

**MICHAEL CROW:** Well good morning, everyone. Why don't we go ahead and get the event started? My name is Michael Crow. I'm the President of Arizona State University. And together with the New America Foundation, we're sponsoring this discussion today, which we hope will be one somewhat differentiated from typical discussions where one talks about theories as to why we can't advance American energy independence. Today, our discussion's going to focus, hopefully to the extent that we can, on the revolutionary steps necessary to achieve that as a goal, to achieve that as an objective.

Last week, some of you might have read the article in the *New York Times* with the fantastic graphic about the move and counter move scenarios of an Israeli attack on the Iranians and what might happen, and what would happen, and so forth. And I remember reading all the way down at the bottom, it said, "And at the end, somehow the Straits of Hormuz would be once again politically or militarily compromised." And I thought back to 1974 when I was in a class in college and they were telling us the same thing. And I thought that somehow I hadn't actually grown up or aged, and I was living in an era where people had forgotten how to read and no longer had any conceptualization of the political complexity of our energy stream.

And so I thought today what we would do is just go to our panelists, I'll call on them one at a time. They can very quickly introduce themselves and sort of attack this question of how do we actually achieve energy independence? And I'll start with Sunil Paul, who has some fantastic ideas that are out there. Sunil?

**SUNIL PAUL:** Sure, thank you. So I am the founder of an organization called Gigaton Throwdown, a project to encourage scale thinking. I'm also, sort of my day job, is as founding partner at Spring Ventures, a venture capital firm that invests just in clean technologies.

I actually think the most important thing, there are lots of new ideas out there, new technologies, being able to convert algae directly into fuels or into bio crude, new technologies for allowing electrification of our transportation fleet, that are breakthrough, new ideas. But what is necessary, almost as much as those technologies, is a realization of what it means to be secure, energy secure. And I think a useful analogy is one put out by Anne Korin and popularized by James Woolsey, in a coauthored article, using algae of salt. Salt used to be a strategic commodity. Wars were fought over it. Ever since the invention of agriculture, salt was fundamental to energy, energy of human beings because it was the only way to preserve food.

The reason why today salt is not a strategic commodity, we don't care who has the power over salt trade, we don't fight wars over it, is not because a substitute for salt was found, it's not because we mine more salt in the United States. It's because we discovered an alternative to that energy preservation. Salt was used to preserve food. We now have lots of other ways to preserve food, most importantly refrigeration. So, that alternative of managing energy is the kinds of innovations we need to be thinking about. What's an alternative way to deal with oil for transportation? Because that is what we fundamentally need.

Lots of interesting innovations out there. These two companies that I'm involved in, Solazyme, a company that's converting sugar directly to various kinds of oil that can be using, including for transportation, using algae without having to build large scale pools of algae ponds. Another company called ZeaChem that's got the highest conversion ratio of woody biomass, trees, into products like ethanol. So it's just two small examples. There are many others like them, LS9 and Ameris, and many that Arun has supported as well. And I'm sure he's going to talk about even more radical ideas.

But without this kind of thinking, there is a possibility and that we can scale these technologies up to the scale that's necessary. Not necessarily to completely eliminate the use of oil, but to give us alternatives so that it no longer becomes that strategic commodity that it is today.

**CROW:** So Sunil, to sort of pin it down, you're using the salt analogy. We absolutely have to have more alternatives to break this focus on these single, simplistic ways of viewing our systems. And so we need to, in a sense, embrace complexity, which is something that is difficult to do sometimes?

**PAUL:** Yeah, that's right. Right now, when you produce electricity, there are a number of different ways of doing it; coal, natural gas, hydro electric, nuclear, et cetera. When you want to move a car, you want to move a truck, you want to move a tank, you want to move an airplane, there's only one way to do it, get stuff out of the ground.

**CROW:** Okay. Gary, I'm going to turn to you next and your focus on, particularly with your experience having run BP Asia the last more than a decade. Sort of what's going on globally and what that all means for us and how there are solutions, our revolutionary ideas that come at sort of changing the angle of our perspective?

**GARY DIRKS:** Thank you, Michael. My name is Gary Dirks. I'm the Director of LightWorks at Arizona State University. And as Michael said, I spent the last 14 years in Asia as President of BP China and President of BP Asia Pacific. I'd like to take a step back, then, and look at this from a global perspective and build on some of the things that Sunil has already said. And I'd like to start with a quote that I find very compelling that actually came out of the International Energy Agency's World Energy Outlook in 2008. And this quote says, "The world's energy system is at a crossroads. Current global trends in energy supply and consumption are patently unsustainable; environmentally, economically, or socially." This is from an agency whose role is to look at the world's energy perspective and comment on where it's going, and in particular, the security of the system.

You might ask yourself, why would a group like this say something so provocative? And I think the way to understand it is to begin by looking at, well what does the forecast actually say? They've updated this, the 2009 when it came out recently, and in that forecast primary energy demand growth grows by about 1 ½ percent per year globally. The implication of that is that by 2030, we'll have to have a 40 percent increase over today's energy provision in order to meet that new demand.

The bulk of that demand is going to come in developing Asia and in the Middle East. The International Energy Agency projects that it'll cost \$26 trillion in order to meet that scale, about 50 percent of that for power, and more than 50 percent of that in the developing world. So what are the implications of that? Well, the implications are that we are going to see a revolutionary shift in the demand pattern away from the developed world towards the developing world, requiring on the order of a trillion dollars a year of annual investment in economies where you have to ask yourself, where is that money going to come from, and how is it going to be mobilized to produce not just the supply of energy, but the ability to distribute it and get it to places where it's actually needed. This is a mammoth task and I think it creates, as I said earlier, a revolution in its own right.

I'd like, then, to just leave that point for a moment and step back and say just a few words about the current energy system. And I would have to say you probably would say, "Well, he would be saying this, wouldn't he," having spent 34 years in the energy industry. But it is a marvel of human achievement, the energy supply system that we have today. It's literally evolved over periods of hundreds of years, technologically sophisticated. It represents enormous amounts of support by public institutions and intervention by public institutions. And a massive amount of public and private investment. It really does what it's supposed to do.

But equally, if not more important, it has co-evolved with the system for consumption. So they form an ecosystem, production and consumption, that has been designed for the purpose of reducing cost, maximizing reliability, maximizing availability, maximizing the overall convenience of energy. I'd remind

the people that service stations didn't just come in this planet on corners convenient for people to use them. Having electricity in our homes is something we take for granted.

Now, why is this important in the context of a revolution? Well, it's important because this system is sophisticated, it's competitive, it's adaptive and it resists change. It really, really resists change. And it has the capacity to resist change because the costs are so low. Now, there is something about it that creates vulnerability, and this is a global vulnerability, and that is it can only be adaptive to those things that it can sense and that it can price. And arguably, neither energy security, at least not over long wavelengths, nor the climate challenge can be priced. But if you look at the forecast from the International Energy Agency, you see that we have a long wavelength fundamental shift in the demand pattern that will inherently create security issues. Oil, for example, has to go from 85 million barrels a day, roughly today, to over 100 during this time period. And without intervention, the forecast takes carbon in the atmosphere to over a thousand parts per million.

So this is the big challenge, and this is what the revolution has to be about. How do we deal with a shift in demand, this extraordinary demand, in the context of a system that is deeply resistant to change?

**CROW:** So what I hear you saying, at least partly, Gary, is two things. First, the scale is the revolutionary opportunity from an economic and economic development perspective. And scale, at the same time, is the barrier because it's driven price down so far because of the wave of innovations over such a long period of time. So we've got scale both for us and against in this. And so, Skip, I'm going to turn to you. A lot of people say the way to reduce our dependence on anything is to just use less of this stuff and to be Spartans in a technological view. So Skip, can you talk to us about energy efficiency and scaling and some of the things that you worry about?

**JOHN A. "SKIP" LAITNER:** Yeah, there's a conundrum, it's exactly right.

**CROW:** Skip Laitner.

**LAITNER:** Skip Laitner, I'm the Director of Economic and Social Policy for the American Council for an Energy Efficient Economy. And we do focus on that critical link between continued energy productivity and a robust economy. And we're finding that scale is the critical issue. But the conundrum is we have inexpensive energy, relatively speaking. Since 1970, our economy has worked to a great extent, and we've been able to bring down the amount of energy we've used per dollar of economic activity by over half. That's been a phenomenal accomplishment. In other words, since 1970 to today, energy efficiency has provided about three-fourths of all new energy-related demands for goods and services new supply, only about 25 percent. But we still have essentially a supply side focus, although productivity has been the sleeper, it's been the invisible resource and we have to somehow bring that forward.

And it is that incredible productivity gain that has enabled the cost to decline. And that's been an underpinning of our economy. And the suggestion of evidence coming forward now, unless we achieve a scale, unless we move to about double the historical rate of efficiency improvement, our economy may not be as robust as in the past because it has allowed other economic activities to move forward.

And in fact, it's a story of— I might take a moment— four devices. I've got here four different things that tell the story. They all look alike, they're about the same weight. They're all made of roughly the same material. This is a Travel Lodge toothbrush. Not very exciting, it's useful in a moment. This is a flash drive, about a 500 megabyte flash drive. I've been using it for a while. Fairly big, fairly fat for its size. This is a four gigabyte flash drive, and the smallest of these is a 16 gigabyte flash drive. If we continue the current path, we may be tapping into the 500 megabyte conventional perspective with efficiency. If we continue with an accelerated path, like Jim and others, and Sunil, are going to be talking about, we may

be thinking about a four gigabyte pattern. But the semiconductor, the electronics, the new materials and new designs, could get us to a 16 gigabyte path called energy productivity should we choose to develop that resource. And that's a critical issue. Taking a step back, identifying that larger opportunity, understanding the science, understanding the materials, understanding the new designs.

And let me close with this thought. That the President has announced offshore drilling as a possible way forward. And there may be, in fact, a critical link. But I'm thinking that that might get us about 20 billion barrels of oil. Efficiency by 2035 could get us 60 billion barrels of oil, with apologies to Jim, I'm thinking barrels of oil instead of kilowatt hours. But the only way that can come forward is if we make an active choice, and choose to develop that resource and not think of efficiency as a 1980s technology we think of as compact fluorescence, or maybe some insulation. But we think critically about new materials, new design, and a choice that has to be made.

**CROW:** So one of the things I hear you saying is something I think people in the United States haven't really fully grasped yet, which is that innovation can't be an episodic thing, it has to be a perpetual thing, always moving forward, always driving in a certain direction to enhance these efficiencies and so forth. And how do we drive innovations when we have huge systems that are so efficient that innovations within the system produce only marginal returns versus transformation returns?

**LAITNER:** Exactly. I recall Kenneth Bolding, an American economist, perhaps because he was married to a sociologist, he said images of the future are critical to choice oriented behavior. And I want to pick your notion there. It's going to have to be purposeful effort in a consistent way that drives these kinds of changes. And all of what we're talking about needs to be underpinned by a huge understanding of the role of energy productivity writ large.

**CROW:** Lisa, we live in a world where both market forces and policy forces combine to create for us the environment in which we advance technology. Our energy system is a complex array of public policies and market forces that shape and guide some of those market outcomes. One of the areas people talk about is policy revolution, talk about policy.

**LISA MARGONELLI:** Okay. I'm Lisa Margonelli. I'm the Director of the Energy Policy Initiative at the New America Foundation. I come to policy as a reporter. I spent four years hanging out along the oil supply chain and watching how the sort of micro economies of oil work together.

I think one of the things that sticks in my mind when I think about the task that we have in front of us is that the McKinsey Global Institute estimated that over the next 40 years, we essentially need to have the productivity growth of the industrial revolution, which means that we need to have the industrial revolution in triple time. That is a huge whoosh of activity, an enormous opportunity and, of course, an enormous upset, the equivalent of the previous industrial revolution.

And I think the real question is how do we get to the power stick that Skip talked about? How do we make sure that we're on that path? One of the things that's really a problem in the U.S. at the moment is that the issue of greenhouse gases has become a competitiveness issue. Right now in the U.S.— which may seem strange. If you talk about it here, it seems like it's a huge political issue. A lot of people will say, "Well, we don't know if it's really happening." There's a lot of confusion in the U.S.

The problem is that in Asia and in Europe, policies are already in place to basically take advantage of this massive remodeling of the global energy system. And when you look at Europe's standards for autos, you have to wonder how on earth are U.S. auto companies going to compete 15 years down the road? And when you look at South Korea's initiatives on the smart grid, or Europe has the super smart grid, and the U.S. is sort of vainly trying to pull together \$11 billion worth of funding from the stimulus bill towards a smart grid. We're trying to get all the utilities going in the same direction. We've got 50

different public utilities commissions in 50 different states, and each one has a different relationship with their different utilities. We're trying to get everybody kind of facing in the same direction.

And South Korea has this kind of schematic drawn out of how much money they're going to save, how much carbon they're going to save, how they're going to recycle those dollars into their economy and how they're going to create 50,000 jobs a year building appliances for the smart grid.

And what you see is that in the U.S., because we have to discuss greenhouse gases in this very politicized way, we can't see that we're missing this huge competitive opportunity to get out and get a jump and be in the same place as the rest of the world. And that, frankly, I find scary.

And we need to start. I think it's kind of a dirty word in the U.S., but we need to start thinking about having an industrial policy and we need to start thinking about having an energy policy that's a lot more systemic where policymakers are willing to take some hard looks at the overall system and say, "These are some problems we want solved and we need to create markets to solve those problems."

**CROW:** So two things. I really hear you talking about clock speed, that our decision making apparatus in government, even in markets, is perhaps insufficiently rapid enough to engage with the scale and the speed with which change has to occur. And then you were hinting at, and I hope the panel discusses later, you talked about the South Koreans and other government. I think many people are looking at the way our democracy from its agrarian, distributed pre-1800 model competes against other types of more modern democracies, or other types of differentiated nation states that have the ability to make decisions in different ways. And so I hope we can come back and talk some about that, because I think that's a factor here also.

**MARGONELLI:** I think there's a slight generational change as well, which most of us in this room are, frankly, rather old, myself included. [laughter] I mean, half of our work lives, or more, are over. And that 40 years, anybody graduating from college right now, that 40 years is their entire life, their entire working life and it's quite different. They have a very different perspective on this than we do.

**CROW:** Well, one of the things we've noticed at the university with all of our students is that they are increasingly different from previous groups. The millennial generation, in particular, has a different view, a different clock speed, different ways of synthesizing information. They want to study across more subjects at the same time, a different focus on duty, a different focus on environmental outcomes, and so forth. So there is some chance that once we're all gone, things will be fine. [laughter]

**LAITNER:** April Fools.

**CROW:** And so the only hope, Arun, the Secretary of Energy and the President bring you out from California where you were one of the leaders of the Lawrence Berkeley National Laboratory to run this new thing called Advanced Research Projects Agency - Energy. At the end of the day, is it all about what brains we have and what we can do?

**ARUN MAJUMDAR:** Yes, but more. [laughter] So yeah, my name is Arun Majumdar. I'm the Director of ARPA-E. As Michael said, I was at the Lawrence Berkeley Lab and UC Berkeley as a professor. But I started my professional career at ASU as a 26 year old young assistant professor. So thank you. And I still have a lot of friends out there.

Let me just make a few points. I'm going to make five points, and quickly. Number one, I believe we are living in a moment in history which I believe is a sputnik-like moment. And it's a wake up call.

There are three issues. One is energy security, the second is environment. And you could split environment in many different ways, but it's greenhouse gases are just pollution, it is just environment. And the third is technological lead. And if you look around the world, there are some tectonic shifts



going on. I mean, we talk about India and China. India, China per capita energy use will increase, and their population is also increasing. And so they have really a double whammy. And we are seeing the tectonic shifts of shifting towards the clean energy, they're really motivated to do that. I believe that's a business opportunity and for us to change our carbon profile or how we use our energy, getting more efficient, et cetera, is also a business opportunity.

So, that's the reality today. If you ask the question, if you are to capitalize on these tectonic shifts, both hopefully in our nation and in the other nations around the world, it's a global issue, the pace and scale of innovation that we need is something that we need to understand that. The way I like to put it is that if you look at the last hundred years of innovation, whether it's going from artificial fertilizers to airplanes to nuclear energy, all the way down to internet, all is innovation. Imagine that happening in the next 20 years. That's the scale and pace that we need. Because the next 20 years really has to be the most inventive time of our history if we are to take the technological lead and really capitalize and be part of this tectonic shift that's going on.

So what are the strengths we have in the United States? We still have the best R&D infrastructure in the world, whether it's universities, whether it is national labs, the small industry, the large industrial labs. This is the best in the world, no matter what people say. People are going short on the United States. This is the higher education system, is the best in the world. That's why people— that's why I came here.

So that's our strength. The innovation ecosystem or business and entrepreneurship is really the best in the world. We are the envy of the world. People are trying to emulate it. It still quite can't get it right because there are many factors which builds this ecosystem.

And the third one, I believe, is the idea that, as was pointed out, the kids in our colleges are knocking on our door, breaking down our door saying, "We want to work in energy." And it is a different generation. "Tell us what to do, where to go and how to do it." And they're going to figure out how to do that. And so our goal in ARPA-E is to be the catalyst, is to unleash the technological innovation in the United States. It's to harness these strengths and unleash that.

And we try to do that, and our goal is to look for disruptive technologies. It's not the business as usual, incrementally. Because I think we are in this moment of history that I think we need to do the incremental part, but we also need to look ahead. Just to give you an example, we invent the lithium ion batteries. We have one percent of the manufacturing of lithium ion batteries in the world, one percent. And so if we keep working on today's lithium ion batteries, guess what? We are sort of feeding someone else. We need to look ahead and see how can we make that lithium ion battery obsolete and create the manufacturing technology for that as well. And that's the kind of thing that ARPA-E will be looking for. And one of the things we need to recruit the best people, partner with industry, et cetera.

Finally, I just want to say that we need a policy environment that can pull these technologies into the market at cost. To look at cost as a very important factor, and performance, and pull this and stabilize it. And that policy environment is very, very critical. Because I think, from my vantage point, the ideas that I've seen, just amazing ideas coming out from the university and national labs, industry, small business, large business, amazing ideas. But where do they go? The reason people are going to China is because there's an infrastructure being created, there's a demand. And how do we create that kind of a demand and pull those technologies that will leapfrog over today? So I'll stop here, but I think this is a huge opportunity for us.

**CROW:** What I hear you talking about is, what I wrote down, was high speed innovation ecosystem. And so something, perhaps, we can talk about a little bit later, there are some that say, "Well, we could create that and we could be wonderfully and powerfully innovative, but then be unable, either because

of our market issues or our government policy making issues, to take advantage of our own innovative capability.” And other places on the planet, because of the way that decisions are made, might have the ability to take greater advantage of the innovations that we’re actually producing. And so let’s just come back to that when we can.

Jim, you run one of the country’s largest utilities and one of the most innovative producers and distributors of energy. Let’s hear from you?

**JAMES E. ROGERS:** First of all, Lisa, my great grandfather lived to be 104. My best years are in front of me, okay? [laughter] So let’s get over this young thing. We’re in a unique position—

**CROW:** This is Jim Rogers.

**ROGERS:** Yeah, Jim Rogers, with an old grandfather, and I hope I have his DNA. We’re in a unique position in the power industry to deploy the solutions to raise the capital, not raise the national debt, to do it at scale and to do it in China time. And let me put this in context. Go back to 1910, I can barely remember. [laughter] But in 1910, we started down the road to provide universal access to electricity in America, and we did it. And our price of our electricity has been flat, in real terms, for 50 years. That’s scale, particularly in a world where 1.6 billion people have no access to electricity today. And we did it where the prices are lower than other developed countries around the world. And it’s allowed huge gains in the development of our country.

When we started down that road in 1910, we couldn’t envision what we would enable. Go a hospital, x-rays, MRIs, laser surgery. Just the ability to do things in the medical world. We couldn’t envision that as a result of providing electricity to every home and business. It would lead to productivity gains of how we developed steel in this country with electro technology, which means our steel industry has the lowest carbon footprint of any steel industry in the world. We couldn’t envision computers, the internet, and all came as a consequence of providing universal access.

And we did it with 50 state commissions, and we did it across this country. It transformed our country. And one of the reasons we are where we are today is because we were a high tech business in 1910, and we enabled things that no one could envision then. My challenge to you, and my challenge as a CEO, and this is back to solution capital, scale, China time, I sit here today in the 21<sup>st</sup> century and said, “Universal access, enabling all the things that we take for granted today, was yesterday.” But I believe we can have a twofold mission in the 21<sup>st</sup> century that will achieve all the things that we’re talking about here. And we have the capability to do it.

First of all, we can modernize and decarbonize our entire fleet by 2050. Whether it’s carbon legislation or not, we’ve got to do it. And that’s why I’ve been an advocate for carbon regulation, because I want a roadmap so we can get it done. If we do that, and we have to do it, that’s going to stimulate the economy and create jobs. And it’s going to create jobs that will rebuild the middle class. It is going to be a huge scaling. So modernization, decarbonization, mandate by 2050. We will raise the capital. We don’t need the government to raise the capital.

Secondly with respect to our second mission, I believe we’re in a unique position to make the communities that we serve the most energy efficient in the world and do it at scale. Is we convert our distribution grid into a two-way communication. We then have the capability to put the apps, so the other side of the meter, that will allow people to reduce their energy use and have huge productivity gains. And we can do this at scale. In a sense, we’re a distributor for all the creative innovations that come from ARPA-E, that come from Silicon Valley, because we can deploy it and make it happen. And we can have the capability to raise the capital to make it a reality.

And so, my point to you is my job has always been affordable, reliable, clean electricity 24/7/365. I know that our industry produces 40 percent of the carbon footprint in America. But I also know that if I can achieve my first objective, I can reduce dramatically the carbon footprint. I also know I'm going to enable—I can only envision two things now. There's probably a zillion things that will actually happen. I can envision the ability to use renewables and make them a better contributor.

But equally important, I know that I will enable electrical vehicles and plug-in hybrids. And the transport sector represents 30 percent of the emissions. So if I carry out these two missions, I raise the capital, I come up with the solutions, and I do it in China time, the reality is we could reduce our emissions close to 70 percent and stimulate our economy, create jobs, create energy independence and have much cleaner air at the end of the day. So I know what the challenge is, and we're in a unique position to go to work. What we need is policymakers in Washington, is to develop a roadmap so we can get it done.

**CROW:** So what I hear you saying, Jim, is in a sense, we've lived in cities and villages for 8,000 years or so, and those were primarily non-electric. The last hundred years, which is really nothing in terms of time, we built this platform which is amazingly efficient, but it's not particularly modern in the way that you're using it, it's not sustainable. It doesn't have the kinds of things that you're talking about. And you say just let the market work, let us move it in real time and we can take that same platform to higher and higher levels of broader performance; that is, performance not only to deliver that— what you called universal access to electricity, but also to deliver it in ways in which it is more sustainable, more environmental, and all of the other things that you put on the list. And so it's a maturation process that in real, what you call China time, we can get to work.

And so the other thing we've lost is we've sort of lost track of how long it takes to do things. We've just had this electricity for a hundred years. Why don't we now take the next few years and make it into the system that we can now visualize that it needs to be?

**ROGERS:** No, but said another way, think about it. In 40 years, I got to retire, replace every plant. I got to do in 40 years what it's taken me a hundred years to do. I'm prepared to do that. But the other point, and I think this is the point that's really so important from Skip, is that we have the ability to provide universal access to energy efficiency and productivity gains in the use of electricity. No one else has the ability to optimize the use within a home, in a home, in a neighborhood, and a residential customer class against industrial, against our grid. Our ability to optimize is terrific. And I have a prediction. I know I'll be around long enough, I hope, but I bet in ten years, that what we think of as energy efficiency today will be very primitive compared to what we'll be doing then, if we can get on the road and get the work done.

**CROW:** So I hear a lot of positive and upbeat thoughts. Let's hear a little bit about what it is that holds us back. Is it there's been studies that every time someone tries to advance new innovations into this massively efficient system, Gary that you described, or Jim or Skip, the system that we have, they just break down? And so Sunil, you're investing in companies, you've got other people's money, you're moving things forward. Arun, you've got hundreds of millions of dollars down on the betting table relative to projects that you've invested in around the smartest groups around the country. So we get all this going, what holds us back?

**LAITNER:** I might throw in the first two observations, and picking up on what Jim said, and I think we're pretty much in synch together with this. The first is I commented on, previously, images of the future. We need better images that we are a can do, that the technologies, that the behavior changes, are available to us if we choose to develop them. So really helping the U.S., helping the global economy



understand the huge opportunities before us, if we make those choices and allow that capital to be deployed, that's part one.

Part two, the roadmap. We absolutely do need a roadmap. We need a clear, persistent, increasing signal of what needs to be done to transform the country.

**CROW:** So the lack of a roadmap holds us back and the utterance of the word 'roadmap' evokes from some the notion of Soviet state central planning? And so how do we get past that?

**DIRKS:** If I may, Michael, I think I'd like to pick up on a point that Lisa made at the beginning. And that is when we talk about we here, I think we're substantially talking about the United States and not the world. Because there are big chunks of the world that get it and are actively on their way. Germany has done an enormous amount, the Chinese are onto this in a very big way because they see the economic potential that a number of the panelists have mentioned. Britain is into this, South Korea, as Lisa has mentioned, has made it a national imperative to innovate in this area. So substantially, the we in this, I think, in terms of the big economies, are us, the United States.

For us, I agree, it is substantially this idea of the roadmap. And I think part of what gets in our way, and is both a great strength, and in this case a potential weakness, is we have a very deep reliance on market mechanisms. And market mechanisms cannot see the risks that we face because of the way they're presented to us. And they don't yet see, although they're beginning to, the opportunity. Whereas some of these other economies don't have those same challenges, the Chinese in particular do not have that same challenge. They can just go for it.

**ROGERS:** Let me say, when I say roadmap, I say put a price on carbon and a cap on emissions. And let companies find the cheapest way to achieve those objectives going forward. I don't mean an industrial policy where you lay it out. I mean, the Russians proved five year plans don't work too well. We've got to harness the power of the market, but the government has got to pour money into the R&D, we've got to commercialize these things. But it's a partnership between government and the private sector. And it's not either/or, and I think we need to be sophisticated enough to be able to do that in a way to harness market forces. We have clear guidance from the government of where we need to go, we will find the solutions in the way. We just need to know directionally what we have to achieve.

**CROW:** Sunil, you were going to jump in?

**PAUL:** Yeah. I mean, the idea that government planning is the way to the future is something I simply can't abide. I mean, I'm a venture capitalist, and I absolutely believe in venture, I believe that American innovation can absolutely get us out of this problem, of these sort of manifold problems of security, climate and economic development. And I absolutely believe that markets can get there. But markets only work when the price is set and reflects what the real scarcity is. Right now, we have a scarcity of energy security, we have a scarcity of a stable climate. Neither of those things are incorporated into the price of energy today. Incorporate those prices and the market will work. It is the best known mechanism we've got for allocating resources. Works far better than a Chinese system, or any other system out there. It's not perfect, but it does work.

Those \$13 trillion that have to be invested worldwide between now and 2020, the sort of 26 trillion by 2030, the vast majority of that needs to come from private capital sources. The government cannot, not just here but around the world, cannot be the— we cannot look to government to be the banker for development of that energy infrastructure. We need to look to government to be the referee and the rule setter; the rule setter for the markets, the rule setter for infrastructure and building out that sort of natural monopoly kind of infrastructure that can't be done through competition. And we need

government to set the rules for regulation of how profits are made; for example, by Jim's company and other utilities.

Things like something called decoupling, so that energy efficiency is incented rather than simply building more power plants. So there is a role for government. It's a super important role, but it needs to be a stable and thoughtful role and not sort of command and control role.

**ROGERS:** Actually, Secretary Schlesinger, the first Secretary of DOE, had a wonderful insight in terms of the roadmap our government has set for us.

**CROW:** That was way back in the '70s.

**ROGERS:** No, but many years later, he looked back and said, "Our energy policy in this country swings between complacency and panic." It's never been consistent and we've never looked at energy and environmental policy as inextricably linked. We've actually in the House and the Senate, it's worked in different committees. It needs to come together and we need a comprehensive energy and environmental roadmap, or rules, or however you want to describe it. Because we're going to continue to do this. When the price of oil's 140, we'll do one thing. When the price of oil is 40, we'll swing back to complacency.

**LAITNER:** I'd like to add to what Jim just said, this thought. As an economist, I would be remiss if I didn't admit that prices do matter, yes. But they're not all that matter. We do need a persistent signal, and it has to grow steadily over time. While we do want the price to help provide that signal and motivate in the direction we're discussing, we can enable the economy to respond, enable the markets to respond if we also invest in our education, in our laboratories and the technologies and the invention, patent process, what have you, to bring that about. If we don't, whatever the price may be, we may not be able to respond as adeptly or as quickly as we might otherwise. So we have to have both, that roadmap, I agree with some sort of price signal that's clear, persistent, steady. But it has to be matched by investments in the human resource in our institutions to make that response effective and possible.

**CROW:** So Lisa, why is this so hard from a policy perspective in particular?

**MARGONELLI:** I think a couple of things. One is that in addition to needing a long-term roadmap, we really need it to be bipartisan. This needs to be something that everyone actually agrees on. And it can't be just one party. And it can't be that one party is saying "my way or the highway," that sort of thing. It actually has to be a joint decision and everyone has to get behind it.

I think the other thing is we have to recognize that this is going to cost us some money and we need to recognize that it's worth it. Our petroleum infrastructure was basically built by my great grandparents, some of whom couldn't read. They came over here from starving villages in Europe. That those people had the generosity to pay out of their paychecks and out of their lives to build us this giant petroleum and electricity delivery infrastructure is extremely moving. And the fact that we're not interested in investing in that to that similar degree is really kind of depressing. So we need to start, policymakers need to start talking about the vision thing. And we need to see this as sort of a responsibility, as something that we can leave to our great grandkids.

I think another thing that we haven't talked about here, we've talked a lot about technological innovation. We also are going to need innovations in finance and in business models. And one of the issues, we have this enormous opportunity in people's homes to reduce the amount of electricity that we use, and to even generate electricity and throw it back on the grid. And once we start using plug-in hybrid cars, we'll be in a whole 'nother world in this sort of— in these terms.

But right now, it's very easy to finance a new power plant and it's rather difficult if you don't have a pretty healthy income to start weatherizing your home. You either need to get in on a government program, which means you're in the lowest 20 percent of income, or you're kind of in the upper part where you can throw some solar panels on the roof and get a tax break.

But we actually need to make it easy for everybody and we need to start, as a society, investing in private homes because they're using a lot of the power. And we also need to be investing in individuals' cars or individuals' commute options, maybe not cars specifically. But we need to start investing in that. Because right now, what we have is we have a private credit system for individuals and then we have a big sort of bond-based system for financing power plants and other big initiatives.

**CROW:** Let me just add a point first, Jim, just to deal with this roadmap thing. So there are some scholars that are out there that have said what we've lacked is the ability to get bipartisan consensus because we've avoided those things where we actually can agree. And there are places that we can agree. There are outcomes, there are views of what America can be that people can agree to. And one of those would be, for instance, a capitalism driven high speed innovation ecosystem that produces universal access to clean and efficient energy. I would guess you could get people around that sort of outcome oriented view. And this notion, then, of the roadmap, it's the outcome. And once you're driven by that outcome, then things start to fall in place.

And so one of the things that the policy process, I think, has avoided is this coming together and agreeing on outcomes. We've sort of forgotten that, to some extent. Jim, you were going to add something?

**ROGERS:** I was just going to make a point that every major piece of environmental legislation has been passed by Congress has been overwhelmingly bipartisan. That is also true with respect to energy legislation in this country. So, we have to find a way. We have to be more centrist in our approach because that's how real progress is made in a democracy. I mean, there's many great books, and the greatest leaders in our country have been centrists who found a way in the center to make progress.

But I want to kind of comment on one thing that Lisa said, and this gets to the scaling idea. We did a project in North Carolina where we asked permission to put solar on the rooftop. We went out and we invested \$50 million, put solar on the rooftop and at the end of the day, we were able to do it cheaper because our cost of capital was much lower than our customers. And during the middle of the worst capital meltdown in the history since the depression, we raised over \$7 billion at about 5 percent. We then used the money, put solar on the rooftop. We didn't force families to make a tough choice. When they have \$20,000 to send a kid to college, or do you do solar on the rooftop, we invested, we looked at the rooftop as if it was a power plant site. We paid them, we install it, we operate it, we dispatch it. As a consequence of that, we have the equivalent of 1,300 homes that are powered by solar.

And this is an example and I can give you examples on the energy efficiency side, where we become a distributor of these technologies that are developed whether it's a silver spring technology or a grid point technology, and we can take our low cost capital and deploy it so families don't have to make the tough choice between sending a child to college or insulating their home, or sending a child to college or putting solar on the rooftop. And it's using the same principles that we used when we brought universal access.

And the last point, we used the phrase decoupling, and I'm afraid we use it a lot of different ways. But decoupling for utilities just makes us indifferent. And my thought is, can anybody in the room think of anything that's ever been done as a result of indifference? I don't think so.

**MARGONELLI:** Bad things.

**ROGERS:** Huh?

**MARGONELLI:** Bad things.

**ROGERS:** Bad things.

**CROW:** Anarchist close.

**ROGERS:** But, there is a step beyond decoupling. I think decoupling is fine, but the step beyond is to give companies like us the incentive, the same incentive we have to put ten billion into a nuclear plant, we should have the equal incentive to put ten billion into energy efficiency. If you get those rules right, at the end of the day on a risk adjusted basis, I'd much rather spend ten billion on energy efficiency than on one plant. So I think it's not just decoupling, it's getting the incentives right and letting us bring capital in the scale we have to the job.

**CROW:** It's like the whole ecosystem services logic that has been derived in economics, this new way of looking at things. We've done that. At the university, we've put in five megawatts of our first twenty megawatts of solar. Paid for none of the capital, get a guaranteed price for electricity that fits what we need, and we don't have to worry about anything and others take the risk to advance it. And I think, Arun, you wanted to add to this.

**MAJUMDAR:** Well, I think since there were comments made about the role of the government, since I'm the only government person out here, I thought I'd make a few comments on that. And if you look at the innovation that has happened over the last 30 years or 40 years, and the biggest player in the game is internet. If you ask the question, "Where did internet start?" it started in 1968 because of DARPA funding, the government funding, to create an option which no one even imagined what the world could be with internet. Even the people who developed it.

So, if you look ahead now, what the government can do, as I think Jim pointed out, is to invest in the R&D infrastructure to create technological options. We need multiple options. Let me just give you one example. My daughter is applying for college. You think she's going to apply to one college? She's going to apply to ten, hoping to get one. That's the kind of options that we need in this country. And let the businesses with the right policy, with the right sort of signals, whether it's price or regulatory signals, pull, pick those which makes best business sense.

So I think the government can be the front end and the R&D that needs to be done, and tweaking it in the right way so that business, that train, moves as fast as possible. So that, I think, is what we really need to do.

**CROW:** So talking about as fast as possible, let's turn to this clock speed question. So we have this way in which markets can move very quickly and capital can move quickly. Consensus in a 310 million person democracy is perhaps sometimes less swift. Let's talk about clock speed. How do we speed up innovation and change in technology, in government policy, and whatever the area happens to be? What do we need to do to speed up the clock speed?

**ROGERS:** One thing I would say is every Ph.D. that graduates from a university in this country that's from another country ought to have a visa stapled to their PhD, okay?

**CROW:** There's a lot of people that agree with that.

**ROGERS:** I mean, that's number one. Because 50 percent of the patents last year were really won by foreign-born creators. So, I mean, I think that is one thing. The other thing, and I think this is something the Chinese do really well, and I've been to Ching Wah (?) University a couple of times. And what they really try to do is they take the R and the D and they put it right next to commercial. And so what's

happening is, rather than having hundreds of science projects, one at Berkeley, a science project at MIT, a science project at University of Texas—

**CROW:** ASU. [laughter]

**ROGERS:** Well, I think ASU would be a wonderful place to do it. But, I think that it needs to be coordinated, I think it needs to be— if you're going to give money to ASU and you're going to give it to MIT and you're going to give it to wherever, it ought to be a systematic plan where they're all working together.

**CROW:** Rather than thousands of independent actors?

**ROGERS:** And the labs? We have an incredible resource in our labs. But, we need to tie the work of the labs more to the universities and then to the commercial deployment.

**CROW:** So one way to speed it up is to enhance the network, unify the networks, tie the networks together. What are some other ideas?

**DIRKS:** I'd like to just add to that a little bit, Michael. Because I think this whole thread in the conversation that we've just been having underpins an idea that I think is going to be very important for this energy system. We cannot step change the energy system. It is too big and it is too resistant to change. But if we think about it as an energy ecosystem of supply and consumption, and we think about it end to end, technology, finance, policy, radical innovation coming from our entrepreneurial community, we can radically evolve it. And it isn't resistant to that. It'll take that on board if we have the right roadmap and we have an end to end view of what we have to line up.

I think Jim's example of putting solar on a rooftop is brilliant. It's not simply about technological evolution. It'd be great to have a better solar panel. But you get the right finance, you get a company with this kind of very forward-looking attitude towards finance and you can make it an important change. So the first thing I would say is that we have to see this as an ecosystem that we have to have end to end view of and we have to radically evolve it.

The second thing, the point that I would make, is it's about looking for ways that we can cooperate in other parts of the world to build strengths that we have that we can share with others. Jim has raised China a number of different times, and I had a great time over the 14 years that I was here. BP spent \$5 billion putting steel on the ground and it was great fun. There are some real strengths that China has. I wouldn't advocate that we take their system, but they have some real strengths. And one of them is China time, and the other is China cost. There's an enormous opportunity for us to cooperate with them. There is a place in the north central part of China called Ordos, and the future of the world's energy system is playing out there right now.

And the reason that I say that it's playing out there right now is partly for the reasons that Jim has mentioned. The Chinese are able to connect R&D with commercialization and they're really good at doing big demonstration projects. They pick a national champion, they give him the money. They tell him, "Go away and find out what it is we have to do." They've built the first thousand kilovolt AC line doing exactly that. The world's largest carbon captured storage projects are going to happen in the Ordos. They're going to be done by the Shenhua (?) Coal Company. And they're going to be done because that's what the Chinese government wants.

They also have the door open to the United States to cooperate in any way we choose to do it, but we have to just do two things. One is, we have to be willing to cooperate with them as partners, as equal partners, and we have to be willing to pull our end of the bargain. We have to come up with our money to match up with their money. We don't have to fund them, they've got plenty of money. We have to



come up with our end of the bargain and be willing to see it through. This is a historic opportunity. We can radically accelerate the—

**CROW:** So one of the ways, then, of speeding up how we're thinking is to become more cooperative and engaged in projects on a global scale?

**DIRKS:** Yeah.

**CROW:** Skip?

**LAITNER:** Yeah, let me make this observation and then suggest five ways to achieve scale China time that might be useful. First of all, the United States, just as a normal part of its investing its own economy in the next 25 years, is going to invest something on the order of 65 to 70 trillion dollars anyway. That's money in our homes, money in our hospitals, money in our bridges, our infrastructure. That has to happen anyway just to maintain any kind of robust economy in the first place. That opens a huge opportunity. If we know that's going to be spent—

**CROW:** That number, by the way, most people don't know that that number is larger than all of the investment of the republic from then— the founding of the republic until now.

**LAITNER:** It's that scale, exactly right. So if we have to do that in any case, we redirect that investment away from the inefficient, the less useful, the less environmentally friendly, through a couple of mechanisms. One is to help the policy and the public understand the imperative and the opportunity. That's step one, images of the future, again, are critical. Secondly, it's to provide that signal. That signal is absolutely important. It's got to be clear, persistent, and increasing over time.

**CROW:** Lisa's got to tell us how we're going to get that signal done.

**LAITNER:** Oh, good. Third is to invest, make that continuing and accelerated investment and that human capital we've been discussing about research and development, our workforce, our skills, our technologies and the like. The next is to align the incentives. I think Jim's exactly got it right. If we made the incentives out there so he would prefer to invest \$10 billion in efficiency rather than a \$10 billion set of power plants, that's going to get us there. And it's becoming then a means of delivering energy services, not any particular form of energy, but that useful energy that's required at that moment, at that time, given that business or that household. Energy services is a critical element.

And then finally, I like what we just talked about with the idea of collaboration. We need to build absolutely more collaborative models, not only within the U.S., but among private universal relationships and other countries as well.

**CROW:** Let's hear from Lisa and Sunil on this question of speed and these signals, Lisa. How do we get these right?

**MARGONELLI:** Well, I think that we need to figure out— one of the issues is, is that Jim's company, Duke, is doing all this amazing stuff. But any other utility who may not be doing all this amazing stuff, who may be keeping their grandfathered coal plants online or whatever they're doing, they get the same perks. So we actually need to put incentives in place so that we disincentivize the bad stuff, the environmental effects, and we incentivize the good stuff. And those things need to be in place over the long term, so utilities, oil companies, all of them are thinking in 10 or 20 year time horizons. Chinese bureaucrats are thinking in 60 year time horizons, and you won't find hardly anyone here thinking in those horizons.

But one of the things we need to do for policymakers is they need to be thinking in these longer time horizons. They need to have, as Skip mentioned, the rising sound of the signal. So you need to

know that in the beginning, there might be a certain number of incentives to start acting and then there will be costs later on that will be added to the undesirable results. But there needs to be this basic vision of where we want to go, and a willingness to let the market take us there if we can get those incentives in the right place. So we need kind of long-term policies. That's really hard for policymakers to do because the people who we have in office for the longest are in for six years and in fact, they're still thinking in terms of short, midterm election cycles anyway. So we're kind of in a pickle with our political time, is very different from energy time. Energy time is 10 to 20 years, minimum.

**CROW:** And so one of the issues would be how do we start dealing with this? We interviewed someone to be the director of our School of Public Affairs the other day, and this person had a fantastic idea about the fact that we need to start focusing reform on the design of our policy formulation structures themselves. If they're not scaled to operate fast enough, then they have to be re-thought and modernized, to some extent. And so, you're saying, I hear you saying, that that's a part of all of this also?

**MARGONELLI:** Right.

**CROW:** It's not just decisions, it's perhaps that system can't produce the decisions that are needed?

**MARGONELLI:** Well, I think that what we need to do is produce the visions and then put in place a structure for making those decisions and figuring out how to— I mean, as Arun mentioned, how to tinker with the system on the back side to make sure that the incentives are all aligned. Right now, we've got incentives going in all sorts of different directions.

**CROW:** So maybe a Congress that floats 10,000 bills in a session perhaps ought to focus more energy on vision itself and outcomes that they'd like the country to achieve, as opposed to floating 10,000 bills?

**MARGONELLI:** That's their nature, to float 10,000 bills.

**CROW:** That's their nature.

**MARGONELLI:** I mean, I think it's to us to come up with visions and to say this is that we want and transmit that to them. They listen to us in their way, and we need to send that message. We need to say, "Look, we need to stop dithering."

**CROW:** Sunil?

**PAUL:** I think the biggest thing that we could do to accelerate change is to create a culture that where leaders think— leaders in the capitalistic world think about more than just the return. And absolutely, return on capital has to be a top priority. But we are also human beings, we are also citizens of the country and of the world, and there needs to be better leadership on that front. Part of the reason we created Gigaton Throwdown was to create that vision of for the community of clean tech and clean energy, to think more than just about return, to think about what are the implications for climate and what are the implications for energy security?

And it's already had some benefit. I can tell you that at least one investor that participated, because he was thinking— now, this is interesting because by having that same kind of leadership and thinking big about scale, has resulted in what he thinks is the most interesting investment in his portfolio. Because he came in and asked the question, "What does it take to get to gigaton scale? What does it take to get to big climate impact with this idea that you have, Mr. Entrepreneur? And the result, after a couple of months working on it, turned into his most promising portfolio investment.

I think that same kind of leadership and that same kind of vision is possible, and we should expect it from our political leaders. Yes, of course, they care about votes and they should care about votes, just like capitalists should care about return on investment. But, it's more than just about votes and it's more

than just about politics. We should hold them to a higher standard of, and expect them to have a vision for what happens to future generations. It's not just about the next election.

I'd say one final thing, which is to accelerate the pace of innovation and the delivery of this new world that we see, the most important thing we could do from a policy perspective is don't screw things up. Things are actually moving along. Because of innovations in biotechnology, information technology, material science, those innovations, many of them funded by the government, are accelerating the pace of change. The reason why there are these interesting bio fuels companies, the reason why there are advances in batteries and power electronics, the reason why I've got a fuel cell company that is able to deliver a return on investment, or payback time of often 12 months with no subsidy.

The way that those things could get screwed up are messing up the immigration and the fact that we've got this great powerhouse of a country that accepts people and accepts brains and energy and power from all over the world. We're in the process of screwing that up. We could screw up the education system. Not just at the higher levels of education where we're actually doing a pretty good job, we could easily screw that up. But we're, I think, failing at the elementary and secondary level because this new economy that's coming, it is a new clean economy and it is not just for Ph.D.s. It requires steel in the ground, it requires welders, it requires pipe fitters. Those people need to be educated and able to perform at these higher levels.

So whatever you do out there in the policy world, don't screw it up because we don't actually— we need clear policy signals and a roadmap. But more than anything else, we need you not to mess up the great strengths of what we have in this country.

**CROW:** Arun, and then Jim, and then we're going to go to questions.

**MAJUMDAR:** So let me just say a few words. I think we need pervasive and constant innovation. And I think we are hearing that. And we talked about science and technology, and that's sort of obvious. We talked about policy innovations, whether it is decoupling or decoupling plus or single watt, whichever. We need some innovations out there. In terms of financing, aligning the incentives, yes.

Let me just come to one that we have not talked enough about, and I think Sunil just touched upon, is the education. And we are— ASU is an educational institution. I like the idea of stapling a green card to every Ph.D., foreign born Ph.D., I think that's a good idea. I mean, I came here because this is the place, action, where it happened. This is where the country sent the person, the first man on the moon. So, we need to create that environment, and those Ph.D.s that you staple the green card for, that's great. But those numbers are dwindling. And those numbers are dwindling because the economy is improving. Where did they come from? They came from China and India. Those economies are improving and those numbers, and you probably have the statistics for that, I saw that at Berkeley, those numbers are going down.

So we need to have the human capital in this country to be interested in science and engineering. And I was, for a while, on the advisory committee for National Science Foundation Engineering Directorate, and they funded the National Academy to do a study of how much are the kids really interested in science today? And actually, they gave priorities. The number one attractive profession was, this was right after 9/11, was fireman. That's understandable. Then doctors, et cetera. Engineering came way down below being a priest. I was shocked. I was shocked at that. [laughter] Given the current state of priesthood, I mean, this doesn't make sense.

And I wouldn't say what the in between, the other professions were, but for— anyway, the point is that we need to change that. And again, we are in a sputnik-type moment because if you look at the

history of science and engineering after sputnik, it was a huge bump. And the idea of being a rocket scientist was in the jargon of everyone, of the kids.

**CROW:** One of the things that we've done at your old school, by the way, has gone from about eight or nine thousand science, math and engineering majors to 18,000 science, math and engineering majors in the last ten years. And the reason that we've done that is we've changed what it is that they're focusing on so we now have a grand challenge oriented engineering school. We have a school of earth and space exploration, a school of sustainability and that's what these younger kids want to be engaged in. If you go to study, you know, differential equations, yeah if I need to know them, I need to know them. But why do I need to know them? And so we focus more on the why. Jim?

**ROGERS:** No, I'm happy to report that my grandson made the decision to go to engineering school and not be a priest. [laughter] Not that the world doesn't need more priests. There's nothing wrong with it, I'm delighted. I mean, I'm a lawyer by training and my son is an investment banking business, and I'm so glad to have a grandson actually going to build something.

**CROW:** That's how you dig out of these little holes you find yourself in sometimes.

**ROGERS:** And I'm confident that your daughter will get into all ten schools and have lots of choices.

But let me pick up on something Gary said, and I think it's really important. And there's two aspects to it. One is, is at BP— I mean, when I went to Ching Wah, I was struck by the fact, it was a Sunday morning, and I was struck by the fact that embedded within Ching Wah University was a BP low carbon center where they had people there at the campus, part of the facility, working. I was impressed. And it gets back to the point of the R, D and commercialization all tied together.

But the second thing I'll quickly share with you so we can go to questions, is our company has entered into three MOEs with Chinese energy companies. One is the largest producer of electricity from coal, and they are pioneering green gen where they're doing CCS. We're building in Indiana the world's largest coal gasification plant where we're going to do carbon capture sequestration. We're going to share technology, we're going to exchange people with them.

We've entered into one with the state grid because of their expertise. And we've also entered into an agreement with the largest private company, which by the way is made up of a lot of Chinese Americans who got their Ph.D.s here, worked for G.E. and Siemens, are now back working for ENN. But the reason we're doing it is really quite simple. One, the Chinese have what we have always had, a great can do spirit. Increasingly, I find it's becoming more like the chattering class of our European ancestors who spent a lot of time talking about it and not as much can do as needed.

But the second thing is most important, we need to be smart enough in this country to recognize they have an imperative, an economic development imperative, to scale energy infrastructure as the rural people move to urban centers in the way that happened in our country from 1880 to 1950. And so what we need to be, have relationships that are nuanced enough where we cooperate and compete and ride their imperative because I believe there's a reason they lead the world in solar panel production and wind turbine production. They're building 14 nuclear plants. They are experimenting in advanced underground coal gasification, CCS. And they're doing these things, and they're building a coal plant every other week.

And when you're scaling this kind of technology, every plant you build, you really innovate and get smarter about. So at the end of the day of my mission as affordable, reliable, clean, I increase the probability that it will be affordable if I'm working with the Chinese and I increase the probability of reliability and clean because there's a lot of political debate in Washington about the Chinese and Americans.

My reality is actions speak louder than words, and I see their leadership in the renewables and these other areas, it says a lot more to me about them building a bridge to a low carbon world than all the chattering we're doing in Washington about cap in trade.

**CROW:** So let's go to questions. There's microphones. Just raise your hand and someone will give you the microphone. And let's try to make sure there are questions. You want to say who you are?

**AUDIENCE:** I'm Chris Bentley, I'm with the White House, I'm an intern there. All of you have mentioned there's a role for government. Each of you have seemed to have a different perspective on that. But I'm just curious, I don't really feel like I've gotten any clear cut answers as far as what the government should do, given the fact that Congress is built on individuals who are really concerned about getting reelected. I'd love some comments about that. What do we need to do to make sure the government makes these changes that you all want?

**CROW:** Short answers. Listen, we've already talked a lot about focusing on outcomes, that is describing what the outcome is that we're working toward in this realm which isn't well described. Who wants to take a short answer stab at this. You want to go first, Lisa, or Skip? Okay.

**LAITNER:** I think government needs to play a role that complements what we might think of as the ideal marketplace. And where the limits on the market are insufficient to allow this kind of innovation to move ahead, government needs to take a role. For example, if we need new buyers and sellers of energy efficiency or new renewable technologies but they are not there, then government needs to help create or incubate, if you will, through training, through education, through technology, R&D development things, to give rise to that opportunity. So government plays a complementary role to the ideal marketplace.

Where Lisa commented earlier, the inability of people to have access to financial means to actually go after these kinds of opportunities, government can play a role in helping shape the design, but letting the energy service companies deploy. Use their scale, use their ability to make that capital available. So the critical role of government is to complement what we might think of as the ideal and learn and offset the inadequacies or the weaknesses of our market institution.

**CROW:** Anybody want to add to that? By the way, there's a whole new literature that's sprung up on what's called public value mapping, which is contrary to trying to put definition to market failure when the government becomes engaged in market failures. And it's a fantastic literature that you might find interesting. Arun?

**MAJUMDAR:** It's actually very simple. It's to enable businesses to create jobs and make money. That's how it'll scale. Whether it's in the front end R&D or aligning the right incentives and giving the right price signals, or regulatory signals. That's it.

**CROW:** With a vision that the outcome of those people making money and creating jobs creates a certain kind of outcome of the world, right. Yes. That's the part that people have difficulty adding, is that.

**PAUL:** Other exact mechanisms for doing that, to me, are put a price on carbon. I don't care how it happens, it needs to be there and it needs to be stable. That's in the larger context to incorporate these price signals. Create and incentivize infrastructure, electricity infrastructure as well as infrastructure in the fuels regime that creates a lot of choices. For example, encouraging flex fuel cars that can operate on a mix of ethanol and methanol. Make sure that immigration reform is there and education systems are conducive to increasing the amount of talent and expertise in this country so that we have good paying jobs.



And make sure that we have a regulatory scheme that encourages efficiency through decoupling and adding incentives to utilities. And making sure that you don't mess it up by disallowing states from being able to do those same kinds of innovations. Because one of the sort of problems with the federal government is that the likelihood of action at the federal level sometimes dampens enthusiasm for action at the state level. And there's all kinds of interesting innovations happening there. We haven't mentioned the Pace program, which is this great way to encourage energy efficiency and solar and other kinds of distributed generation through property tax levies, has already had some great success.

**DIRKS:** Michael, the only other thing I would add to that is, and we do this within a 20 year framework so that the policy remains consistent over time.

**CROW:** Okay, next question? I don't know where the microphones are.

**AUDIENCE:** Thanks. John Harper with NPRI. My question is for Mr. Rogers, but if anyone else has any comments, I would appreciate it. Barring major government subsidies or carbon regulations, do you envision a time frame for the development of commercially viable smart grids on a state or national level?

**ROGERS:** My judgment is that modernizing our grid— I mean, we built our grid with analog because that was the technology that was available. We produce electricity, deliver it 99.99 percent of the time. As we move to digital technology, that's going to enable plug in hybrid, it's going to enable our ability to manage solar on the rooftop, is an intermittent source distributed on our system. We are prepared to make those investments and we will make those investments. But what you find, what we're finding, is that we started out looking at 900 different companies in a funnel and then we dug into 250. And then we tested the products of 100. We're actually piloting five. There's a zillion great ideas out there, but trying to get them narrowed down to the ones that really work is a challenge.

The real challenge is the integration of the technologies. And no one, because each company has its own deal and there is no company in the historic suppliers, like G.E. or Siemens or ABB, this isn't where they make the big part of their money. So in a sense, what we're finding for ourselves, we're creating a capability of integrating the technologies and actually building the roadmap of how the upgrade your distribution and you create the apps beyond the meter and you tie it all together through communication. And that is really the better way to talk about it. I've tried to get away from using the word smart grid because everybody has a different definition. It's like ten blind men standing around an elephant trying to describe it. So I try to kind of narrow it to upgrade the grid, come up with the apps beyond the meter.

**CROW:** So it might mean that a state regulatory commission then that regulates price to the benefit of the consumer might not necessarily be the best governance mechanism for a technology company attempting to advance economic development through a bimodal digital grid which will affect all forms of interaction and transportation? It's one of those forms of government that's probably outmoded.

**ROGERS:** But I would say maybe not. And I'm reluctant to challenge the President. [laughter]

**CROW:** Mr. Chairman, go ahead.

**ROGERS:** And that is state commissions really understand the balance between affordable, reliable and clean. You have to think about it as 50 different laboratories, as was said earlier, around the country. Some of our states have been very supportive of us doing this in terms of smart grid and getting the right incentives for energy efficiency. Other states have said, "Let's do pilots." Other states have taken a different approach.

Our point of view is if we can't convince them of the value for the consumer, then it's our fault. And so we're going to prove it one way or another because we believe deeply that it's the right thing to do. But I think it would be a huge mistake, and I know Lisa hinted at this, of having the federal government sort of step in and mandate things where over the last hundred years, state commissions have done it. And that's why we have universal access with the real price of electricity flat. That's been done by those state commissions and with the right charters, they can also achieve this transition.

**MARGONELLI:** I think this is kind of where the vision thing comes in. We don't need to know what color the cat is, it needs to catch mice. We already regulate gasoline based on performance standards. We don't tell BP which molecules we want in it. We say we want them to explode this way when they're in your engine, and we don't want them to fly off into the air when they're lying on the ground. I mean, we have performance standards. And I think what we need to do is come up with basic performance standards or incentives for the smart grid, one of which is that there needs to be real time pricing for consumers.

I mean, I'm interested in utilities making nice grids, but I'm also really interested in enabling the Ron Popeil of the smart grid. Do you know Ron Popeil? He does the pocket fisherman and the stovetop rotisserie and all those wacky inventions?

**CROW:** Slicers and dicers.

**MARGONELLI:** Exactly, exactly. That's exactly what we want on the smart grid. We want the weirdest possible solution to air conditioning that pulls an electrical load, a 30 percent of the electrical load off the grid in the heat of the day. And it's not necessarily going to be something that I come up with sitting in an office, and it's not going to be something Jim comes up with sitting at the utility. It's going to be somebody sitting out in a hot trailer saying, "We could do this differently, and here's how." But we need to— that opportunity is not going to be there if there isn't real time pricing, and that's what has to be there. That's where the vision thing comes in.

**LAITNER:** I might add one other word. You started your question with the word subsidy, picking up on the idea of vision. And I think Jim nailed it right. We're talking investment. One of the things we need to do is move away from divisive words like subsidy and think instead in investing in our future and investing in our education, our population, our labor force, and providing the incentives that allow the market to get the job done.

**CROW:** Any question? You have a question up here? There's one in the front, one in the back.

**AUDIENCE:** Chris Hartow (?), Argonne National Lab and recent ASU sustainability grad. So we talked a lot about increasing the clock speed of innovation and ecosystems. How do we in hand improve the speed of our monitoring analysis and feedback systems so that we can also avoid some of the problems like we've seen with corn ethanol as we introduce some of these new, untested technologies into our technology ecosystem?

**CROW:** Who could have imagined that the price of tortillas would be affected by energy decisions in the United States, which they have been?

**ROGERS:** And actually, there's another example of that. I mean, we need to think through the unintended consequences. You can't always identify them all, but you have to have a little speed to ball in terms of solving it once you identify it. Take Shell Gas, which everybody calls is a game changer. We don't quite know what the environmental impact is going to be of that yet. And we know that water, and from Arizona, you all really know this, but we have seen it all across our country, water could be the next oil in the 21<sup>st</sup> century. If Shell Gas takes an incredible amount of water with chemicals and the potential to contaminate aquifers, we might find ourself championing Shell Gas as a game changer—

and by the way has 50 percent of the carbon footprint of coal, and at the end of the day find yourself in the same tradeoff, water versus fuel, that we did with ethanol in terms of food versus fuel. So we really need to think our way through this and remember the lessons learned before.

**CROW:** I just want to add, one of the things we've been urging the Department of Energy to do is look at the social and economic implications of every single project idea that they advance from science forward, which is a new way of engaging in some of these things to catch some of that earlier.

**PAUL:** Can I just say one thing, though, about this? Is I absolutely think— I spent three years at the Office of Technology Assessment on Capitol Hill, really inculcated this idea that you have to think about the whole system and think about the implications of technology beyond the immediate horizon. But we also are susceptible to the way that what is sort of the convenient way to think about things. The whole corn ethanol causing corn prices to increase is one of those little ideas that just is convenient and has stuck in our heads. Every food economist that's looked at this problem has concluded that, in fact, those corn prices went up because of demand in China and India and the rest of the world, especially for their increase in need for meat, and not for ethanol. And it's an idea, it's often, often repeated, but I think especially with so many press in the room, it's important to understand that that was not the cause. We absolutely need to pay attention to it, there's lots of problems with corn ethanol, but increasing food prices was actually not one of them.

**ROGERS:** But I would add one other sort of footnote. We blocked sugar based ethanol coming in from Brazil, which would have been a chapter alternative and a better alternative, and we continue to block it today. So to your point, we need to look at this comprehensively and understand if our true mission is to wean ourself from oil, then why not sugar ethanol from Brazil? Why do we block that?

**CROW:** And Gary's comment's going to be— I'm getting the signal. Gary's comment's going to be the last comment before we break.

**DIRKS:** I think the reason is pretty straightforward, actually. And that is that the whole corn ethanol episode has very little to do with energy policy. It's all to do with agricultural policy. With the WTO closing in on farm subsidies, there needed to be another way to deal with this problem and that's the way it was dealt with. No energy person that I know of thinks that this has anything to do with energy policy.

**CROW:** There's politics around agricultural in the United States? [laughter]

**DIRKS:** None.

**ROGERS:** I might add the sugar lobby didn't have any influence on it, either. [laughter]

**CROW:** Well, let's thank our panel this morning. We'll make sure that everybody, that we have your email addresses, and so forth, that you get this video of this. We'll send you the web archive so you have this if you want it, as well as whatever else we put out of this. And so thank you for being here. I want to thank again the New America Foundation for working with ASU to advance this, and hopefully we've got some good ideas generating here today. So, thanks a lot.

**END**