going to have overcome your reluctance to approve fracking and fossil fuels, but that's what we have to do as the only real solution. If you don't believe in global warming, then it's worth doing for humanitarian piece -- reasons alone because there are 50,000 people dying every year in China just from the pollution. And so we can address that. It's a good thing to do whether you believe in global warming or not.

Greg Dalton: Let's have our next audience question for Richard Muller.

Male Speaker 3: How urgent do you feel the climate change problem is? And do you feel there's time for us to respond adequately?

Richard Muller: Working on the assumption that the IPCC is right, that the global warming that we verified--

We're now doing work to study how much of this is due to humans, but we don't have a conclusion we're prepared to announce yet. Let's assume that the IPCC is right, that most of the warming is due to humans, then I regard it as an urgent problem. On the other hand--

Greg Dalton: And something we can do -- do something about.

Richard Muller: And something we could do something about.

Greg Dalton: If we're causing it, we can correct it.

Richard Muller: But I think it hurts the problem if we rush and do the wrong things. If you say there's a fire, and it's urgent -- the old story of the fire in the movie theater, it's urgent, you do something about the fire, so shout out top -- at the top of your lungs, "Fire! Fire!" It's the wrong thing to do. We need to do something that really will work. And so I think it's urgent but we have to do the right thing. I think the two big ones are -- the biggest of all is the global, is the natural gas in China, and the second biggest one is energy efficiency and conservation.

Greg Dalton: Richard Muller is a professor of Physics at UC Berkeley. I'm Greg Dalton. Let's have our next question. Welcome.

Ann Devero: Hi. My name is Ann Devero, and I'm a new member here at the Commonwealth Club. You've mentioned nuclear gas, but what about -- I mean, you mentioned natural gas, what about the nuclear issue in China? They're building hundreds of nuclear plants. Does that have an impact or will it have an impact?

Richard Muller: The impact that they're having on climate change will be substantial but it's not enough. Now, let me just say a few things about nuclear because there's so much misinformation. And in Fukushima, a little over a year ago, there was a horrendous event in which a earthquake created tsunami that killed 15,000 people. There was also a nuclear reactor that was damaged and had leaked a lot of radioactivity, not enough to cause anywhere near the damage of the tsunami.

Best estimate, I put the numbers in and I do the calculations, is that it's almost certainly fewer than a hundred excess cancers caused by the radiation leak. Nonetheless, Japan is overreacting. They are shutting down -- they have shut down most of their nuclear power. Nuclear power should be an important part of our energy future and the energy future of the world. And it's unfortunate that Japan is leading the world in overreacting when the real danger to the future of Japan is not from nuclear reactors, it's from tsunamis. And if they're going to build 30-foot walls around their entire country including the Tokyo Harbor, I have yet to hear about that, but that's 15,000 people. Let's not forget that. I think if you kill 100 people from an accident that kills 15,000, let's worry about that accident. In fact, I think the nuclear reactors at Fukushima did amazingly well given their -- how horrendous the bigger event was.

Greg Dalton: And there are now known design flaws that they had. Let's have our next question. Yes, sir.

Scott Westbrook: Hi. My name is Scott Westbrook. And what I recall from the graphs I've seen for the carbon dioxide plots, every year it goes up and up, but it also goes down, especially when the -- summer in the Northern Hemisphere. It makes me wonder if we should be paying more attention to deforestation in the third world, how much impact that is having, and if we were doing more to solve that problem, what we actually have is much of a climate change issue.

Richard Muller: Okay. Well, deforestation, particularly in Brazil, has been a major contributor to the carbon dioxide in the atmosphere. And I, too -- it's been a major contributor. I'm not -- I don't

know off the top of my mind recall how much it is, but probably more than 10% and less than 20%.

I mean, the good news and the bad news is we're going to run out of Brazil. The warming we see in the future is going to come from the burning of fossil fuels. I believe in preserving Brazil more importantly for preserving Brazil. I've been there, it's a wonderful country, it's a wonderful rainforest, and it's something we need to preserve. Other people argue we need the diversity of life that you find in Brazil. But in the long term, it's not going to have a big impact on global warming. The worst that can happen from global warming is to burn all of Brazil. And then, global warming will take off after that from the burning of the fossil fuels. I don't mean to sound cynical about that, but it's not a happy story.

Greg Dalton: Yes, sir. Welcome.

Male Speaker 4: Hi there. This is a pretty simple question. I know natural gas is cleaner than oil, but how much cleaner is it than oil?

Richard Muller: Cleaner than oil by about a factor of two, a bigger factor than that compared to coal. The reason is simply that coal is carbon, you burn a carbon, you get a CO2. Natural gas is CH4. You burn that, you get a carbon, but you also get -- the H is burning, to make water. Water is completely innocuous as far as human caused global warming is concerned. And so, you wind up getting, I believe the number is two and a half times more energy for carbon from natural gas than you do from coal.

Greg Dalton: Let's ask you about -- you talked earlier about political leaders and using people as leverage to get at political leaders. In this political season, politicians from both parties rarely mention climate change. And, in fact, particularly in the Republican Party, people who previously acknowledged the science now have backed away from it.

I'd like -- interested in your comment on that.

Richard Muller: Well, I predicted this back when I first saw "An Inconvenient Truth". I predicted that people would discover that most of what is in that movie is either misleading or wrong. And when they discovered that, people are deeply offended and they overreact. The fact is climate change is a serious problem, but they were oversold with distortions and exaggerations.

Greg Dalton: So it's Al Gore's fault?

Richard Muller: Not just Al Gore, but certainly he played a big role on that. I've had people come up to me after meetings like this and say, "What do you mean the polar bears aren't dying due to global warming?" I said, "Well, the studies have been done. We tag the polar bears, we watch them from satellites. None have died from the retracting of ice." And this woman said to me, "But that's the reason I got involved in global warming." I feel one has to trust the public, one should never exaggerate. When I say that we've verified the global warming as real, and I'm really concerned about it, but hurricanes had been decreasing in number and intensity, that the tornados have actually been going down. I can show you the data on that. It doesn't mean that's not a problem.

Greg Dalton: But you're saying -- the Republican Party and Democrats, to some extent too, will no longer talk about climate change as a real problem. You're saying that that's Al Gore's fault, that they're overreacting to Al Gore. Al Gore's fault--

Richard Muller: No, they're not overreacting. The public has overreacted and it's become a subject on which they no longer trust anybody. And as a result, the politicians don't want to take stance on that. The Democrats have a problem because in the past they have said, "Well, look at

Hurricane Katrina." Now, you can demonstrate -- the scientists will demonstrate Hurricane Katrina was not due to global warming. They talk about the tornadoes and the increase in hurricanes--

Greg Dalton: And any specific event cannot be attributed, right, to a--

Richard Muller: The things -- the specific events that grab the public imagination are the ones that cannot be attributed to global warming.

That's the problem. If we had simply said, "The temperature is going up," people might have said, "Ho-hum." But the other events, those are not attributable to global warming, and they can't be defended.

Greg Dalton: Do we have another -- we have time for one more audience question, if you want to – if they want to--

Gary Malesi: The young lady got up here -- Gary Malesi. The young lady got up here and asked about what can the individual do. I think it's the activity of the individual that's creating the problem. People are adopting the western lifestyle. And I see as the only way you're going to correct it is through individual activity, not through government, which is contrary to what your belief system. I'd like you to comment on that.

Greg Dalton: Governments haven't done much so far.

Richard Muller: Well, I think the idea of setting an example and having very low energy consumption, what I keep in mind is what can I do that would do that, that would impact the source of the future global warming in the developing world. And becoming a vegetarian wouldn't work because they're already vegetarians in much of the world and it doesn't affect the carbon dioxide. So what can I do? I could give up the automobile in hopes that somehow I will set an example in the United States and nobody will use automobile, won't use electricity, they won't use air conditioning. These are the things that we -- if this is the intention, you can set an example and maybe people will follow it. But I think in China, what we're seeing in China is an increase in liberty, an increase in freedom of speech, just not like it is here, but it certainly has increased. We're seeing more improved health. We're seeing better education. All this is happening and they all associate that with the use of energy.

And to convince them that that doesn't depend on energy, I think, is – well, you're right, I don't agree with it, I don't believe it. You can set that as an individual example, but it's hard to convince the world by setting in -- by not using energy yourself. It's hard to convince the world that therefore an up and coming civilization like China doesn't need to use energy.

Greg Dalton: Well, they could use energy in a more efficient and wise--

Richard Muller: Well, that we have to do.

Greg Dalton: --than we have. To not develop the way that we did, to develop--

Richard Muller: You mean, that we used to use it. Right now, we're pretty efficient and would love to have them be as efficient -- energy efficient as we are now. We are far more energy efficient than they are.

Greg Dalton: Then we -- well--

Richard Muller: So we're setting an example on that.

Greg Dalton: And in some ways China is leading us. They have some leading technologies and energy--

Richard Muller: Oh, yeah, they have technologies, but I say as a country, we are far ahead of them. Matter of fact, we have two or three in energy efficiency right now.

Greg Dalton: Let's it end there. Our thanks to Richard Muller, professor of Physics at UC Berkeley and founder of the Berkeley Earth Surface Temperature project. I'm Greg Dalton. Thanks for listening to Climate One. The full podcast of this and other programs is available in the iTunes store.

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