THE BROOKINGS INSTITUTION

ENERGY DISCOVERY-INNOVATION INSTITUTES:

A STEP TOWARD ENERGY SUSTAINABILITY

Washington, D.C.

Monday, February 9, 2009

Welcome:

AMY LIU
Deputy Director, Metropolitan Policy Program
The Brookings Institution

Introductory Remarks:

KEITH W. COOLEY
CEO, NextEnergy

Featured Speaker:

THE HONORABLE SHERROD BROWN (D-OH)
United States Senate

Moderator:

MARK MURO
Fellow and Policy Director, Metropolitan Policy Program
The Brookings Institution

OVERVIEW: ENERGY DISCOVERY-INNOVATION INSTITUTES

JAMES DUDERSTADT
President Emeritus, University of Michigan

E. GORDON GEE
President, The Ohio State University

MICHAEL M. CROW
President, Arizona State University

ROUNDTABLE: TOWARD NEW PARADIGMS FOR U.S. ENERGY RESEARCH

Moderator:

WILLIAM BATES
Vice-President for Government Affairs
Council on Competitiveness

JOHN DENNISTON
Partner, Kleiner Perkins Caulfield & Byers

BILLY M. GLOVER
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Boeing Commercial Airplanes

M. PETER McPHERSON
President, National Association of State Universities
and Land-Grant Colleges

MICHAEL SHELLENBERGER
President, Breakthrough Institute

HOWARD BERKE
Executive Chairman and Co-founder
Konarka Technologies, Inc.

WILLIAM HARRIS
President and CEO, Science Foundation Arizona

CLOSING REMARKS

JEFFREY WADSWORTH
President and CEO
Battelle Memorial Institute

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P R O C E E D I N G S

MS. LIU: Good afternoon, and thank you so much for joining us this afternoon. My name is Amy Liu, and I am the deputy director of the Brookings Metropolitan Policy Program. I'd like to welcome you today to a forum to discuss a bold and promising idea about how to strengthen our nation's capacity to move toward a strong alternative energy future.

Today's topic could not be more timely. We are in the midst of an economic downturn with some very fervent debates here in Washington about how to stimulate short-term job growth while at the same time laying the foundation for a 21st century economy. At the heart of that 21st century economy is the desire to build a green economy that will help us move towards energy independence.

Now, our interest at Brookings in this moment is primarily twofold, and it is based on an initiative we launched almost over a year ago called A Blueprint for American Prosperity, which aims to offer to Congress and the new administration a series of practical ideas to modernize bottoms-up approaches to economic prosperity.

First, as the Metropolitan Policy Program, we want to remind our national leaders that our economy is inherently metropolitan. As competitiveness guru Michael Porter recently argued, there is no U.S. economy, there is just a network of hyperlinked, hyperintegrated

metropolitan economies. In fact, the largest 100 metropolitan areas alone generate 75 percent of the nation's GDP. So, our mantra has been -- our mantra has been, even in this economic recovery package debate, let's focus on investments, lets' focus and stimulate smart approaches where the economy is.

Second, metropolitan areas are our economic engines, because the public and private sector leaders in them wake up every day leveraging the very assets that drive productivity and economic prosperity. Those assets are innovation, infrastructure, human capital, and building high-quality places to live and work. This idea, then, to create energy discovery-innovation institutes embodies the real-time way that one of these assets, energy-innovation, will be deployed. The reality is that we will need a network of universities, of federal labs, industry, venture capitalists, work force developers, and others working together, albeit sometimes in little messy ways but working together to create and commercialize alternative sources of energy for the nation. So, if done right, this concept that we're going to talk about today will yield a three-pronged prosperity -- high productivity, energy and environmental sustainability, and an inclusive economy that engages and expands the skills and opportunities of our workers, which brings us to today.

We have an exciting program planned filled with a number of top-notch speakers and presenters. We are very fortunate and honored to

have three universities' presidents present and discuss the proposal to create the shorthand of EDIIs, and the universities are an important part of this equation, because they are not only the anchor institutions but very much the foundation for learning, innovation, and work force development in our urban and metropolitan economies.

So, to start, we will hear from Jim Duderstadt, the Emeritus president of the University of Michigan and a long-time professor and expert on science, engineering, and technology. I just want to say a brief word about Dr. Duderstadt. The notion of how to generate energy alternative did not germinate here in Washington, D.C., but really outside the Beltway, which is how we do the bulk of our work -- is really learning from practice on the ground. We learned that Jim was working to make his own university a hub of energy research and potentially being a model for other universities in the important Great Lakes region. So, we began to consider whether there wasn't something of wider national value useful to multiple cities and locations and for the nation as a whole. And Jim agreed to partner with us, and we then enlisted the chairs for this R&D effort with Dr. Gordon Gee and Michael Crow, the presidents of the Ohio State University and Arizona State University, two of the leading university presidents and innovation champions in America. Now, to hatch the paper and this concept with them was a really stellar cadre of science, energy, climate engineering, and research experts that became the NextEnergy

working group behind this effort. So, this afternoon you will hear from Dr. Duderstadt, who will present this policy idea. Drs. Gee and Crow will then comment on this new paper we are releasing today.

Now, following their discussion, we will hear from Senator Sherrod Brown, who has been working to build an alternative energy industry in Ohio, and then after some questions from you in the audience -- and we do want to leave some time for that -- we will hear, then, a variety of reactions to the proposal from leaders in the field who will be very much affected and partners to those dynamic concepts, someone who represents environmental thought, the venture capital community, the private sector, and regional economic development. And this discussion will be moderated by our good friend, Bill Bates from the Council on Competitiveness.

Before we get started, I do want to thank a few people who have made extraordinary contributions to this work. Again, we wouldn't be able to announce, inform this very wonderful idea if were not for a large group of partners in this effort. First and foremost, we want to thank Jim Duderstadt and the entire NextEnergy team for their ideas and labors this year, as well as a number of people whose guidance and insights were consistently helpful, including Joe Cecchi of the University of New Mexico; Don Lamb, the University of Chicago; Nate Lewis of Cal Tech; Terry McCulskie of Sandia National Lab; David Pines of University Illinois --

again, all of these are prominent leaders and thinkers in the field in their own right -- Brad Whitehead of the Fund for our Economic Future in Northeast Ohio and then, finally, Nancy Zimpher, President of the University of Cincinnati and the head of the Coalition of Urban Serving Universities. Again we very much value your engagement thus far.

Finally, I do want to give our deepest gratitude to Mark Muro, who's the Fellow and the policy director here at the Brookings Metropolitan Policy Program and also a co-author of this report. You will meet him in a few minutes, because he's going to be able to -- he's going to step up here and help facilitate today. But I think all of us who've been working through this project really want to thank him and his Policy team for really being not only an intellectual innovator in this project but really managing this concept from inception to now.

So, without further ado, I now want to have us kick off this afternoon with just a very dynamic force of energy himself, and that is Keith Cooley, who is the CEO of NextEnergy. NextEnergy is a nonprofit corporation in Michigan that's dedicated to developing alternative energy technologies through technology collaborations, smart energy policy, and incubating support for new business ventures.

Now, prior to joining NextEnergy, Cooley was the director of the Department of Labor and Economic Growth for the State of Michigan under Governor Granholm, and for many of us who care about workforce

innovations, we especially appreciate his time as CEO of Focus: Hope, a national model of manufacturing-based workforce development serving under-represented urban youth. So, please join me in welcome Keith Cooley.

MR. COOLEY: Good afternoon to all of you. As Amy mention, I am Keith Cooley, President of NextEnergy, a different NextEnergy than the team you have here certainly but I have to offer my thanks for allowing me to be part of this august group.

As Amy pointed out, NextEnergy in Michigan is doing a lot of really neat things that I think fit well with this meeting. We facilitate research and development through strategic public university and private consortia. We connect ventures and emerging technologies to key strategic partners, including potential markets, supply chains, and investors and help companies break into new markets through a perfect fit of auto suppliers in our area and wind turbine manufacturers to support a wind industry growth in the mid-west markets. So, in some ways what we do represents a microcosm of the key points in today's presentations -- the promise of innovation, the challenge of commercialization, and the power of collaboration -- because the pathway we've used in Michigan build strategic partnerships that draw on the strengths of the universities, the federal agencies, the labs, and industry.

But our discussion today is about more than a small

organization building alternative energy assets in the mid-west. It's about America, because energy drives America. This isn't any news to any of you here, but I want to remind us of the backdrop against which this wonderful discussion will take place.

Cheap, accessible energy is so integrated into our lives that it is a fundamental American expectation. We need it for transportation, manufacturing, business, homes, and offices. It fuels our economy and our lifestyles. The problem is the demand is growing and the supply is shrinking. U.S. energy consumption alone has more than doubled since the 1960s and continues to head north. China is now number two behind the United States for consumption. Ten years ago they weren't in the top ten. So, the results are predictable. Energy prices are rising. National security has weakened. The environment, of course, has been threatened. So, it's clear why we are all here today.

Now is the time for finding alternatives and making them work, not just as proofs of concept, not just as technologies in the lab, but in the broader landscape of the American energy industry, the transportation sector, our national infrastructure, our businesses, and our environmental values, and as a continuing driver of our economy as a whole.

That won't be easy, because on many fronts in this country a sense of urgency around this issue doesn't exist. You here have a

different sense. You've looked around. You know that clearly we ain't in Kansas anymore. International competition is worrisome. Our power grid is aging. I've learned that in some places the grid is a hundred years old or more. The hidden cost of oil and coal is an increasing burden, and the current state of the economy is untenable. Across the nation, unemployment is now about 7.1 percent -- that hasn't been that high in 26 years -- and in Michigan where I'm from, 10.6. We lead the nation; we can't live that way anymore.

There's an old saying we have. Maybe you have it, too. It goes this way. When everything is coming your way, you're in the wrong lane. Let me tell you what I mean by that. Alternative energy isn't the answer to everything, but it's a key piece of the puzzle if the United States is going to continue to lead. And innovation in that space is crucial to our survival. Point of interest for you. As we talked earlier, we're having good success on a much smaller scale in Michigan with NextEnergy with collaboration. We have something we call the state centers of energy excellence built around specific technologies -- new tech companies, universities, the Department of Energy, our utilities, and others. They build a concentrated value chain for success. Gasification, biomatter, bioenergy, waste energy initiatives are collaborative projects with the universities, DoD, DoE, and others. That's what's moving us forward, and that's what's working.

So, what would happen if we in this room pledged as we left to take the best of what DoE and the other federal agencies have to offer, the best of what the universities do, the best of what industry does and bring them together with a real sense of urgency and a real focus? That's how we as a nation have to move forward. We don't have the time, the money, or the resources for business as usual.

Now, I don't mean to suggest that is simple. The energy industry is a complex system. Multinational companies, government regulations, varying state mandates, incentives and subsidies, value chain interdependencies, and feedback loops that would drive you crazy. Trust me, working in government I know for a fact.

But we are in the wrong lane. We're in the wrong lane right now and we know it. So, our challenge is to find a model that works on a national scale, and that's a perfect opportunity to give the floor to a very good friend of mine, Jim Duderstadt, and his colleagues President Gordon Gee and President Crow. They have an intriguing option for us to consider.

So, President Duderstadt, the mike is yours.

DR. DUDERSTADT: If you drill down deep down enough Keith Cooley's past, back beyond his current role at NextEnergy, Michigan State government, Focus: Hope, go back through General Motors and Cadillac, General Electric, you'll find him in the early 1970s as a graduate

student in nuclear engineering where I was a young wet-behind-the-engineer assistant professor. So, we do go back a long ways. And I apologize for stealing the NextEnergy title to refer to our team.

I should point out that that team not only consisted of a number of faculty, scientists, engineers, and others from universities in the mid-western United States and the mountain west and in the west, but as well colleagues from other universities around the country, from the national laboratories, from industry, and, most recently, with members of the transition team that were considering innovation and energy policies for the new administration. Hence, leading this effort is a little bit like herding cats, but with each revision, I think the whole effort got a bit stronger.

Let's see, that's me. Let me begin with a punch line. Our report consists really of two primary recommendations. The first is to recommend a very significant increase in federal energy R&D, which, despite the increasing urgency of the need for new energy technologies, has actually declined over the last two decades and remained frozen at about one-fifth of that of the level of the early 1980s. Furthermore, the energy industry itself, for a variety of reasons we'll go into later, has one of the lowest levels of R&D among the nation's economic sectors. So, the first major recommendation is we've simply got to step forward and pump up that investment, most of which will go into existing resources like the

federal laboratories and into industry. But in addition to the critical efforts of the labs and industry, new research paradigms are necessary, we believe, that better leverage the unique capacity of America's research universities to span the complex array of issues that characterize our energy challenges, not simply science and technological but economic, social, behavioral, and policy issues, and further more to produce the human resources -- the scientists, the engineers, the managers -- who are going to have to build and then maintain this new energy infrastructure for the nation.

America's challenge? Well, in a sense here I'm really speaking to the choir. America faces an interrelated set of very broad energy challenges -- supply, security, and environmental challenges, which plague world's energy production. It's going to require transformative innovation to commercialize and deploy new energy breakthroughs, and multiple-market and government failures are going to have to be overcome but today hinder energy innovation and problem solving. Everyone here I think knows this, but let me kind of remind you what some of the issues are.

If you look at the projected growth in energy demand around the world over the next couple of decades, you'll see most of that growth is occurring in developing economies soon projected to swamp those of the developed world. This rapid growth is likely to create a permanent

imbalance between energy supply and demand, causing frequent price spiking and havoc with energy markets.

Second, despite rhetoric to the contrary, federal inaction and inadequate policies have left us becoming ever more dependent on important petroleum. Here you see that we're rapidly approaching the situation where we're importing 70 percent of the oil used by this country.

The environmental challenge -- well, here I have to speak as a scientist, and I have to join my colleagues which represent the vast majority of the scientific community in stating my belief that global climate change driven by fossil fuels is not only real but, to quote John Holdren, the most serious environmental challenge that will be faced by our civilization. We simply must develop and deploy alternative energy technologies, and we must do it soon.

The technology challenge -- current energy technologies, although promising, have not yet achieved both the scale and the cost structures necessary for commercialization. There are a couple of reasons for this. They have to do with market failures in part. Current energy prices do not internalize all of the cost. For example, the cost of carbon emissions. Furthermore, as I mentioned earlier, the energy industry seriously under-invests in R&D, but on the other hand this is in part because of the long timeline that's required for developing, commercializing, and deploying energy technologies, which is

incompatible with the very short quarter-by-quarter focus of investors on P&L statements.

Finally, the complexity challenge. Large-scale deployment as sustainable energy technologies involves not only advanced scientific research and development of new technologies, but they also involve a very complex array of other issues -- social, economic, legal, political, behavioral, consumer, and market issues -- and they're all characterized by complex interrelationships at the regional, the national, and international levels.

Existing federal policy simply is not adequate to deal with these complexities. This involves both the magnitude of current U.S. energy research, as well as the character and format of the U.S. energy research itself. Let me go into these in just a little bit of detail.

It's striking to note how much the decline in federal R&D and in industrial R&D in energy has occurred over the last three decades, so it's a shock of the OPEC oil embargo. Federal energy R&D, despite the increasing urgency, has declined to a level only one-fifth of that of the 1980s. As I mentioned earlier, the energy industry itself has one of the lowest levels of investment in R&D, and in fact high-tech industries, such as electronics and pharmaceuticals, spend now over ten times as much of their revenues relatively on research as does the energy industry.

Hence, our proposal is to call on the federal government to

increase its investment in energy R&D to levels comparable of other national priorities, such as health care, space exploration, and national defense, which would take it to a level somewhere in the range of 25 to 30 billion dollars a year.

The second recommendation -- let's see if I -- okay, the second recommendation has to do with the character of the format of the U.S. energy research activity itself. The national laboratories and corporate R&D activities have critical resources and capability, and there's no question that they're deserving of much stronger support, but we believe that they need to be augmented to address the full complexity of the energy challenge, which involves more, as I said, than science and technology. It extends the business issues, innovation, commercialization and deployment to social and behavioral issues, getting people to conserve energy, to invest up front in energy-efficient technologies. Furthermore, unlike biomedical research and defense research, federal energy research activities have failed to adequately engage the third leg of the triad of the American research enterprise, which of course are the nation's research universities, which not only have broader intellectual span but furthermore are the key to producing the human resources -- as I say, the scientists, the engineers, and others -- capable of building and maintaining the energy infrastructure this country is going to have to achieve.

So, we're suggesting a new federal approach. These are the two bullets that I gave you earlier to increase energy R&D by at least an order of magnitude and then to augment the existing activities with new kinds of research paradigms. Let me go into each quite briefly.

We suggest that federal investment in energy R&D should grow to between 10 and 20 to 30 billion dollars a year annually. You can get at this number in a variety of ways looking at the size of the energy sector of our economy, at the size of federal investments in other national priorities of comparable importance -- health care, space exploration, national defense, and so forth. Most of the growth we believe would flow to existing major players in the nation's research community -- the federal laboratories, particularly those of the DoE laboratories and to industry. But these represent only two-thirds of the national research enterprise. As I said, the complexity and scale of the nation's energy challenges demand that we engage the third leg, America's research universities. Today these have not been key players in energy R&D that they are in other national priorities, such as health care, agriculture, and national defense.

To this issue -- to this point, what we're doing is we're suggesting one of many possible paradigms, one that's particularly interesting. These are called Discovery-Innovation Institutes. They were an idea that spun out of the early effort that led to the Rising Above the Gathering Storm report of the national academies. These are research

centers, rather significant in size, that are designed a couple fundamental scientific discovery with use-inspired R&D that will add the technological innovation leading to new products and processes. You might think of these as the kind of research that was done years ago at places like Bell Labs until it was eliminated essentially by very strong shareholder pressure focused on quarterly earnings statements.

But there's another wrinkle in all of this. The Brookings energy team has expanded the concept somewhat by drawing on the highly successful examples of the land-grant programs of the late 19th and 20th centuries, which in many ways were responsible for the modernization of American agriculture and industry. Establishing our nation during the 20th century is not only the breadbasket for the world but the economic engine of our society. By creating agricultural and engineering experiment stations and their associated extension services, the land-grant universities were able to couple use-inspired research and technological innovation with commercial markets. They worked hand in hand with farmers and small business. They align national priorities with a powerful mechanism for stimulating regional economic development.

This network today of land-grant models continues as a highly successful paradigm for technology development, commercialization, and deployment in the marketplace. It's done so for over a century, and we believe that this model can and should be applied

to address the nation's energy challenges. In fact, we suggest that the pervasive character of the energy challenge is more similar to that of building a modern agricultural industrial society than it is of landing a man on the moon or building the first atomic bomb. Rather, our proposal is to create a national network of energy discovery-innovation institutes associated with the nation's research universities and national laboratories that is in fact an effort to apply the highly successful 20th century land-grant models to address the 21st century challenge of building a sustainable energy infrastructure. The energy discovery-innovation institutes would combine the best qualities of a number of paradigms. Like agricultural experiment stations, they would be responsive to social priorities, with regional impact. Like academic medical centers, they would link research, education, and practice. And like corporate R&D labs, they would link discoveries with the applied research necessary to produce innovative products but would also educate the next generation of high-tech workers.

Now, you have to -- our proposal suggests that there be quite a broad diversity of these institutes both in scale and in character. Some would be associated with universities, some with federal laboratories, still others with partnerships of universities and national laboratories. Some would address specific technologies, renewable energy, biofuels, nuclear energy, carbon sequestration. Others would

address social issues, such as conservation, mass transportation, behavioral change. Some could address unusual regional challenges, such as the energy-intensive nature of the economy in the Great Lakes area or the fragile environmental conditions characterized in the mountain west.

We see core federal support for these also over a diverse range, from smaller institutes typically associated with a single university or laboratory that might be funded at the level of tens of millions of dollars to perhaps very large institutes at perhaps the $200 million level that would be operated by consortiative universities, by major national laboratories, or by partnerships between national laboratories and universities. Total federal commitments for several dozen of these would build to roughly 20 percent of the growth we're proposing in federal investment and energy R&D approaching $6 billion a year. It would be augmented by support from the states, for example, that might provide land or capital facilities by industry, by investors, and by universities themselves.

Now, there are a great many other issues involved in how you put together a program like this. We think the reward process should be evaluated on an interagency basis, involve strong peer review -- might be led by an organization like NSF in terms of the competition itself, which has had experience with launching a series of major research centers

across the country. Their work criteria would certainly include scientific merit capability but also strength of the management plan, commercialization, integration into the regional economy. And it would require continued evaluation of the effectiveness of that. There's also a suggestion that's been provided to us by a number of eminent scientists that would link together existing and perhaps future fundamental research both on the campuses and elsewhere in essentially a hub-and-spoke kind of a network. We think that because of the size of this, it would be appropriate to phase it in, perhaps creating a competition for half a dozen such institutes a year. It would require a tiered organization. These are partnerships, okay, so that it will involve some kind of a management structure with executive authority not only involving the labs and the universities but participating industrial partners, perhaps entrepreneurs, investment community, state and federal government as well linked to the external relationships. Today we can build these in a way you couldn't have done in the land-grant era using powerful cyber infrastructure to coordinate these activities. In fact, you might even imagine these as virtual organizations in some cases, which do not have a physical location but link together a large number of institutions across the nation.

Finally, we see these established, managed, and funded as an interagency effort on the part of the federal government, but it's important to have a lead agency, and that would, I think, likely be the

Department of Energy. Where would the funding come from? It might come from the diversion of existing energy-related subsidies. Over the last 30 to 40 years, the nation has invested almost a half-trillion dollars in energy, some of that in R&D, much of it in other kinds of support. It might come from general revenue, or it might come from the appearance of a carbon tax or a cap-and-trade scheme, but in the end we believe that the need to reinvigorate America's economy and place it on a more sustainable footing compels the transformation of U.S. energy policy. Quite frankly, the sheer scale and complexity of the nation's energy challenges requires not only a greatly enhanced federal investment in energy R&D comparable in magnitude to the R&D addressing other national priorities, it also requires new approaches that extend and complement the very considerable capabilities of our national laboratories and industries with the assets of the nation's research universities. The creation of a national network of regionally based energy discovery-innovation institutes also represents a very worthy successor to the visionary modernization of American agriculture and industry undertaken by the Land Grant Acts of the 19th century.

The time has come for America to innovate, and the earlier Land Grant Acts appear to provide an appropriate model. It's time, as well, to increase federal investment in energy R&D to levels commensurate with efforts to address other major national priorities. To

augment the very considerable capability of the nation's federal and industrial research laboratories with this proposed network of energy discovery-innovation institutes would catalyze a new partnership of research universities; federal laboratories; business and industry; entrepreneurs and investors; federal, state, and local government to stimulate strong, regional, economic growth while inventing and building a sustainable national energy infrastructure for the 21st century.

So, with that as kind of a summary of what the report is proposing, let me now turn to the introduction of the two co-chairs of this effort, Presidents Gordon Gee and Michael Crow. Both are regarded as among the most visionary, energetic, and effective leaders in higher education. Both come from states with great energy assets but also considerable energy challenges. Both come from institutions that have beaten mine at the University of Michigan in football but only very rarely during my watch as university president.

President Gee.

DR. GEE: Thank you very much, and I want to thank the Brookings Institute for inviting me to be part of this report's development, and I also want to acknowledge that despite Jim Duderstadt's connection to the University of Michigan, he really did a brilliant job. I will also that during my first tenure at Ohio State, our football team was 1-5 and 1 against Michigan. That was the reason I had to leave. Then Jim stepped

down and now, of course, we've fared better, so I'm grateful to be here today with Senator Brown here and myself and Jeff Wadsworth from Battelle. It might seem like we have an Ohio cabal . I assure you we do not, though I'm honored as always to work in partnership with them. In fact, the creation of this report was also a true collaboration. I firmly believe in this effort, in combining thoughtful, creative people who care deeply about these issues, and I believe that this is the only path toward the resolution.

Now, we've heard this a lot over the past weeks and months, but let me say this again. Moments that are particularly vexing are also moments ripe for revolution. We have now a groundswell of agreement. America's utter dependence on fossil fuels weakens us in very critical ways. As supplies dwindle and our environment suffers potentially irreversible damage, we cannot sit idly by. It is inconceivable -- and Jim just made this fact, and I just wanted to emphasize this again to all of you -- it is inconceivable that the federal funding for energy is now merely a fraction of what it was some 25 years ago.

Now, I would ask the question is additional funding required? Well, of course. But, more importantly, we must form a new intellectual infrastructure, one with urgency of purpose and agility of unified action. There is much promising work at my own institution, Ohio State, and there is much at Arizona State and Michigan and Iowa and Washington State

and so many of our colleges and universities and, of course, in our great national laboratories. But too much is occurring in isolation, and this is the result and the focus of this report. So, idle thinking will not pull us out of this crisis. We must partner aggressively, and we must partner strategically. We must capitalize on areas of mutual interest and greatest potential.

Regional partnerships -- regional partnerships -- those proposed in this report make absolute sense. I'm especially pleased that Ohio State's neighbor, Jeff Wadsworth from Battelle, is part of today's panel and is part of this thinking (interruption) the public good economically, and environmentally, socially, and in so many other ways. And I am fully determined that we will help reinvigorate our region's Rustbelt towns with green collar jobs. American universities must apply our enormous resources to leading this new industrial revolution. We must be nimble and responsive, we must be open and accountable.

We all share a moral imperative to cast off old habits of heart and mind. We must believe and we must act in common purpose. And we must move with unparalleled ambition and deliberate speed. Simply put, our pace must hasten or our nation will sputter to a halt.

Truly, the stakes of this crisis are much bigger than even a sputnik moment. At issue is nothing less than our safety and security and our health and wellbeing. At issue, and this – people are saying this all

the time, but I believe this firmly, at issue is our nation's future. It is time for each and every one of us to roll up our sleeves, seek common ground, and intensify our work.

It is, simply put, ladies and gentlemen, it is now time to act. This issue is far too important to allow it to languish any longer. So I thank you for letting me be part of this project, and I know turn it over to my friend and colleague, Doctor Michael Crow; Michael.

DR. CROW: Thank you, Gordon, and thank you, Jim, for your leadership, and Mark and the Brookings Institution for their leadership in all of this. I think I'd like to take an angle, a view in this discussion that asks each of you to think about why it is that we could find $25 billion, if we took just the first part of this equation, put it in from a government expenditure perspective into the existing intellectual infrastructure that we have, and we would almost certainly fail if we didn't do anything else.

We could find all the money that we could possibly print, which is what we do with money these days, and pour it into this problem, and it wouldn't actually allow us to organize ourselves to move in the right direction. We would take the existing infrastructure and we would fail.

So we need a change of mindset, and this report and this proposal outlines how this mindset can be shifted. Let me pick five particular points. The first thing that we have to start doing is stop

measuring our scientific success by the amount of money we spend on science. We need to start thinking about and focusing on what is the outcome that we actually hope to achieve, regardless of what the outcome costs. So, for instance, if we're worried about our energy security, and if we're worried about our national security, if we're worried about our national sustainability, both economically and environmentally, let's set that as the objective, let's measure every dollar that we spend toward that objective, that we move toward that objective, not have we produced more scientific papers, we have to do that to get to the objective, have we obtained movement toward that objective, so that's the first point of changing mindset.

We've got to start focusing on outcomes, not on inputs, because it's not about inputs, it's actually time to grow up.

Second, we need increased cooperation between sectors, we just can't pull it off. Let me use an example of a project that we're managing at ASU right now, $100 million from the Army, the Army came in and said there's a whole series of unknown scientific things that need to be worked out, a whole bunch of things that need to be thought through about how to produce a particular technology that the Army wants, a flexible display technology that a soldier can wear on their uniform to get information in real time. They said we don't know what all the problems are, we don't even care what all the problems are, don't even tell us what

all the problems are, just figure out how to make it, it's a completely different logic.

So right now in one of our facilities are 30 companies, the Army, the university, and everybody else that you can possibly imagine focused on a cooperative venture, not to parse out who does the science and who does the technology and who does this part and who does that part, there's one objective, produce this technology and deploy it.

It's a very different way of thinking about things, a very different way of approaching things. You have a solution and a mindset that you work toward.

Third point, the linkage between research and development and entrepreneurial venture engagement needs to be shortened and greatly enhanced. I used to be the Executive Vice Provost of Columbia University for more than ten years, and we ran a technology transfer operation there, and this is not to criticize the Department of Energy, which I admire greatly, but that single university produced more technology transfer outcomes than all of the Department of Energy Laboratories combined, not because the Department of Energy Laboratories weren't fantastic scientific institutions, but because the notion of instantaneous doesn't exist in the lexicon of operating a government laboratory, it can't for lots of reasons.

And so how do we then design these linkages between

research and development and entrepreneurial adventure activities so that in the United States we can take advantage of two powerful forces that we have, the force of entrepreneurism and the force of discovery, bringing those together to actually match up into this term that we're using for these institutes called innovation, instantaneous technology transfer.

Fourth, we need new institutional structures that permit high speed engagement around small scale solutions. I think, Jim, you mentioned that. This isn't going to be like the Manhattan Project or the Apollo Project, which were projects designed to produce a technological outcome with a single purpose that ultimately – while it had some side benefits to the economy, is very different than everything that we're talking about relative to energy. I think Jim says it right and the report says it right, it's more like agricultural, it's more like other things. We need to find ways to build institutional structures that permit high speed engagement across small scale solutions, thousands, and thousands, and thousands of them, not single pathways.

And then lastly, we need a regional network approach, which these institutes really outline for us and are really critically important to us. And let me use another example from Arizona. We've been struggling, I've been struggling in the seven years that I've been there, why is it that, you know, we don't have just like the solar everything that you can possibly imagine in Arizona because it's very difficult.

It's very difficult to take all the forces of an economy, all the forces of innovation, all the things that are working, each company's little direction and so forth, to actually build a plan, build a strategy and so forth. So we've been working, for instance, the last few months in Arizona to build a conceptual plan for a 20 gigawatt solar electric distribution system. I mean everybody is at the table, all the solar companies, the universities, everybody, the power companies, the California power companies, the Arizona power companies, everybody. It is extremely difficult, and the existing structures that are in place, the existing mechanisms that are in place, the existing ways in which we integrate or don't integrate mostly, research with other kinds of things are actually the principal barriers that we have to success in building that 20 gigawatt solar electric distribution system in and around Arizona and Southern California.

So the most important message I hope that you get from this presentation of this new concept for this institute is, we have to change our mindset seriously. It's not about the money, it's about how we organize ourselves and how we move forward. Thank you.

MR. MURO: Well, Jim, Dr Gee, Dr Crow, thank you for those highly valuable perspectives. And with Jim's presentation, the President's reflections, I think you have framed our discussions quite well today, and we're going to continue doing that now. I also just wanted to acknowledge Congressman Gary Peters from the Ninth District of

Michigan who is here and perhaps will join the conversations later.

Good afternoon, everybody, I'm Mark Muro, Fellow and Policy Director at the Metropolitan Program at Brookings, as well as the Manager of this project, and it's my great privilege now to usher our conversation on today by introducing Senator Sherrod Brown of Ohio, who's going to provide some initial comments here; a few I would say are really better place to do that.

For three decades, Senator Brown has been a tireless advocate for job creation and working families all across Ohio. As a U.S. Senator, he's combined his dedication to rebuilding our nation's middle class, and his commitment to protecting our environment, with work to turn Ohio into what he calls the Silicone Valley of Alternative Energy.

In the last two years, he's held more than 125 roundtables in all of Ohio's 88 counties; that's a lot of advance work for somebody. But pulling together local business leaders, academics, workers, community leaders, to talk over how to rebuild the economy and put Ohio and the nation on a course for energy sustainability.

It was at all of those roundtables he introduced the Green Energy Production Act of 2008, which he has recently reintroduced. And legislation will provide grants to encourage sustainable energy manufacturing technologies. More broadly, and I think provocatively, Senator Brown has emerged as an important member of what's being

called the Tech 15 group of senators who is going to play an inordinate role in any climate legislation in the coming session. Here is where Senator Brown has focused intently in combining cost containment on carbon pricing with aggressive investment in new technology. So Senator Brown is an important person to hear from today. So let's all welcome Senator Sherrod Brown.

SENATOR BROWN: Mark, thank you, and it's a pleasure to be here. President Duderstadt, nice to see you, and President Crow, and Gordon Gee, my long time friend from Ohio, Jeff Wadsworth, whom you'll hear from later, and the work that Batel in Ohio State, the synergism coming out of there, it's a big part of the future, not just central Ohio, but energy answers and other answers, and thanks for the work – the leadership you're showing in the national labs and the work that you're doing at Ohio State.

When I came in, Doctor Gee was particularly nice to me. My mother passed away a week ago today, and he was very kind when I walked in, and I wanted to tell a real quick story about my mom. My mom was 88 years old, and she was doing very, very well, very active, until the middle of December, and then got sick, and she – but she was very lucid and talked to us right up until the last two or three days. And we would, my brothers and I and my wife would – spent most of every day, most days with her in these last six weeks at our home in Mansfield, about

halfway between the cities of Cleveland and Columbus, and I would – my mom was devout, we read – she would like us to read from the Bible, I'd read from Psalms or read the Beatitudes to her, whatever, and she also – one day she asked me if I would sing a couple of Lutheran hymns to her, and I got my Lutheran – I found the old Lutheran hymn book on her shelf, the one from when I was a kid, and I began to sing Beautiful Savior, a song she loved, and she smiled as she was listening, this was about four or five days before she died, and then after I finished she said, that was very nice, but, you know, you sound better in a group. So she never really lost her ability to always say what she needed to say.

Special thanks, too, to Bruce Katz at Brookings. Amy, thank you, and Mark, thank you for what you're doing with all of this. And Bruce has been particularly helpful in thinking about solutions in a state that's facing a lot of challenges. This country has been in recession for a year. My state and your state have been in recessions longer than that, as we know, and deeper recessions, and the work that Bruce has done to help Ohio figure out how to revitalize our Metropolitan area is really, really important, and we're so thankful for that.

We're here obviously today to discuss a new era in green energy research and innovation, and I appreciate particularly President Duderstadt's comments about commercializing as we this – as we do this research, as we develop news ways.

And this will be an era that draws upon America's greatest strengths of creativity and entrepreneurship. It's a – we need – it's a – if you've listened to the outline of the three college presidents, university presidents, it's an environmental strategy, it's a national security strategy, it's an economic strategy.

I want to talk mostly about the economic strategy, taking on some things that Keith said about unemployment and all that that are so important. The stakes, as we know in our country today, couldn't be higher, the opportunity couldn't be greater, and I'm one of those people that thinks that climate change is probably the greatest moral question of our generation, and it's an opportunity also, though, to grow our economy and do all the things that everyone talked about here. Unemployment is at its highest in 16 years. We lost 2.6 million jobs in 2008 alone; we're now losing jobs at the rate of 400,000 to 500,000 a month. The unemployment rate – your statistics were about three days behind because they're now 7.6 percent nationally, I believe.

If you look at the underemployment, because a large number of Americans are either not looking now and not in all the statistics or underemployed, that number is really double that, it's a size 14 percent.

Obviously, the economic and environmental policies that we've pursued in the last few years simply aren't working. That's why what you do as scientists, as advocates, as university people, as policy

experts, all the work you do is so crucial.

By investing in green energy research, in policies that tackle climate change and reduce our dependents on foreign oil, we can put our nation on the path for renewed economic success. It's not just an environmental issue, as you know, it's not just an energy issue, it really is about American jobs and rebuilding this economy. We can build – we have a rare opportunity to reinvigorate manufacturing, which is not just a mid-west issue, although many analysts and many reporters and many politicians seem to think it's sort of only a mid-west heartland issue, but manufacturing is much bigger than that, it's national. California is the biggest manufacturing state in the country; Texas is a major manufacturing state. It's not just Ohio, and Indiana, and Michigan, and Illinois, and Iowa and states in our part of the world.

We can build, in the case of my state, we can build on our auto industry, which has been a leading economic engine for all kinds of next generation manufacturing.

Wall Street Journal had an article a couple of weeks ago tracing the auto – the importance of the auto industry along the Ohio Turnpike, from Toledo, to Cleveland, to Akron, to Youngstown, and the story wasn't the auto industry itself, but it was all the companies that grew out of auto entrepreneurship, of auto technology, of all that the auto industry did.

Companies as diverse as jobs in the aerospace industry, even the soap industry, some major soap manufacturer makes Purell, you know that company, Gojo, came out of the tire industry, which, you know, was obviously related to the auto industry in Akron. Those jobs were created out of American manufacturing's ingenuity and entrepreneurship. Plain and simple, we work to build more fuel efficient autos, we'll expand opportunities for new manufacturing jobs that become part of the green job supply chain. We'll literally grow our economy as we protect our environment.

Just a sampling of a scale of opportunity, every commercial scale wind turbine built uses the equivalent amount of steel as 225 mid sized cars. Every time you turn a light bulb powered by solar panels, you use enough glass to replace your car windshield. If every home were insulated at current energy department recommended levels, we'd need an additional 34 million tons of insulation, and that means jobs, and we would save nearly $13 billion a year in energy costs.

As Mark said, I have conducted about 125 roundtables around Ohio. We'll invite 20 or so people from a community, a good cross section of people, and just ask them questions about what we can do in partnership with local government, with local business, with local labor, with local community service organizations. One of the things that's come out of this repeatedly is a program called – a program with community

action organizations called Weatherization, where the government hires teams of four people, usually one team per county, and counties of 30 to 50 to 60,000, and they will weatherize this team of four people, they'll go out, spend three, four, five days at normally the home of an elderly person who's low income, and they will weatherize their home.

It creates jobs, it builds skills for these workers. We in the stimulus bill are going to perhaps close to double the amount that we're spending on weatherization through this program.

Every place I've gone in my state, people have told me the waiting list is two or three years for senior citizens that – low income senior citizens who need their homes weatherized. And that plays right into Owens Corning, in Newark, Ohio was the first and the largest home insulation plan in the nation.

It's not the first thing that pops into your mind when you think of green jobs, but that's the point. It's an example of reach and diversity that defines the green energy manufacturing supply chain. Just this morning, I was reading on the way in, the *Wall Street Journal*, there's a special journal report on energy, how to go green in hard times, and it's not just going green, they give examples, what we do with high tech thermostats, and air filters, and compact fluorescent lights. And it's not just people individually save money and companies saving money, it's the number of jobs that it creates by doing the right thing on energy.

And I remember growing up, when I was first in politics three decades ago, there was always the – it's either good for the economy or it's good environmental policy, that the environment always costs jobs, and we've obviously grown way beyond that to understand things like this, that good environmental policy, good energy policy obviously creates jobs.

Yet it creates jobs in a lot of sectors, but it, particularly in manufacturing, which is woven into the fabric of our nation for good reason, we let our countries manufacturing capability erode at our own peril.

Manufacturing for many Americans, perhaps for most Americans in our history, in our recent history, in our last 50 or 75 years, has been the ticket to the middle class. Manufacturing jobs pay better than other jobs, have a stronger multiplying effect, supporting as many as five other jobs, and are critical in helping support the vital public services and schools and communities across the nation. – manufacturing can build the new green energy technologies that can halt climate change and our dependence on foreign oil and keep us – help to keep us globally competitive.

How do we do that? We first, as President Duderstadt suggested, we pass a climate change bill that puts a price on carbon. That will drive demand for green energy. By creating markets for green energy, we can stabilize our nation's energy supply, reduce our

greenhouse gases, and bolster manufacturing.

It's been estimated in terms of a global market, the advanced and energy sector will double several times over the next decade, from $55 billion to $225 billion. Wind power alone will grow from $18 billion to a $61 billion market, and if we do not – but if we do not establish a significant green energy manufacturing component in our nation, as part of our larger climate change efforts, we'll end up exchanging dependents on foreign oil for dependents on foreign solar manufacturing. That's no plan for success.

Oberlin College, one of the great small colleges in our country, it's about 15 minutes from where I live, Oberlin College is the home, built about five years ago, the largest building, fully powered solar energy building, many of you are nodding, thank you for knowing that, on any college campus in the nation, even larger than any building in Arizona, if I could add. Maybe that's not still true after –

DR. CROW: It's not still true.

SENATOR BROWN: It's not still true, okay.

DR. CROW: Not still true.

SENATOR BROWN: I won't tell the story again or I won't tell – at least I won't tell the guy from Arizona in the audience.

DR. CROW: We just installed ten megawatts of solar on our campus.

SENATOR BROWN: Okay. Nonetheless, but more to the point, there is a point to this, at Oberlin –

DR: You asked.

SENATOR BROWN: Yeah, I did ask. At Oberlin College, when I talked to the gentleman building this and the architect, they had to buy all their solar panels in Germany and Japan, no surprise there. Putting a price on carbon to create green energy demand is crucial, but it's not enough. We don't have the luxury to rely on one winning strategy, as you can see in this report, we need to pursue all of them. We must make a major investment in green energy research and development so we can achieve these – and that is why this report and the discussion it starts is so important to all of us and to our country right now.

Our nation's system of energy production delivery is unsustainable. Our dependence on fossil fuel threatens our economy, threatens our national security, and threatens our grandchildren's' earth, as you know.

The global economy is relying on fossil fuels for 85 percent of its energy needs. And by 2030, global energy needs are expected to grow by 50 percent over 2005 levels. Existing technologies are, of course, simply inadequate to meet those sustainability goals. Investments in new green energy technology is the only path towards economic and environmental sustainability.

Green energy technology must be researched here, and that research must be translated and commercialized into jobs where we build green energy here. And I would close as I was thinking – listening to the President speak, it occurred to me that what we are able to do in this country and what we've done in the past, when I saw the picture of Senator Justin Morrill of Vermont, who was the – whose brain child was the land grant universities of which some are represented here today, I thought about when the federal government makes a major commitment to a national effort, and you can go back as early as the Erie Canal, when the U.S. government made a major commitment to build the Erie Canal and the other canal systems, and what that did to spawn all kinds of economic growth, all kinds of technology, all kinds of advance in the sciences and in our economy.

And then you can look at what happened with the land grants. You can look at what happened when the government made its commitment with President Eisenhower and Senator Albert Gore, Sr., on the Interstate Highway System in the 1950's, and the government's commitment on technology and computers in the '70's and '80's.

And then you figure what happen when the government makes a major commitment and puts some of the brightest people in the country together, like the people representing in this room, people that have an understanding of the public sector, have an understanding of

science and technology, have an understanding of how to work to translate that research and commitment into the private sector. And you can look at the kind of growth and you can look at the kind of – the ways that our country has so well met those challenges. That's why your work is so important, that's why we can't stop, that's why the real work for all of us starts now. Thank you.

MR. MURO: Well, thank you for those really thoughtful remarks, Senator Brown. It will, indeed, provide us some important perspectives about the issues, but also the opportunities before us. And we'll let you – we wish you well now as you get back to saving the U.S. economy with the recovery package.

So with that, we now do have a good, you know, 15 or 20 minutes for some questions of our three presidents here. So why don't we go now to some questions from the audience, with the usual urging that you limit speeches and ask concise questions. I think we have capable Brookings staffers brandishing mics for you. Let's take the questions actually three at a time, and please preface your question with your name and your affiliation. Here, sir, yellow shirt. So we'll take three.

SPEAKER: Hi, my name is Seth -- and I'm just here as a concerned citizen. My question about these institutes, and I think they're a great idea, is, how do we distinguish between basic science research, which is already funded, and energy research, because it seems like in

many cases there will be an overlap; how do we sort of make sure that both of those are funded, but this doesn't – basic science funding?

MR. MURO: Good, okay. How about a couple more? Good, right here.

MS. WORTHEIM: I'm Mitzi Wortheim, I run something called the Energy Conversation and also the Energy Consensus which we started back in '05 and managed to get into the President's State of the Union speech, the nation is addicted to oil.

I think you've left something out. My own view is that energy, though technology is really important, the really important thing is how people think, feel, and behave. I grew up as a Bell Labs baby, my father had over 100 patents there, I know what that was like, and he got rewarded for doing good work, he got $1 for each patent.

We have this problem now where the value system in our country is about how much money you make, and what worries me is the intellectual property issues that are likely to come out of what you're talking about, and until we can change our value system, which says the commons is more important than what I get, I don't see how we're going to get there. Because I do think the technology is going to be abundant, but it really is about people.

MR. MURO: Okay, thank you. Maybe one more. Let's see, how about over there.

MR. DOTY: David Doty from Doty Scientific. We have heard and can all understand that the DOE has not done an adequate job of fostering innovation. I worry that the institutes that you describe may fall in this same trap, that they publish extremely narrow solicitations, outside the box ideas that may be scientifically sound, and even really breakthroughs often are not supported. Is there that same risk with these fairly narrowly described institutes?

MR. MURO: Okay, very good. Jim, do you want to take on distinguishing, powerful, and viable propositions from other ones, so I think the first question?

DR. DUDERSTADT: Sure; you know, there are various flavors of research, there's some that's driven by curiosity, by the interest of science, that wins Nobel Prizes and so forth, there's some that's driven by technical applications, by a certain objective, that's sometimes called Jeffersonian Research, because although Jefferson portrayed the purpose of the Lewis and Clark expedition as fundamental curiosity driven research, actually he was trying to – not to get the Spanish too upset while he explored the American West for eventual colonization.

I think what we have here is a situation where the knowledge base that's necessary for taking fundamental discovery out of the laboratory and into the market place where it serves society is simply not there. It does require a certain amount of long term research, that's, in

fact, what's missing. It used to be done by places like Belabs and General Motors Research Labs and so forth, it's just not done anymore in my industry.

The labs do it, but consistent with their mission. And what we're talking about are new structures that really have that as their most fundamental purpose. They will do some degree of fundamental research, but it's use inspired, it has as certain application associated with it, and that's I think the theme of this.

MR. MURO: Great; Doctor Gee, do you want to take on the moral issue here and the question of peoples' behavior?

DR. GEE: First of all, let me just say that I do believe that Oberlin still has the largest – I think –

SPEAKER: But they don't have any sunshine.

DR. GEE: You know, and when Senator – what my Senator says is true, is true, I just want it to be on the record, Michael, and I hope you'll tell him that I said that after he's left.

DR. CROW: I'm meeting with Senator McCain later, and I agree with everything.

DR. GEE: You've got a problem. But anyway, I think that – I would say that, first of all, I agree, absolutely. The issue I think the three of us are trying to talk about is not about doing the same business in the same way, it's really about a word that I think we'd all agree with, it's about

reinvention, it's maybe even about reformation or revolution, and that has to do with creating different kinds of structures that will not only create a culture of collaboration, but also that we will collaborate with many different partners, including our publics, because if we – you're absolutely right, if we continue to reward people in the same way, if we continue to have the same kind of reward structures, but yet we're talking about trying to create something revolutionary within that, we will fail. But the moral imperative drives us, because we realize that we are now facing a cliff and we're going to fall all off – we're all going to fall off that. But if we can change the moral imperative by changing the structures themselves, by moving from these very – and I happen – I don't want to quote myself, but I will, I talked yesterday about the fact that the universities are organized very vertically and what we've got to do is, we've got to organize ourselves horizontally.

And this is the same kind of thing, we're moving from a different paradigm, and if we do that, then we do change moral behavior, we do change personal behavior, and that I think is what we're trying to accomplish.

MR. MURO: Very good. Doctor Crow, what about the narrowness question, the question of sort of repeating the same in a new context?

DR. CROW: Yeah, so to Mr. Doty's question, yeah, that's

the most likely trap that we would fall in, which would be to replicate what we already have, which I already indicated at the opening of my comments, if we have that and just put more money into it, we will fail. And so it means that these institutes, and I think the way that they're described under various types, various structures, various mechanisms, and with this regional focus, work in ways to try to avoid following the same structural path. It is, as Ms. Wortheim suggested, often about behavior, not only the behavior of the citizens, but the behavior of the scientists, the researchers, their drivers, their motivators, and so forth. And so if we find ways to change the metrics, from the metrics of scientific output to the metrics of a certain kind of outcome for a region, then we're looking at behavior, then we're looking at different types of scientific activity, then we're looking at different ways to measure our success, and if we stick to that and we change our mindsets, we'll have a better chance of not falling into that sort of structural mechanism that we have right now that you're worried about.

MR. MURO: Very good. How about three more questions? Let's go way over to the left, politically or otherwise.

MR. ROSENBERG: I'm Adam Rosenberg with the House, Science and Technology Committee. I think that there is broad consensus that we need far more resources for energy research and development throughout the federal government. The big question I have is, the

recommendation is that this builds up to $6 billion roughly for e-DIIs, when that's roughly equal to the current amount that we spend on energy R&D. And within that, you have $100 million to $200 million for each e-DII. How does this not become another – essentially become a network of permanent earmarks, which you might say current large laboratories and other institutions are, and how does this compare to the energy frontier research centers which aren't permanent earmarks, but the Department of Energy, Office of Science has recently proposed and has a lot more targeted focus on specific areas with a lot of research behind them?

MR. MURO: Good question. Now, let's vacillate over to the right. How about back here in the –

ANGELINE: Hi, I'm Angeline with a local non-profit called Artesk. And my concern is kind of general overall sustainability, and I worry that if we focus too much on solving the climate crisis without thinking about overall sustainability, we'll kind of end up in our same position with other external problems, kind of like biofuels ended up leading us into a food crisis, so something like that. In this proposal, is there any kind of consideration of how we'll integrate studies of sustainability and make that an important part of this thing?

MR. MURO: Very good. And how about back to the middle here? Yes.

SPEAKER: The efforts you're talking about, which are very

important, all tend to centralize. But in terms of getting adequate, true innovation, don't we need to increase our funding for investigator initiated grants, spread it around?

MR. MURO: Okay. Let's – Jim, why don't we – how do we avoid this becoming a system of energy discovery earmarks?

DR. DUDERSTADT: Let me talk a little bit about scale. The energy sector of our economy is about 1.4 trillion a year. We spend about 400 billion a year in imported oil. We spend about 150 billion a year on federal R&D, about 30 billion on biomedical research, and a significant fraction of that goes to the campuses. We're recommending a similar kind of an investment, 25 to 30 billion a year, most of which will flow into the existing energy research activities, the national labs and industry.

And so within that range, five to six billion a year for this kind of an activity is not that large a scale, it's very comparable to biomedical research, in fact, it's less than that. It's when you add in state support and so forth, that's kind of comparable to what agricultural research has been for a long time. It's very large; if you try to take six billion out of the 3.4 billion a year, you're now spending on energy R&D, okay, and that's the problem, okay. The simple fact of the matter is, for a variety of reasons, whether you're a conspiracy theorist or whether you just think it's been – we have throttled back in both the public and private sector the necessary investment and the new kinds of knowledge and technologies we're going

to need to lick the energy challenges faced by this country.

And we've got to step back up to the plate and begin to reinvest, okay. Where do we get the money? Well, we're talking now in the trillions, right, in terms of the economic stimulus package. But in reality, we're talking with numbers much larger than that in our existing subsidy, not in R&D, but simply of the energy sector.

When you talk about cap and trade or ways to control carbon emissions, you're talking perhaps in the hundreds of billions. So the money is there, the resources are there, what is absent is the will and the recognition that this is one of the great challenges today faced by our society. Will these become entrenched? Well, the energy frontier or frontier energy R&D centers are really nothing more than the engineering research centers, the science and technology centers that the National Science Foundation has been running for many years, the same size, just the fact the Department of Energy never has gotten into that, they're finally being lured into it, they're going to build some of these things.

The National Science Foundation has been managing dozens of these things around the country, they put sunsets on them, so that after ten years, they fade away, they're rigorously evaluated.

We think that the energy discovery innovation institutes would also be determined through some kind of a peer competition, they would have very strong kinds of evaluation, not simply for scientific merit,

but what their real impact is on regional activities at regular intervals, and we would probably recommend that they have sunsets put on them so they don't become a permanent entitlement.

So all of the issues you raise are certainly appropriate things to raise, but they're a part and parcel of how we do research in this country, and have done it for many, many years, and I think agencies like the National Science Foundation and National Institutes of Health have extensive experience in managing these kinds of activities at the scale or larger than the ones we're talking about today.

MR. MURO: Doctor Crow, why don't you take on the question of whether we're missing the point and missing some overarching sustainability across sectors and across industries?

DR. CROW: Well, Angeline's question was actually very good because it is something that we commonly do and that is that we limit our thinking to these small boxes, and so we say, well, let's do biofuels and build switch grass options and corn, and lo and behold, the price of tortillas in Mexico changes and the social and cultural infrastructure around the world begins to be effected by a whole range of things.

And so the thing that we have to do goes back to what I talk about as mindset. We've got to stop being cavemen and cavewomen. They're people that have very limited thinking, they think only about the

isolated part of the problem. We need new tools. There's a new tool being developed out of an NSF center right now called Real Time Technology Assessment, it tries to look at all of the areas of implication, social, cultural, economic, technological, behavioral, across all dimensions of a technology as it moves forward. And I think that we need to make certain that we don't do what we did in the past, which is try to pick a technological pathway, and no matter what happens with that pathway, that's what we do, and then we end up finding out later that, yes, we created all this energy, at the same time we can't deal with the nuclear waste, and we've, you know, doomed the Columbia River.

And so we have to think through these things at the time that we advance these technologies, not later, and so that's a very, very good question. And these institutes would be very equipped to be able to do that, in my view.

SPEAKER: Can I respond to the last question just a moment?

MR. MURO: Absolutely.

SPEAKER: There's no question that to be successful in this, you have to provide sustained support for the brightest minds in the country to get them to focus on these issues. That will take sustained significant – over a very long period of time of faculty, of other researchers that work in the kind of traditional mode of a faculty member, a laboratory,

graduate students, and so forth. There are many models on how this can be done effectively. I think one of the most effective ones is the Howard Hughes medical investigators, which support eminent scientists over a long sustained period of time so they don't have to worry so much about grants -- and has enormous impact.

Some of the members of the transition team that have been looking at energy and innovation issues believe that same paradigm, what do they call it, the National Energy Initiative, or something like that, should be a model that's adopted in this.

It's perfectly compatible, what we're talking about, and this so called hub and smoke system, where these groups, faculty with very long term support, probably on the campuses rather than these institutes, would be supported whether they're supported directly channeled or through the institutes, but they would be coordinated both among themselves and with other people doing the more applied stuff.

But I couldn't agree more that in all of this, we have to sustain, and, in fact, increase the support of getting the best people to begin to address this problem. And it's going to take those kinds of very senior kinds of appointments and research grants to make it happen.

MR. MURO: Let's just take two more questions. How about here by the aisle?

MR. GROVE: Bob Grove –

MR. MURO: Hi, Bob.

MR. GROVE: How do you do? We go way back. This is a question for – just you talk about the brightest minds, and go – why not go global, you know, bring them here? We already have, in Arizona, first solar, but they do manufacturing in Malaysia. So – and then light emitting – energy conservation, these are global issues in the – community, they can't save and do a lot of good.

MR. MURO: Good question. And how about here, again –

MR. AJEMIAN: Thank you; Chris Ajemian. I'm a consultant who has worked for National Laboratory. And my question to the presidents is, it sounds like this is an excellent initiative, but is it going to be housed within the Department of Energy, which, in my view, is an organization that doesn't really seem to know what its mission is? We could debate whether we have a national energy policy or whether we should, but it seems like DOE has several masters, and sometimes it feels like DOE is – its main goal is really to be tech support to other agencies. And so if we're going to do science, we're going to do energy, or outcome related energy policy in DOE, does that mean that it's going to be its own master? Thank you.

MR. MURO: Okay. Two good questions. How about D.r Gee, do you want to talk about how this should intersect with, you know, global innovation?

DR. GEE: Let me try to – there are so many questions that are floating around here, let me try to draw just a general analogy, if I can. The answer is yes, it should, but let me try to put it a little bit more in context.

I think that Jim and Michael and I, when we took on this project and agreed to do it, do it because we do not believe that we can put old wine in a new bottle, rather what we have to do is, we have to put new wine in a new bottle. In other words, we believe totally in a recreation, in a new way of thinking about these issues.

And so when you ask these questions, whether the Department of Energy is set up to do this, I think that what we are talking about is a fundamental recasting of the way that we really do our business. It starts with our own universities. Michael has done remarkable things about – at Arizona State, certainly we try to do that at Ohio State, and certainly the University of Michigan has been doing that. And so the answer to your question is, absolutely. The world is flat, we're going to have to connect ourselves, and if we don't, then we will certainly become an isolated island, and we'll become a third world country very quickly.

And as to the Department of Energy, the same – we would ask the same question, as we think about a new – in terms of this pattern of real time, real opportunity, we're going to have to ask our government to

reinvent government as part of this process. So this is not simply about energy, it's also about a way of thinking.

MR. MURO: I think the same two questions should be handled by each of our team here, so Jim, do you want to go, and then Mike?

DR. DUDERSTADT: Sure; science today is a global activity. Cyber infrastructure means that I'm interacting in real time with dozens of scientists around the world every day. In fact, I interact 100 times a day with someone from the Brookings Institution. I mean that's just the way science works. It's now independent of time and place, and most intellectual communities are global in extent. Whether we should attract people to the Unites States, well, we're always interested in attracting outstanding people to the United States, but on the other hand, we're also interested in working with them to tap their minds and their ideas and that can be done around the world, so that's just kind of the way things work.

To the DOE and the National Labs, the National Labs are extraordinary resources for this country. They're one of the greatest concentrations, scientific and technical talent that we have, they have enormous creativity, they have the opportunity to do not only fundamental research, but they can do it at immense scale. It would be very difficult to replicate by universities or anyone else.

But the problem is that much of that creativity has been

difficult to unleash because of the way that Washington constraints the labs because of their history and so forth. I think, from our interaction with people in the labs, they also understand that new paradigms are necessary, they have some very creative ideas to approach it. Many of them liked very much the idea of these kind of partnership interacting with regional markets and so forth that are characteristic of the discovery innovation institutes, and that's why we viewed the labs as, just as universities, as potential sites where these things could form. But I think the key here is to realize that different paradigms are necessary, and organizations, whether they're research universities or national laboratories or industry have to have the flexibility to allow creative people to shape the way they do things to adapt to that.

I personally have enormous confidence that now, as Secretary of Energy, you probably have a person that understands this better than anybody, someone that understands the frustration since time of leading a major national lab, someone that has done Nobel laureate quality work in universities, someone that has actually spun off institutions, kind of similar to what we're talking about with the bioenergy institutions that were formed with the Lawrence Berkley Laboratory and University of California Berkley and so forth, he gets it, and whether Washington bureaucracy will let him follow through, I don't know. But I think finally we have a person at the helm that may respond to some of these frustrations

that many of us have had.

MR. MURO: Doctor Crow, do you want to take one final?

DR. CROW: Yes, very quickly. To my Arizona and Bob from Tucson, a fellow Arizonian, the simplest way to deal with this immigration issue associated with scientists and attracting the best talent in the United States is just staple the green card to the back of the diploma.

So the issue is, we want to attract talent, we want them to prove themselves, the diploma is the proof of their effort and their ability, they need to just staple the green card and then let things sort of take forward from there.

To this question of the Department of Energy, while I agree very much with Jim's comments about Secretary Chew, he's also inherited one of the strangest and most bizarre institutions in the universe, and so – in the following sense, it transitioned from the Manhattan Project, which was a U.S. Army Corps of Engineers military project designed to produce a weapon of mass destruction, to the Atomic Energy Commission, which was an effort to continue the development of weapons of mass destruction and maybe on the side do something else with it so that you could continue developing the weapons of mass destruction with a little bit less heat on you, and then there was this temporary thing, the Energy Research and Development Administration, that existed for a short period

of time, and then in 1977, the Department of Energy was founded.

Along the way, the mission – the core mission remains, develop the weapons necessary to protect and defend the United States, that still remains at the heart of the core mission.

And so one needs to go in, I believe, and seriously adjust, expand, enhance, whatever the word is, the definition of the core mission of the Department of Energy, I think that was the framing of the question, that goes to what I was talking about in terms of the outcome, what is the outcome that the Department of Energy is working toward.

Right now, I don't think you could get consensus among the leadership within the Department of what that outcome ought to be. There's too many conflicting things in the intellectual history, the legacy of that department.

SPEAKER: -- is the right word given what you've just described as blow it up.

MR. MURO: Well, with that, we're going to need to move on from this very stimulating period of Q and A and get ready for our panel discussion, which will hopefully be as lively. So essentially now we're going to pivot from framing the energy problem and Brookings suggestion of one proposed response to some discussion of these ideas, from a variety of very specific and relevant perspectives, that of the environmental community, that of the VC world, that of the private sector,

that of regional economic development, that of public education.

Basically, as you're hearing, we assume that the move to a global clean energy economy is going to require fully engaging capabilities of the entire American and global innovation system. That means we need to create forums for intent, high speed and production interactions between research universities, units of the DOE lab system, corporate R&D centers, venture capital and entrepreneurship community, regional economic leaders, regional clean tech industry clusters.

Given that, we thought it would be valuable to hear the opinions, suggestions, and caveats of an array of such voices. Since all these communities are going to be critical to the success of any drive to – the kind of revolution we need to enter into a low economy – low carbon economy. So I'd like now to invite our panelists. . .

(Recess)

[in progress]. . .answers and five for the future, each of which have set out critical issues that will determine America's ability to compete and prosper in the global economy. In each case, accelerated energy sector innovation strategies have been important portions of his story. In addition I should add that Bill is a published novelist and the author of the Washington political thriller, *A Good Day to Die*. I'm not sure how large sales were on this; in fact, Googling it and Amazoning it did not yield high placements.

MR. BATES: And that's all you need to know!

MR. MURO: But I do see intriguingly this in a story from *Roll Call*. "It's a nice, apocalyptic story that involves the demise of the capital, Bates said with a smile."

So with that, let me hand this over to Bill Bates, who will moderate our panel discussion and, again, field questions from the audience. We're hoping we can leave a little -- a few minutes for that. So as soon as Bill is ready, we'll let it rip. All right, thanks a lot. Talk to you later.

MR. BATES: Great. Thanks. Can everybody -- mike's not on? Okay. Everyone take a moment and stretch. Okay. Now can everyone hear me? Terrific. We'll probably have to send a dollar to Verizon every time somebody says that, right?

Thank you, Mark, and good afternoon. Okay, we can do better than that. Good afternoon.

There we go. I want to make sure everybody is still paying attention. I want to thank The Brookings Institution for allowing me to be a part of this event today. On behalf of all my colleagues at the Council on Competitiveness, I want to say how excited we are to be partnering with Brookings on issues that are so critical to America's future. The Council is the only place where CEOs, university presidents, and labor leaders come together to ensure that America can prosper in the global economy. And

we share the urgency that's being expressed today about energy security and sustainability. It was the case that these were a defining challenge for this country before the current economic crisis, and it will be that case once America is on the path to recovery from this crisis. The Council has an energy security, innovation, and sustainability initiative. We released a report last September called "Prioritize," which identified key steps that the President and Congress need to take to put America on the path towards a secure and sustainable energy future. Two recommendations from that report: Tripling America's investment in energy research, and better leveraging federal research assets to drive energy innovation and economic development, are both echoed by the report that we're discussing here today on Energy Discovery-Innovation Institutes.

I'm very fortunate today to be joined by a tremendous panel made up of experts in the energy arena who are going to offer their perspectives on the energy challenges that this country now faces and how the Discovery Institute idea could address those challenges. What I'm going to do here is briefly introduce everybody, and then we're going to get right to a discussion. If all goes well, we should have opportunity for some more audience questions at the end of that discussion. I think you have everybody's full bios, so what I'm going to here do is summarize their entire careers in a sentence or two, and if they're still talking to me at the end of that, we'll start our discussion.

To my direct left is Michael Shellenberger. He's a futurist, a political strategist, and the president of the Breakthrough Institute. Michael's going to help us understand the magnitude of the challenge that we face and what the appropriate response needs to be.

To Michael's left is John Denniston. John is a partner with Kleiner Perkins Caufield & Byers and someone who is very familiar with the challenges facing startup companies, and the challenges that they and the country as a whole face in the clean-tech world.

Our third panelist is Howard Berke. He's the chairman and co-founder of Konarka Technologies. Howard has lived the commercialization story, helping develop power plastic, a material that can convert light to energy. He also serves as a senior advisor to Good Energies, a leading global private investment firm in solar photovoltaic companies and wind developers.

Sitting to Howard's left is Billy Glover. He's with Boeing Commercial Airlines. Billy leads the team responsible for developing and implementing a global environmental strategy for the company, including everything from design to greenhouse gas emissions.

Next down the line is Bill Harris. Bill is the president and CEO of Science Foundation Arizona, and works at the intersection of research and economic development, demonstrating that innovation is much, much more than what goes on in the laboratory.

You know, we've heard the EDI proposal, hearken back to the land-grant college concept, and our final panelist, Peter McPherson, knows more than just a little bit about that. Peter's the president of the National Association of State Universities and Land-Grant Colleges, which include 217 members and over 5 million students.

Okay. So that's who we are. So we're going to jump right into what we know. Michael, I want to start with you. Speaking as a leading environmentalist, you've emphasized the urgency of the energy challenge and why innovation is so important. What else needs to be done to transition to a global, clean-energy environment?

MR. SHELLENBERGER: Well, I think first some context is needed. So between now and 2050, the world is going to triple its consumption of energy. And if we want to get to where the United Nations IPCC says we need to get to in terms of keeping global temperatures under 2 degrees Centigrade or less, we need to cut global emissions in half by 2050 and basically zero them out by the end of the century. So tripling global energy consumption, cutting emissions in half at the same time -- it's been China, India, the rest of the developing world are going to contribute most of those new emissions, and they've made it really clear that they're not going to reduce their emissions or put a cap on their emissions until they reach our per capita emissions levels or Europe's per capita emissions levels. So that creates a particular challenge, which is

that fossil fuels are cheap. It's not just a consequence of having a big fossil fuel lobby here in Washington. China built one to two new coal-power plants a week last year and the year before that. It's doing so because coal is an inexpensive and easily available technology, not just for China, but the rest of the world. So if you want to deal with this emissions challenge and deal with the energy challenge, you've got to have a strategy to make clean energy cheap in real market, unsubsidized terms. And so I think when we start thinking about what is the strategy for the labs, what is the strategy for the DOE, I think President Obama and the Congress need to come together and agree that our goal is to make clean energy cheap.

Now, that's a different strategy than my colleagues in the environmental community have largely pursued, which has been one of having fossil fuels represent their true environmental cost. The challenge of making fossil fuels cost a lot more is that neither the public nor governments around the world have been willing to do that. So -- and even in places like Europe when they've had a $40 price on carbon, which is a fairly high price, it wasn't enough to slow coal-plant building or plants for coal-plant building. So what we're suggesting is that in order to get those massive cost reductions, you need a great deal of innovation. The good news is that America, in particular, is a country that's had a lot of experience getting those cost reductions. Microchips cost about $1000 a

chip. In the late 1950s, the Defense Department bought so many of them through government procurement that the price came down to less than $20 a chip. And we like to think that Silicon Valley was sort of invented by these great inventors like Hewlett and Packard in their garages, and they were great inventors, no doubt about it. But Hewlett-Packard wouldn't exist if the Defense Department hadn't bought radios during World War I. Intel wouldn't exist if the government hadn't bought microchips. Xerox PARC, the federally funded R&D programs, responsible for the personal computer. Our point is that we didn't get personal computer revolution by putting a cap-and-trade system on typewriters. You know, we didn't get the Internet by putting a tax on faxes and telegraphs. We got there through direct government procurement. And what we find is that innovation is a large process that includes customers telling their suppliers how to innovate. And so R&D is important, but in the case of things like wind and solar, we had to get out of the labs into the real world. Denmark had to deploy large wind turbines offshore in order to get these very efficient, much cheaper, sources of wind power; same thing for solar panels. Japan had to outright buy solar panels; same thing with hybrid technologies. It wasn't as Thomas Friedman has often claimed that it was just because Japan had a higher -- had greater efficiency regulations. The government worked very closely -- I think, to the president of Arizona State's point -- the government of Japan worked very closely with its auto

industry on R&D, and it also guaranteed a market for those products. So if I was to emphasize anything, it's that R&D -- the R&D proposal that Brookings has created -- is absolutely essential, but it's not enough. President Obama and the Congress need to also have a major commitment to deployment and government procurement of these new technologies.

MR. BATES: Fantastic, appreciate that. John, let me turn to you next, a similar question along a similar vein. We read a lot about how much money venture capital is pouring into green-tech or clean-tech. Does the federal government need to get involved? I mean, we don't want to set up a competition, as Michael was just sort of hinting at. How do we strike the right balance?

MR. DENNISTON: Sure. So, it's a very interesting question. I've actually testified several times in front of Congressional Committees, and that actually, exactly, is a question that I got last year, and so here's the answer that I gave -- is that the venture community and federal energy research are not in competition at all. They are synergistic. And so, just as we've heard some examples historically of the interplay between federal research funding and commerce, let me add two additional examples. The first is the entire biotechnology industry. The biotech industry was funded by NIH's predecessor in an area that was then called "genetics." Nobody called it biotechnology back in the 1960s

and 1970s, and my venture capital firm in Silicon Valley, Kleiner Perkins, had the great fortune of funding two researchers out of UC Berkeley and Stanford, and we called the company "Genentech." And that was the world's first biotechnology company, and we would not have had the privilege of funding those entrepreneurs if NIH's predecessor had not forward-funded for a decade this area of research. Today the biotech industry is an enormous industry, employing a large number of Americans. And it's made a big difference to our economy and to our world, not to mention saving millions of lives.

The second example is the Internet. The Internet actually owes its origin to DARPA, the Defense Advanced Research Projects Agency, which is an agency of the Department of Defense. And what DOD was doing in those days is actually something that is quite similar to Jim Duderstadt's idea, which is let's do research for advanced military technologies in a collaborative fashion, not in a siloed fashion. And to this day, anybody who has knowledge of the history of federally funded research in the U.S. points to DARPA as a beacon of success. You can point to lasers, robotics, so many different industries, but I'll focus just for a second on the Internet. So to encourage collaboration to make it more efficient, the people at DOD said hey, can we create a network so we don't have to fly every time to Washington, DC, or to Ann Arbor, or various other different places for everybody to meet? Can we create a network

where we can share documents? And that's exactly what they did. And so for a period in the 1970s and 1980s, DARPA funded research into that network which they called the "DARPANET." Through trial and error, they figured out the protocols, and they perfected it. And again, my firm, Kleiner Perkins, had the great fortune of investing in two of the earliest Internet companies, AOL and Netscape. And we would not have had that ability had DOD not forward-funded DARPANET. And so I think it is very synergistic what federal research funding does. From the venture capital perspective, we love to see the research. We need more shots on goal.

The other thing I will say is, separate and apart from the different functions, federal research funding and the venture industry performed, I think it's important, as Jim did, to focus on the numbers. So Jim says that the size of the energy industry in the U.S. is $1.4 trillion. If you add transportation, it adds up to a $1.7 trillion industry in the U.S., $6 trillion worldwide. Last year, in 2008, the entire venture capital industry in the U.S. invested roughly $2.5 billion -- that's with a "b," not a "t" -- billion dollars in renewable energy research. And if you show me an industry that is investing roughly one-tenth of 1 percent of its annual revenue in research and development, I'll show you an industry that's not prepared for the future. We are so far off, we are on an order -- I would say at least an order -- Jim says an order of magnitude -- I think it's more than an order of magnitude off on the kind of research support that we need.

There is no chance, I'll tell you, no chance that the venture capital industry can get us there alone. The venture industry will play a role, but it is -- the federal research funding is -- indispensible. So at a macro level, where are we, and why is the EDII idea such a great idea? We have seen in the IT industry what Moore's Law can do. And it's taken us from an era where the only computers that we had 40 years ago were large, mainframe computers the size of this room that only the largest corporations in America could afford, to a time where now you have your cell phone, your Smartphone -- that is a computer. It has logic. It has memory. It has a display. It has a keyboard. It is a computer more powerful than many of the mainframe computers that we saw 40 years ago. How did that happen in 40 short years? It happened because of Moore's Law, because of innovation, a large portion of which came out of our university labs across this country. The good news is in renewable energy, we're on a similar track right now. If you go back ten or fifteen years, you'll find that in that space of time, we have doubled the efficiency of virtually every renewable energy technology -- solar, batteries, wind, bio fuels, the list goes on. And that's before we had a concerted effort of our best and brightest and significant funding to deploy against the task. And so what we -- the problem we face right now is we don't have enough shots on goal. University researchers across the country are pleading to have the funding to create breakthroughs in the renewable energy industry, and they do not

have the funding to do it. And so we need to significantly increase our research funding to make America competitive, to address the climate crisis, and to become energy independent. And the special idea that Jim Duderstadt brings to us today is yes, let's increase federal research funding for energy, let's do that. We desperately need to do it, but let's be smart about it. Let's create a multiplier effect. And so it is not just silos, individuals researching. Yes, we should do that. Yes, we need to do that; great breakthroughs come through in that fashion. But let's create a multiplier effect by having the researchers, where appropriate, collaborate so we get the best and the brightest working together. That's the DARPA model that was done very successfully, and I wholeheartedly endorse Jim Duderstadt's idea; that is what we ought to be doing in the energy field.

MR. BATES: Thanks, John, appreciate those comments. Speaking of collaboration and a shot on goal that seems to have scored, let me turn to Howard. Can you highlight for us how Konarka is an example of the type of collaborative research and development effort that's really central to the whole EDII proposal?

MR. BERKE: Well, first let me thank The Brookings and The Metropolitan Policy Program for this opportunity. It's also a privilege in that Konarka sits here, and I have the opportunity to present Konarka. But I can assure you that there are hundreds, if not thousands, of other very innovative, alternative energy, and renewable energy technology

companies -- startups, present and future -- that deserve to be in this seat along with Konarka.

But Konarka is unique in a variety of ways, and before this policy statement was put forth, before this research was done, you know, I was out raising capital to start Konarka in the year 2000 and 2001 when you couldn't get a nickel from a venture capitalist. This was post dot-com and the telecomm bust. And I couldn't get but a few to even listen to me about energy technology, with all due respect to Kleiners and others of the world.

I'd like to share with you a perspective. I don't know how many folks have done serial entrepreneuring, but Konarka's my thirteenth company. And I've started companies in a variety of disruptive technology areas. In addition, I've spent my career on Route 128, where I am now, in the Massachusetts area, but 16 years in the Silicon Valley and three-four years in the Midwest with startups and technologies. So I may not look it, I'm 54. I've been doing this for over 30 years, and I've see a lot of new technology waves. What's different from my perspective is in those technology waves, whether it was the Internet which I participated personally and my company did -- and to go to the earlier comment -- you know, let's not tax the incumbent technology. Well, communications is federally taxed, and the Clinton Administration made a wise move and did not tax the Internet for communications, and that was a great shot in the

arm for that technology. So I believe that government interventions, and when done smart, can really push innovative technologies quicker to commercialization, scale up not only in America, but deploy this technology around the world.

The other comment I want to make, and then I'll highlight Konarka, is that in a lot of these waves of technology, I've seen innovation turned into commerce -- commerce companies, and some of the leadership of American companies amongst the Fortune 500, the Global 1000. But that did not happen in alternative renewable energy. In fact, America handed it over to the rest of the world. We had that leadership, and we lost it. And there are lessons, painful lessons, not to be revisited here.

About sustainability -- there was a question about sustainability -- we thought putting lead in gasoline was a pretty good idea. It got rid of the knocks, boosted the octane. We thought putting lead in paint was a pretty good idea. It stabilized the paint to last 30 years. Let's be deliberate about what we do. Let's not have another asbestos in insulation or lead in paint and gasoline. When we scale up these renewable energy technologies, not only should they be renewable, but they should be environmentally sustainable. Let's not trade one crisis for yet another.

About Konarka, well, the heart of Konarka is innovation, and

we're the contrarian. We're the guys who never get funded because we're so out of the box, nobody wants to give us a nickel. So I was going around the world, saying that the future of solar was not just silicon, it was carbon, and at a time when 99 percent, 99 percent or more, of solar was all based on the Adam silicon. If you look at the periodic chart above silicon, what do you have? Carbon. What did Mother Nature pick 600 million years ago? Carbon. The year I was born, in 1954, Bell Labs discovered a photovoltaic effect in doped silicon, and we have the modern day solar industry. So today the largest and wealthiest by market cap company in solar is one that isn't silicon, and it was innovated in our national labs in the 1970s when that budget for R&D was way higher than it is today. And that company is First Solar. And Konarka is based on Nobel Prize recognition -- a discovery that didn't come from the energy industry -- in material science. And I was looking for that intersection between energy and material science, and I found my co-founder, Alan Heeger, at UC Santa Barbara. And Konarka was formed by the spinning out of two state universities, the University of Massachusetts and the University of California, Route 128, Silicon Valley.

Another unique aspect of Konarka is from the start we collaborated with academia. We supported labs. We went out and partnered with leadership labs in the United States, and as well in Europe, to bring the best world scientists around this invention. If we're going to

change the world, we're going to do it around the world.

And then the other thing that we did is we tried to convince the national labs that this made sense, and their initial reaction was this didn't make any sense. But I found a few scientists in the national labs who thought this did make sense. So instead of ignoring the national labs, I embraced them. And when they said no, I kept saying please find a way to work with us. So Konarka spun out of state universities with a contrarian. We've received support from the Department of Energy, from DARPA, from the Department of Defense, the NSF. We've received state support in Massachusetts and California. We've received state economic development support in Massachusetts. And we've raised $150 million of venture capital, private capital, and corporate capital. And from day one, or near day one, I embraced large Fortune 500 companies. I know they can't innovate, but I know they can scale and deploy technologies and make them global. And so Siemens owns part of our company. Total, one of the largest oil and gas companies, now owns part of Konarka. In addition, we partnered with DuPont almost from the founding of our company. So we found this, in my brain, this collaborative model where we would bring together the best scientists in the world, national labs, academic campuses. Now there are 27 around the world that are funded by Konarka. I would raise capital, venture capital, from the leading venture funds in Silicon Valley, Route 128, as well as in Europe. And we

would do all of this in a collaborative fashion. Now ladies and gentlemen, that's what you're hearing this policy recommendation is all about, and it works, and you can use Konarka as an example. And I believe not only do you have to raise the budget, absolutely, but invest it, not spend it, invest it wisely. And this sort of collaboration between national labs, academia, VC innovative startup companies, working with Fortune 500 and 1000 companies to gain scale around the globe, it works and Konarka is a demonstration of how well it can work. Thank you very much.

MR. BATES: Terrific. Well, we'll definitely get to some questions, I promise you. Thank you. That's a great story, Howard. Turning over to Billy Glover, Billy, as the large company representative, if you will, at the table or tables, what's in it for Boeing to push for greater innovation in the energy arena, and how are you going about doing that?

MR. GLOVER: Thank you. Let me start off by saying I'm going to focus on commercial aviation. And if you think about it, we have some really unique energy challenges. We have several million parts, 35,000 feet in the air, flying in very close formation, at 500 or 600 miles per hour, and we need to do that economically and efficiently. The flight for me from Seattle last night was less than 50 gallons of fuel to get me here. What other mode of transportation does that? None. So we've been working on fuel efficiency, basic conservation, through improved engine, airframe technologies, structures, materials, air dynamics, and so

on, since we started with a 70 percent improvement in vehicle efficiency since the dawn of the jet age, since the '60s. So we've been working on efficiency, but what we realized about three years ago is we have a new opportunity. A problem is that our old paradigm is tied to fossil fuels. So while we generate 8 percent of GDP worldwide through commercial aviation, we also -- commercial aviation is associated with 2 percent of global CO2. We need to figure out how to stop that from growing, and turn it around. So we need to keep working on efficiency, but that's not enough.

The other, the only other physical way for us to do that is to fundamentally change the fuel. And so about three years ago, we were complete skeptics that that could ever be done. We have such extreme technical challenges that we need to meet, that we said, you know, that's not possible. But then we saw some things that kind of said well, maybe we should ask around. So we started three years ago on this kind of journey of discovery, and said well maybe there is something here. But one of the first things we did was we decided we weren't going to try to compete in the fuel production space. Instead we were going to collaborate in a new way because we felt that we needed to get something going, it's probably a distributed model of lots of winners, not just one, and the only way that people are going to talk to us was if they feel we are facilitating and not competing. So we set out to do this, and let me tell you

I have had some very interesting discussions with some of our contracts folks. You want to let a contract to a university to do some studies on sustainability, and you don't want to retain any rights to that? No, because if I retain rights, it has no value. If something has to be put out in the public domain so that we can get criteria in place so that we are developing sustainable bio fuels, not just bio fuels that people have questions about, and that it's credible, it's third-party peer reviewed, that sort of thing.

We've been successful in getting to know the space very well. We have now pretty much proven all the technical challenges. We can actually produce fuel that is better performing, higher energy density, lower freeze point -- which is kind of important when you're up at 35,000 feet -- and we have done this in a way that we now have lots of people ready to take the next steps towards commercialization, scale up, and so on. There's still a lot of work to be done, but what we need is -- as was said before -- outcome-based things where we have R&D that's now matured that we're ready to deploy.

There's a lot more work to be done. We're working with Arizona State on algae -- which is a little longer down the road -- but has great promise, so productivity improvements, possibilities. And this is a way to create jobs, improve the environment, sustain the economic benefits and the social benefits from commercial aviation. And we think

we have somewhat of a unique challenge, and we need some help to make that come true. We're not like a lot of other modes of transport or a lot of fixed emission sources. We don't have that many opportunities to fundamentally change our source of energy. So this is something we've been working with federal labs, universities, public and private companies, to do. And this collaborative approach has enabled us to move very quickly, and so I think what's proposed here in terms of an approach to federal research, is right in line with what we have had recent experience on as being very beneficial.

MR. BATES: Fantastic, thank you. Collaboration is quickly becoming a key word down the road here. Bill, let me turn to you. You've had the opportunity to study the research community from inside government with NSF, overseas with Science Foundation Ireland, at the state level now with Science Foundation Arizona. A key tenet of the Council's work has always been that innovation is no longer the tenet of the lone researcher in the lab, but it's cross-disciplinary, it's collaborative, it's now global. I'm curious, does the budget shortfall that a lot of states now have offer unique opportunity to explore novel partnerships like those proposed out of the DII with the federal government as a catalyst, for example?

MR. HARRIS: Well, let me do one thing first. I think the short answer to that is yes, especially in these times. But I think the

premise of the meeting today, and even just the words, discovery-innovation institutes -- I think they're the right words. I know that there'll be people that will be concerned about individual investigator grants, and that's been an issue for a long time. I think what Dr. Crow said earlier, what Jim Duderstadt mentioned as well, we have major societal problems. And I don't think that there's a better sector or a better institution to solve these problems. My concern, I guess, as an observer living in Europe for five years and watching the U.S., is a growing breakdown in the political dialog and the political consensus of getting things done. We used to get things done. We've created a situation that whenever you talk about doing something like this, you're accused of picking winners or losers. What we're talking about is open competition and collaboration. And one of the things -- when I went to Ireland, I had the opportunity in starting this Science Foundation there is they had a pretty much a green field, there wasn't a lot of history. And what I found from talking to industry, from the biopharmaceutical side to the optic side to the computer chip side, is basically what Billy said, they want to work in a new way and collaborate. The model where we dominated the world uniquely after the 1950s and we had a monopoly in so many fields is gone, and yet in some ways we think we still have a monopoly. We forget we've lost Bell Labs. We forget we've lost a lot of other labs, and again when I talk to people -- and we now have experience in Arizona of getting companies who are put there

for manufacturing who want to figure out how to work with the universities. Now Arizona State University is a relatively new university. It didn't do research when Boeing started, so there's not a lot of collaboration that's going on there. We have begun to stimulate that because of there are unique assets in that state. So I guess the thing that I would like to encourage some discussion about is the recognition that first and foremost, our universities have a human capital talent pool that's second to none. We are probably not deploying it as well as we could. We probably don't have the incentives that are in place to allow these things to work as well as they could. It's not the university's fault; it's the incentive system that we've created. And I think when Dr. Crow talked about just counting publications or dollars, we created a system that doesn't talk about economic development and bettering the communities and bettering the states or bettering the region. We've got disincentives. We're trying to work within Mexico and California, a very, very desirable goal for regional cooperation on energy. We want to do that, the scientific communities want to do that, the legislatures of the various states have rules. We have boundaries that we have to live within. So I think to go back to your question, I think if there's a federal role here, it could remove some of the friction that exists in local legislations about you can only work within the state. There are no boundaries in these kinds of problems. We've got to work across the states.

The other thing that I think would be good to talk about is the desire and the important role with the federal government. We have over the last 20 or 30 years given the impression that government is bad. Well, I think we've had enough examples up here that have shown what government can do that's well. And as a society, we have to begin to recognize that government can be a very powerful, unifying force, if we can figure out how to work together.

I'll finish with talking about the land-grant model, which I have been a fan of forever and I'm not going to take your time, your words. But I have been frustrated for years that that concept has not been modernized. The land-grant model is singularly the most effective transformation of a society from a agrarian society to a modern, industrialized society. And it works so well, it seems obvious that if you took that model and applied it at large, you'd have huge success for our society. I actually think that's kind of what Dr. Crow's doing; he calls it the New American University. But he is so connected to the society that he's trying to solve problems. Some people will look at that and say well, that's not what universities ought to do. I think that's precisely what universities ought to do.

And then the last point is the intellectual property. What I found very impressive in the report, Jim, was they focus on exploiting intellectual property rather than framing mountains around it, preventing

universities from actually getting it used. That's been my frustration in dealing with some things in Arizona is getting intellectual property used. Again, ASU has listened to my complaining and their own concerns and has new processes in place, as you mentioned in the report, the new processes at Berkeley and so forth. I think we need to go to the future and innovate and figure out how to define the future, because we did that in the '60s and '70s. The world has caught up with us. They're doing everything we can do. So if we don't learn to work together in new ways, regionally and through these institutes, I think we're missing a huge opportunity. And I commend the leadership for your vision. And this probably doesn't even -- this model, I think, Jim, doesn't even limit itself to energy. It could be used in other areas, and I think what you have done is seeded the possibility of a new paradigm for how research could be done and how the universities could truly transform the society the way they did after the land grant. So thank you very much.

MR. BATES: Great, terrific, and you, of course, teed up my next question perfectly there. Peter, I want to give you an opportunity to respond to the accusation that the land-grant university

MR. BATES: Great, terrific, and you, of course, teed up my next question perfectly there.

Peter, I want to give you an opportunity to respond to the accusation that the land grant university model is a good one here, and also

wanted you to build on maybe a bit of what NASULGC is working on in the energy innovation area.

MR. McPHERSON: Well, when you look back at what this model was about starting 100 years ago or so, the concept was that you would link research with the farmers and education. And there are, of course, lots of differences, but what you had was a whole lot of people out there that were users of the technology and also told back to the researchers what they needed and what the problems were. That it was back and forth.

There's some real comparability to what we have here. We're talking about all of us as citizens using energy, we're talking about lots of players. The land grant system was not a command and control system, it was people working together, lots of disagreements, and to go back to the Mike Crow point, it was an outcome system. Farmers didn't care what you thought if they couldn't grow more corn other than what you told them. And the feedback was reasonably quick, actually. Now, more complex, different society and so forth, that I think there's something really there.

The way I look at this, to step back for a moment on this general concept, I think that there's going to be lots of ideas, there are lots of ideas out here on what the federal government should do, what we should do in this society. There's ideas on the Hill. There's members of Congress that have put forth some thoughts. I think this concept has embedded some key principles, as do some other proposals, and I think we need to keep these principles in mind in Washington. Nothing ever survives as it was originally proposed anyway, so, we're going to go through lots of reiterations, and we just have to keep our eye on what are the key points here.

And, as I see it, there's point one, that you've got to do something structurally, it's not just the way we've been doing it, and I believe this sort of loose structure -- we made the parallel land grant system, but the loose structure involving a lot of people where you link in, in a not very tight way, but structurally somehow, industry government and the universities. To me, that's principle one.

Principle two is you've got to free up with resources and some changes and behavior and so forth, you've got to do a lot more with the universities because they are deeply interested in lots of stuff going on now, but there's a little bit of siloing to it, too.

So, principle two is great augment of the universities, it's land-grant schools, but it's much beyond. It's the bio stuff, it's nuclear, it's wind, the whole list.

Principle three, we've got to put more resources, ease of effort and so forth into making the research into commercialization work better and faster. Of course, that fits into structure, but that's a sub-problem within it that we need to be sure to address.

And principle four, we've got to have a lot more resources.

But I agree with the point made several times here, the answer isn't just more money, it has to be in the context of this whole, and the way I like to look at this is that we are doing the GDP of this country and the healthcare and energy are about the same. But we're putting in terms of federal government resources, depending on how you measure it, five to eight or nine times more into healthcare.

Now, I'm all for the NIH budget. I think that's very important,

but I think that we don't have the problem properly sized when it comes to federal government research in this area.

So, those four principles, and it seems to me when we keep our eye on those, this concept, very sophisticated, very thoughtful, and what Jim and his colleagues and Gordon and Michael have done with this, I think, is just very impressive.

MR. BATES: Terrific. Thanks, Peter.

And we're going to get to some audience questions, but before we do that, let me just ask sort of a lightning round series here. Does anyone have any one-minute-or-less comments about what they've heard from the other panelists here?

Howard?

MR. BERKE: Since we're in the beltway, I feel compelled to say this, I'm a republican from New Hampshire.
And I was part of McCain's energy team. And my friend, Andy Karsner, who was our assistant secretary two and a half years ago in the Bush second term, he and I, late at night, would talk about the very thing we're talking about now, how siloed the national labs were, the disconnect between the marketplace and the researchers.

This is not republican, this is not democrat, this is not liberal, this is not conservative, we all see it. All of us that know and are pushing for a new energy paradigm in the United States -- and this energy transition, whether you're republican, democrat, independent, left, right, when you get into the guts, you see how it needs to be changed. So, it's not just about more budget, which is absolutely necessary. No matter what your

political flavor, we all see this change is necessary structurally and how we fund energy research, deployment, scale-up in America.

MR. BATES: Great. Michael?

MR. SHELLENBERGER: Yes, I was just going to add that, I mean, I think we have to have a higher tolerance for failure. I mean, I think when you go to Silicon Valley, there's good VCs, we'll say that the point is not to avoid failure, but to learn from the failures.

And I think that we have had -- that the golden fleece awards has been such a disservice in many ways. I mean, it's like so many ways we take these examples and we kind of go oh, God, here's just another government failure, but, of course, you go look at -- and I'm sure many of the investments that Kleiner Perkins makes don't work. You were looking for some really big successes.

(Laughter)

SPEAKER: What?

MR. CROW: I know, it's hard to believe.

MR. SHELLENBERGER: Yes.

SPEAKER: That's an outrage.

MR. SHELLENBERGER: That's right.

SPEAKER: It's partners that make the mistake.

MR. SHELLENBERGER: And I think as part of that, we need to also understand what our goal is. I mean, I think one of the things that gets thrown back at us a lot when you talk about the need for government

procurement (inaudible) is they'll say well, look at syn-fuels, look at ethanol, those programs failed.

Well, in fact, in the case of syn fuels, the mandate was to produce an alternative to oil for $60 a barrel. And they achieved that. Now, the problem was that oil went to $10 a barrel, but everybody remembers this colossal failure, and I think the point is, and I think other people have warned against, well, we might have some unintended consequence of these technologies.

We're not going to avoid failure, we're not going to avoid unintended consequences. The point is to keep moving the ball down the field and to continue innovating and keep supporting innovation despite or because of those failures.

And the one example I would just use is that in the case of syn fuels and also in the case of solar deployment in places like Germany, they set production targets or they set deployment targets, but the focus hasn't been actually on getting the innovation you need for consistent price declines. So, I think the metric that we ought to be using is are we continuing to advance the technology, is the price continuing to come down? If not, why not, and that might be a moment to discontinue.

MR. BATES: Great, thanks.

John?

MR. DENNISTON: Yes, the presidents talked about a number

of stark realities that we're facing. Let me emphasize one other that I think was implicit in a lot of what's been discussed this afternoon, but I want to make this abundantly clear that we today do not have the technologies that we need to address the climate crisis and to become energy independent. We don't have them.

I spoke before about the Moore's Law analogy and renewable energy, and that is true, but that's a step on the path that we need today. We don't have the technologies today, and if we stand still, we're not going to get there, and we will be overwhelmed by the climate crisis and we will be dependent on foreign sources of our energy, and if that's where we want to be, then let's not be creative, let's no do the e-DII. If we want to solve those, then we have to be creative.

The other stark realization that we need to come to is that this is not 50 years ago where America is the leader in technology innovation across the board in every industry. Europeans, South Americans, Asians realize it's technology innovation that first and foremost explains the American standard of living, and we are now in a global race to lead the green-tech revolution, which I believe will be the second industrial revolution, and if we aren't creative, if we aren't bold, we will not lead, and, as Jim said before, we'll be importing a different kind of energy source. It may not be crude oil, but may be batteries and it may be solar panels. I don't think that's the path that we should set ourselves.

MR. BATES: Great.

Bill?

MR. HARRIS: Just to go back to the original discussion of the DII, there may be a spin-off here that's possible because, as you begin to distribute these things, one of the things you have the opportunity to do with federal leadership is to begin to engage state governments in new ways, and I think state governments for the last 50 years, for the most part, have not had a responsibility for R and D. By and large, they don't understand it, they think that's a federal thing. And I think if we're going to get true innovation, we want to be able to have a more coherent approach to this across the country so the universities are better understood in their states, the K through 12 is better understood, and that the workforce is better understood.

And I think that the disconnects, I've concluded, are partly due to this lack of understand of R and D at the local level, and at the federal level, we understand it, we understand why we want great universities, but you get to some of the states, and it's really a huge disconnect, and they'll talk about government money for schools. That's just bigger government.

So, we have to really use this kind of a tool to really transform government across the country and not have everything centralized in Washington. I would encourage you to think about models that would have things here, but take advantage of the talent. This is no longer a small country; there are 300, 400 million people, and if you have it all in D.C., it's

going to be very slow and it's going to very unable to solve the distributional problems that we need to solve.

MR. BATES: Great.

Billy, did you have 60 seconds?

MR. GLOVER: I was just going to comment, I don't think we've talked enough about the urgency. And, while the concept we're talking about here is going to take time to mature, as somebody said, it's going to change a lot as it gets followed, but there's good work that's been done in the last 10, 20 years in R and D that's not in the marketplace today. And we have to figure out why that is and correct that very quickly because that's loss, that's loss that we'll never recover, and we need to take some of the principles we're talking about today and find ways to stair-step into that full concept that's offered.

MR. BATES: Great.

Peter, did you have a --

MR. McPHERSON: I was going to say that in addition to the work that we do here, we need to be fostering and encouraging other major users around the world. After all, to some extent, this energy march is fungible, and if China and India, emerging countries, Europe, can't figure out how to do this, it just won't work either.

MR. BATES: Terrific. Well, I know we have about I think 10 minutes left, if I'm looking at my watch correctly, so, let me open it up to the

audience, and we'll start right here in front.

MS. WERTHEIM: I'm Mitzi Wertheim with The Energy Conversation, which I started four years ago with funding from the Defense Department, and our mantra is listen, learn, connect, share, collaborate. That's not DoD behavior, it's very hard to get them to behave in that way.

My question for you is: How are you going to tell the story that I think has been so rich today to the rest of the country? It's bloody complicated, most people have an instantaneous attention span. One of the best things I've seen recently was the film that was shown at Davos which was about three and a half minutes on just the water problem, and it had no words. It's very hard to take the complex stuff you're talking about and present it to the national, but, by God, if they don't feel it, nothing really will happen.

MR. BATES: Howard, do you want to take that?

MR. BERKE: Well, my answer, in part, to that question is listen to our president. I think President Obama has got it. I think he understands it.

As an example, how many here have ever heard of Polaroid Corporation? If you haven't, you're probably young.

(Laughter)

MR. BERKE: But the fact of the matter is, when Obama talks about and when he hears these jobs aren't coming back, dismiss that, that

isn't true. So, when the president visited a company in Ohio, I think it was, that makes gears for wind turbines, Konarka purchased the flagship coating plant of Polaroid. And, today, we're making plastic solar films in that plant, hiring back those 300 employees.

So, if anyone tells you this is not an engine for economic development, this is not an engine for job growth, and that the future is both innovation and job creation, then they're not listening to our fine President of the United States.

So, first, how's the nation going to hear about it? Let's listen to our president.

MR. BATES: (Inaudible).

SPEAKER: I think that is a fantastic question, and I'm very, very concerned about that. I think that's one of our top issues.

I don't know of the solution to that other than sessions like this happening and us getting the word out. Unfortunately, the green industry is not as well-financed as other industries that are threatened by these changes that are coming, and that's a numbers problem, and I don't have a solution to it.

I read over the weekend a very interesting study where the American public, roughly 45 percent, believe that climate change is real and manmade, 45 percent of the American public believes that, okay? If you look at researchers and the climate scientists, experts, okay, the percentages are

90-plus percent believe climate change is real, 80 percent-plus believe it's human-caused, but if you narrow that -- this is, by the way, in a survey that went out to 10,000 researchers worldwide. If you focus that on those who are really writing, who publish research on climate and climate change, 97 percent believe it. Okay, so, look at that dichotomy where you've got 90 percent of the world's experts believing climate change is real and we better do something about it. Less than half that, 45 percent of the American public.

We have our work cut out for us. You ask a splendid question, I'm very concerned about it, we've got to get on it. It's a problem. it's a huge problem.

MR. BATES: All the way in the back? And this will be our last question, I'm afraid.

MR. HURD: Jim Hurd, GreenScience Exchange, San Francisco.

I've been watching for years now the discussion here in Washington, the tussle on Valley of Death issues, and Tom Friedman and others have said we can't compete on emerging on, leading on energy technologies if we don't address Valley of Death issues that get us between research and venture funding and increased corporate funding. And I am just not hearing anybody hardly talk about it. I've written some articles on it, but I'd like to hear what you all think about -- and I'm concerned with who we

have in the Department of Energy and who we have as our commerce secretary, that a lot of people are not particularly interested in funding and dealing with and coping with the Valley of Death issues, which, for people who are not familiar with it, is this crossover between what's funded for research and what gets ready for venture capital and corporate investing. So, I just wanted to ask that question.

MR. BATES: Yes. Great, good question.

Mike?

MR. SHELLENBERGER: Well, it's a great question, and I think it gets to this issue of why aren't the labs able to get us the technology breakthroughs that we need in order to have cheap, clean energy, and, to be fair to the labs, I don't think that's been their mandate. I mean, they've been focused on 20, 30 years out, and I think private VCs are focused on 1 or 2 years out, but you've got the 2-year to 30-year window that's not being invested in, and I think that, again, I worry a little bit that our focus is so much on lab research, university research, when really the big breakthroughs in terms of brining the price down, in terms of wind and solar, it happened through deployment, and it's also obvious to the case what other technologies like radios and microchips.

So, I think if you want to get across that Valley of Death, you've got to be realistic, that you've got to get the economies of scale that are required in order for those technologies to become much cheaper in absolute

terms. And I think part of the reason you just haven't heard a lot of talk about it is partly ideological. I mean, there's just been this sort of knee-jerk reaction to well, the government shouldn't pick winners and losers, and that would be like as though picking technology winners would be the worst thing in the world.

(Laughter)

MR. SHELLENBERGER: I mean, and also, it's interesting. We just did focus groups in Indianapolis and Richmond on the state of the economy, and, literally, we would ask people what should the government do about the economic crisis that we're in, and people would literally draw a blank. People were just kind of -- they had no answer to it, and when we would sort of remind them of the U.S. Government, the railroads, the highways, the microchips, the Internet, it was like everything changed for them, but it's sort of like collective amnesia about the U.S. Government's role in technology deployment and innovation.

MR. BATES: Peter, do you have a thought?

MR. McPHERSON: This area is where there isn't very much money to deal with, relatively speaking. I think there needs to be more research money, there is venture capital money if something is commercial-able, but we don't have much for the gap. And it seems to me that that's part of what we need to do here, there needs to be competitive grants money to be able to do it.

I think the labs have got a huge leap to get into the commercialization business, and universities have something of a leap to do it better.

MR. BATES: Howard, did you have a final thought?

MR. BERKE: Yes. Well, again, I play venture capital, too, with good energies, and there is this valley, and when Fortune 500s meaningfully spent money on R and D, they were able to fund within these major corporations getting that bridge over that valley, and their cost to capital and expectations were different than venture funds, and the risk reward, so, I believe with Fortune 500 companies not playing that role any longer and the Bell labs, and, for the most part, the IBM labs, Watson labs not what they used to be decades ago, I really think this is important for the federal government to step in.

And I give the example of METI in Japan. The Japanese Government does this excellently. They bridge that innovation to scale up, it's called METI, it's called NEDO, and it kicked our ass for about two decades.

(Laughter)

MR. BERKE: So, yes, there is a role for federal government. My Lord, I'm from Live Free or Die New Hampshire and I studied under Milton Freeman, and I'm telling you there's a role for the federal government to address it.

(Applause)

MR. BATES: Well, fantastic note to end the discussion on. Well, please join me in thanking our panelists.

(Applause)

MR. BATES: And I guess I turn it back over to Mark.

MR. MURO: I don't think we want to use all the lessons of Japan though.

MR. BATES: Yes.

MR. MURO: Great, well, that was very, very helpful, and I think we heard strong, conceptual support for the need for some sort of catalytic, multi-disciplinary engagement in the federal government in energy innovation, as well as some suggestions for implementers. So, the devil is clearly going to be in the details.

But to round out the day now, I'd like to introduce one of really our most special guests in some ways, one whose uniquely well-positioned to provide some summary reflections this afternoon. This is Dr. Jeff Wadsworth, President and CEO of Battelle Memorial Institute.

Battelle is based in the Columbus, Ohio. It's the world's largest non-profit research and development organization. And, in that capacity, Dr. Wadsworth manages or co-manages six major, national laboratories for the U.S. Department of Energy in partnership with leading universities and other industrial partners. Battelle, in this respect, lies in

the center of much of the present and future innovation activity we're discussing today, and, indeed, Battelle is increasingly utilizing a variety of unique partnerships amongst industry, universities, and the national labs to move discovery and innovation into the marketplace as rapidly as possible.

As to Dr. Wadsworth, he has special knowledge of these issues, I'd say. As before taking over as president and CEO, he led Battelle's global laboratory operations division and oversaw Battelle's management of it's DoE labs, as well as oversaw the startup of an entirely new renewable energy laboratory in Kuala Lumpur in partnership with the private sector.

Before that, Jeff worked at Stanford University, Lockheed Missiles and Space, and the Lawrence Livermore National Laboratory. He's also served as director of Oakridge National Laboratory.

So, what better way to wrap up our discussion today than by having Battelle's Dr. Wadsworth share his reflections on what we've heard today? Please join me in welcoming Dr. Jeffrey Wadsworth.

(Applause)

DR. WADSWORTH: Well, thank you, Mark, and thank you, Brookings Institution for making today available to all of us, and I won't thank anyone else except my dear colleague, President Gordon Gee, and it's always fun to meet him outside of Columbus, as well as our work

together with OSU and Battelle.

Boy, there's a lot of things I could reflect on. Battelle was created in the will of Gordon Battelle in 1920 to solve the Valley of Death problem. He was an early observer of the fact that research at universities wasn't making its way into the marketplace and dedicated his personal fortune, and then his mother did, to the creation of an institute designed to do that.

I love this comment about stapling a green card to a diploma. I came here for one year in 1976 and never went home. I'm legal.

(Laughter)

DR. WADSWORTH: But they sure didn't staple a green card, it took a few more years than that.

Battelle's tagline is "The business of innovation." We operate about $5 billion of R and D annually. The first comment I'd like to make before I summarize is -- and there was a very good question about it from the back earlier -- why is this such a tough problem? And, in my mind, there are two sort of triads of difficulty.

The first is you can't discuss energy without discussing national security and health. They're inextricably interwoven, they are great historical examples. I won't go into them. But you have to think about all three together, and then within energy, you have the

complication of environment and economics, not to even to mention a few more that we heard today, Jim, that also make it very complicated.

So, this is a tough problem, that's why it's not being solved, but America is a great, great country, and we should take on tough problems, and we've heard a lot of suggestions today.

The second point I'd like to make is that I am fearful that we have not got a system's view, a system's integrated view to all of the energy generation and disposition and that we run the risk of looking at this week's favorite solution, and we have to grapple with our problem, we have the computers to do it, we have the talent to do it, and that's something we're investing in at Battelle, because I worry that if go down just one path, you'll have unintended consequences and they'll be ramifications that are negative. So, that's the second thing we're doing.

So, what have I heard today? I've heard five points, I think.

The first is it's a complicated problem. I've just mentioned that.

The second is we need an increase of investment, and this is surely true. My caution here is that the investment increase has to be sustainable. It can't be a rapid up two years and a rapid down. Many of us have lived through that.

I remember a famous story about IBM where the director of research went to the CEO and said IBM's fortunes are going down, but

please don't kill the R and D because you can get rid of a world-class group over a weekend, but it takes decades to build them. And the CEO said good point, and the R and D budget stayed, less damage. When IBM's fortunes went way back up, he went back and asked for a lot of money, and he said the CEO said I remember you.

(Laughter)

DR. WADSWORTH: He said and what you said then was also true.

So, rapid increases have to be very carefully managed, but my main concern is that they be sustainable. You put together teams of people, teaming with university students, and then suddenly the money goes away, bad things happen.

So, that's my thought on the increase.

Creating robust partnerships amongst industry academia and national labs, yes, absolutely. I have a slightly different view of this because we do it all the time. And I've heard a lot of angst, but every time we run a national lab, we do it with either a university partner or an industry partner. That's how we manage them. We always have a set of core university, 7 to 10 at each laboratory. They're world-class universities. We also collaborate with institutions around the world, including Asia and European universities. Here in the States, we have over 3,000 industrial partnerships and contracts with Battelle and its labs.

So, certainly, there are things that work, and I think we need to look at those and understand why they work and build on them, not just sort of say nothing works and we have to reinvent. Let's look at things that have worked, and I've got plenty of examples from Livermore, Oakridge, and the other Battelle labs, examples of technology that have, in fact, gone out from the labs to industry, with industry.

In order to do that, you have to recognize incentives, you have to sort of say what is the coin of the realm at each of these institutions that makes them tick? And that is doable, but, certainly, we need new tools to help us.

Fourthly, rapidly transferring new technology into the marketplace. And we need to be far more creative and innovative in our business practices, and I've recently taken a new look at this. We tend to think of innovation as being a widget, but, actually, sometimes, the business direction you can pick or the business innovation can lead to better products, and it's an interesting lens to look through.

Who would have thought we'd have been downloading music onto iPhones and iTunes and so on or buying computers without ever handling them, by doing it through electronic purchasing and so on? There's a lot of business innovations, we have a long list of our own, and that's an interesting lens to view innovation through because it's not just the technical solution; sometimes it's the business solution that goes along

with it.

I am speaking from experience here. Rapidly transferring technology into the marketplace is in our DNA at Battelle. We invented the Xerox copying machine, and that was in the 60s. And, at that time, no one was interested in the patents. Everyone believed if you copied the Library of Congress once, you were done.

(Laughter)

DR. WADSWORTH: They hadn't thought about multiple copies and other things. And that was a $500 million profit in that day. And Chester Carlson picked up about one-third of it. We picked up two-thirds of it and lost on non-profit status. That's a different story.

(Laughter)

DR. WADSWORTH: We regained it.

We also invented the CD barcodes, cruise control, a bunch of things, so, we're very interested in how technology gets into the marketplace.

And, by the way, when we make a profit, we invest it in two things: we invest it in education and we invest it in our own R and D funding, including a venture fund, which we have, which is a quarter of $1 billion, and that is a high-risk bet we placed.

So, I listened carefully to your words because we told our board that we would make a significant return on that investment, and it's

nervous-making betting on ventures.

We've spun out 26 companies, and if you're afraid of failure, don't get into that game because some of them just flat-out fail, and you have to know when to get out. So, we're very interested in venture and leveraging and all the things that go with it.

Now, how do we improve getting technologies out of the labs to industry? Well, the first thing to do is ask industry how easy is it to work with us, and the answer is it's not easy enough. There are too many barriers, and it's too challenging sometimes to break through, but it does happen.

At Livermore and Sandia, we attracted a quarter of $1 billion of cash from Intel in something called sub microlithography.

So, again, if you have the technologies and you're willing to work it -- they were frustrated with working with three labs. It was Livermore, Sandia, Lawrence, Berkley, and National Lab. So, we solved that problem by taking one person and saying that's the entry into the three labs.

We then discovered there was more than one Intel. Were quite a few of them. So, we said you like that model, so do we. Who's the person we're dealing with, and then they go back as a scout back into the company and deal with all the language and social issues that they understand far better than I.

So, there are mechanisms, there are models that are being tried that I think could help in this regard, but we need better IP practices. That's the hurdle that causes the biggest problem for us. When we go off and try to do business across the country, even amongst our labs, amongst industries, intellectual property constraints are often very, very difficult to negotiate.

I think sometimes we are afraid of success. I do. I do.

When I was at Livermore helping start with the creators of the early 92s, when we were successful, we got into trouble. So, here's a fundamental problem. If you're paid by the federal government and you help a section of a commercial enterprise be successful, that's perfectly legal and it's encouraged, but if you're successful, it means somebody else is getting less market share than you are. By definition, they almost are. And when they wake up and realize their tax dollars are going to a laboratory that's helping their competitor put them out of business, they say I know how to solve this, I'll tell my congressman and launch into DoE. That's the observation I had. When you take market share and when it's a real transfer of technology and there's real market share being created, then you're going to have to have the stomach to deal with the reality of that.

And, so, you cannot be afraid of success because with it comes to tough decisions and it looks like you're picking winners even if

you're not, and you have to be willing to deal with that.

I'm optimistic that my formal laboratory director and colleague Steven Chu understands these issues. He went through them for several years, and I'm sure he's going to find new ways of producing solutions.

Final point, workforce of the 21st Century. This is being discussed a little bit today, but here's my view. I'm a baby-boomer. Since we're disclosing age, I'm 58. So, I'm right in the middle of a bubble that's going through our workforce. Bottom line, 40 percent of our workforce is retirement-eligible in the next 5 to 7 years. That's the bottom line. Date is freely available. There are some mitigating circumstances, we're healthier as we get older, we want to work longer, but, nonetheless, that's a big number. If you have a lab of 10,000 people, that means 4,000 are going to be gone in 5 years. And where are they coming from to be replaced? Where's the replacement term?

Well, it's U.S. universities. Still the best universities in the world, but the numbers just aren't there. Foreign nationals, they're not staying as long as they did. So, you've got an increase in pull term and two decreasing source terms, and that's a train wreck. So, when we look at our philanthropic purposes, we invest in stem schools, and there's a lot of interest in doing that.

Bill and Melinda Gates are investing with us, they've asked

us to help spend some of their money to try and inject some change into the education system, but all of us who study this problem, all roads lead back to Rome. It's a K through 12 issue. It's a pre-K issue. I wonder where it stops. Somewhere, we've got to increase the number of people coming into our workforce.

I understand the international argument. We're building a laboratory in Kuala Lumpur in Malaysia, Petronas asked us to design, build, and operate that lab. We're doing that. They're paying us. It's wonderful. We have an international workforce, but that's only a piece of the problem. Homegrown or home-retained people are vital for our future.

So, those are my five points. In summary, I'd like thank you for inviting me. I'd like to thank all the participants. I learned a lot; I hope you did. And, most of all, I'd like to thank the people who showed up because they're interested in one of the most important problems of our time.

Mark, would you like to conclude?

(Applause)

MR. MURO: And these are important thoughts for all of us to consider as the nation prepares to act boldly and this congress.

So, with that, I would like to draw this afternoon to a close with first an infomercial and then a thought.

The infomercial first. I just wanted to encourage all of you who'd like to continue to be updated about future discussion of this

proposal and others related in the coming year to e-mail us or leave your cards in the bowls in the lobby and we'll keep you apprised.

I also want to let you know that the full-length and abbreviated papers, Jim Duderstadt's PowerPoint, video clips, MP3 files, and other related materials are now posted or will be tomorrow at www.blueprintproperity.org.

As for the final thought, it's this. It seems like one thing we've heard today very clearly is that we need to invest more, probably much more, in the energy sector transformation, but we also need to invest differently. We can't simply do more of the same, that's been repeated over and over. We need to do more, but do some of it in very new ways. In that sense, I think we're all agreed that a serious discussion of the work before us needs to start in earnest right away.

So, with that, let me thank all of you, speakers, panelists, especially you in the audience, and thanks again. So, thanks so much. We'll talk to you soon. Bye.

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I, Carleton J. Anderson, III do hereby certify that the forgoing electronic file when originally transmitted was reduced to text at my direction; that said transcript is a true record of the proceedings therein referenced; that I am neither counsel for, related to, nor employed by any of the parties to the action in which these proceedings were taken; and, furthermore, that I am neither a relative or employee of any attorney or counsel employed by the parties hereto, nor financially or otherwise interested in the outcome of this action.

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