THE BROOKINGS INSTITUTION

THE ROLE OF DISTRIBUTED POWER SYSTEMS IN THE U.S. ELECTRICITY SECTOR

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PANEL 2: ECONOMIC AND ENVIRONMENTAL ASPECTS OF DISTRIBUTED POWER SYSTEMS:

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P R O C E E D I N G S

MR. FOX-PENNER: Good morning. Welcome to our second panel, and thank you all for being here. My name is Peter Fox-Penner. I'm principal and chairman of the Brattle Group, and it's an honor to be here with all of you today to talk about the subject of distributed power and the release of this fantastic report, which we'll talk about in a moment.

Let me just introduce the panelists, and I'll try to go down in order. First, to my right, Amy Guy-Wagner, who's senior consultant at E3. Second, Tom Casten, Chairman of Recycled Energy Development and a man for whom it can truly be said is a pioneer of the distributed energy space. Next, we have Ken Colburn, a senior associate from the Regulatory Assistance Project. After him, Allen Freifeld, who's senior vice president for External Affairs at Viridity Energy. Next, we've got Pedram Mokrian, who's a principal at the Mayfield Fund. And, finally, Steve Corneli, a senior vice president for Market and Climate Policy at NRG Energy, Inc.

I'd like to begin by asking the panelists to give us their high-level thoughts and I would certainly like to ask them to comment on the potential they see for distributed power systems to help the U.S. meet their energy and environmental goals. But, in addition, panelists, I would say this is your one chance to give us your grand thoughts about the whole energy environmental picture, distributed power's role within it, and anything else you'd like to share with the group.

And as one of the authors and consultants underlying this very fine report, I'd like to begin with Amy because I think she has some announcements in addition to her thoughts. Amy?

MS. GUY-WAGNER: Thank you. So, before I begin in terms of the grand scale of the initial question, I wanted to note that there is going to be an update to the report. The levelized cost analysis will be updated for the online version, and the update provides further support for our CHP conclusions, which we found that the CHP is a valuable and underutilized technology. So, and our LCOE model, levelized cost model will also be posted online so that people can use the model to review the assumptions, put in different assumptions, et cetera, and make it more of an interactive tool and a learning experience for everybody.

I was brought in to help with this report by Jeremy Carl from the Hoover Institute, and I was delighted to be part of it because distributed generation is really a key interest of mine. I think it's a

really interesting topic area, and I think that it's talked about very widely in the public, but not very many people understand sort of the true costs and benefits and it's a very complicated economic subject matter, which is partly why I find it really interesting because I'm a little economic nerd. But the part of the interest is that the distributed generation can provide some unique benefits based on its location, locating new generation in load pockets where you otherwise might not be able to cite new generation, has unique benefits, and I'm going to get into the details of my analysis perhaps at a later date or should I --

MR. FOX-PENNER: Perhaps, at a later date -- later time on the panel.

MS. GUY-WAGNER: I don't know if I should get into all of the details right now in terms of what our findings were, but I'll let everyone else give their general thoughts, and then I'll come in.

MR. FOX-PENNER: Well, this is Washington, and we speak in sound bites. Is it possible to get your thought on what is the headline emerging from the report?

MS. GUY-WAGNER: The headline emerging from the report is that we're very close in terms of the economics of distributed generation. CHP is cost competitive in certain instances, solar is getting very close to being cost competitive, as well, and the cost effectiveness of distributed generation really depends on whether or not you're able to locate the distributed generation in congested node area, which means that you have the benefit of avoiding the distribution and transmission, capacity build-out, the additional generation build-out. Basically, you stack all of these different benefits on top of each other and you provide much more value to the system. And, so, understanding that nuance and what types of technology can actually do that is the real key for the market entry right now, and then as the prices increases over time, as we heard Jim Rogers talk about, then the opportunity will open up even more.

MR. FOX-PENNER: Excellent summary and much appreciated.

Tom, please. Push your button, I think.

MR. CASTEN: Thank you. Very pleased to be here. Thank you for allowing me to share in this panel. My message is very simple: good quality CHP is a proven technology that can profitably address each of the major problems the studies laid out: national security, sustainably, and climate change, profitable to society, and it isn't doing it.

Now, let me just give you the broad overview very quickly of why. I met with Senator Clinton when she was on the campaign trail, and she asked me my thoughts on global warming policy,

and I said well, Senator, none of the candidates on either side are asking the right question. She knew at that point I was a smooth-talking guy and humored me and said what's the right question? (Laughter) I said well, let me give you two factoids. First of all, the generation of electricity and the generation of thermal energy account for over two-thirds of the CO2 the U.S. emits. And she said yes, that sounds about right. I said okay, fact number two, the efficiency of generating heat and of generating electricity have not improved by 1 percentage point since Eisenhower was in the White House. And at that point, she looked at me and said why is that? I said, Senator, you just asked the right question. (Laughter) Why is efficiency the elephant in the room that nobody talks about? And I said I would commend you to ask your secretary of energy to do two things. Ask that question and then provide answers as to what we need to do to improve that efficiency. It's 33 percent; we waste 2 out of every 3 units of fuel, and that creates all the problems that have been referred to all morning. Now, I don't come at this just from theory. In organizations that I've led, including a joint venture with Jim Rogers, we've installed $2 billion of CHP. The worst of the 275 plants were twice the efficiency of the national grid. That should not be possible for somebody with my small brain to do that, and, yet, that's the opportunity that's out there.

So, why are we not doing it? When we reviewed the panel and talked about what we were going to do, we kind of said Amy, this is not a technology question for CHP, we've got the technology; this is a policy issue.

But what are the policy problems that we have? Number one, utilities are not rewarded for efficiency. They get no benefit from doing the extra complexity of CHP. That's one.

Number two, I agree the republicans did create the EPA, but in spite of them kind of looking at the markets, there's not a single market thing in the whole act. The word efficiency doesn't appear. EPA gives no rewards and does not recognize efficiency as a pollution control, and, furthermore, on close examination, you'll find out that it's a capital offense to improve the efficiency of an existing power plant because you'll lose your rights to keep polluting at the old level. We need to totally change the EPA.

The third thing is that markets, in spite of Bill Hogan's great arguments, have shown that they're not able to figure out how to sort the right capacity. I don't know the answer to that, I know what we're doing doesn't work.

Perhaps, the most important thing is that we got into a paradigm of central generation and we build up our whole rhetoric around that, and I just want to make the point of the key difference, which I think is a problem with the report. We look at the cost of generation at the bus bar or at the generator leads on the assumption that all generation is going to need the same set of wires. It's not true. Distributed generation has a tremendous advantage in that it avoids the transmission of distribution, it avoids the line losses, it avoids the peak generation, and when we say it's not really quite competitive, it's not competitive at the generator leads because it's small, this economy's a scale, more complexity, all of those things are going to make it a little more expensive in building a 500-megawatt central plant. But now you look at avoiding $1,500 a kilowatt of transmission, you look at avoiding for every kilowatt hour that you generate. For 100 kilowatt hours, you avoid 113 kilowatt hours of central power from the line losses you avoid. For every 100 kilowatts of new, local generation, you may avoid 200 kilowatts of new central generation on peak. You put all those things together, we're very cost-effective today, but we haven't been able to figure out how to capitalize the value. These are policy issues.

So, just to summarize, we see opportunities to cut the U.S. CO2 by about 20 percent with identified CHP. We think that would save something on the order of $100 billion a year from doing it. It would cost something like $400 billion of capital investment, almost all of which would be American jobs, and it would end up making our manufacturing sector much more competitive, and at the end of the day, instead of having 3,300 generating locations from a national security point of view, we'd have 300,000 generating locations, and we'd be able to island and handle all those problems. So, we have the solutions, the technology has proven the policy sucks. (Laughter)

MR. FOX-PENNER: That's what I call a Washington sound bite. Thank you.

Ken?

MR. COLBURN: Thank you, Peter, and I've worked with Tom Casten enough to know how little there is left after he finishes to add. A delightful job.

First, I want to thank you for the opportunity to join you in this gathering. I do wonder, given the incredible cooperation between Brookings and Hoover, if, perhaps, our interest in this gathering might be better served if we moved it about a mile east and had similar cooperation up there. That's another policy that sucks, I think. Let's figure out how to move it.

Tom did steal some of my thunder, so, let me just add a couple of perspectives. I think we're on the threshold of the next great decentralization. Many of us, certainly not all, I'm sad to say, in the room are old enough to have recalled being wired to central data processing departments. Now we run around with our laptops unhinged from everything, and including sometimes our minds. We all are old enough, at least I hope so, to remember being wired to central telephone stations and now we wander around with these things that exceed our imagination when cellphones were first conceived.

The next one, and Jeremy Rifkin referred to it as the "Third Industrial Revolution," is energy, and I submit that we will have devices and approaches that will exceed our imagination. So, think science fiction because it'll happen if we get the policies right.

As Tom indicated, we don't have a technology problem. There are technologies waiting in the wings, all will replace the kinds that will exceed our imagination if we get the policies correct, and I hope that's a lot of what we'll spend our time on today.

Let me offer two insights into that, which I think the report has materially moved the ball downfield, but still suffers from these problems. And one is distributed generation is almost cost-competitive today with the grid when we don't count all the other benefits that it provides. Is there a message there, perhaps an approach? Yes. Count them. We don't in all cases know the answers to how much they should be valued, and, indeed, that's a big problem for state commissions. We do know, however, that the wrong answer is zero, and taking the example of carbon in particular, since Massachusetts v. EPA, the carbon is no longer an externality. It's a risk, and commissions are used to calibrating risks. Lots of variables, I understand, but zero is the wrong answer, and this is a risk. Let's run scenarios, let's figure out what the right number in this state at this time is.

The second element that I'd highlight for you is DGEE, DPS, RE, et cetera. We have in this subset of the power sector, I think, been extraordinarily effective as circling the wagons and shooting inward. I had advice once upon a time, somebody said never attribute to evil that which can be explained by incompetence. (Laughter) So, I don't know that this is a grand plot by our nation's utilities, but they could not have done a better job at forestalling distributed generation than inventing these different names, nobody knows which is which, CHP is energy efficiency, but not all energy efficacy is CHP, and is distributed? Yes, but renewable energy is also distributed.

But what's DR? Well, it's efficiency, too, sort of. Until we can get our act together, how can we expect to have a positive policy response on the Hill and elsewhere? As you know, in this town and in state capitals, it only takes one to derail and it takes all to build. We will not build if we've circled the wagons and are shooting inward.

MR. FOX-PENNER: Thank you. Allen, please.

MR. FREIFELD: Thank you, Peter. We've been speaking about distributed generation this morning. I want to change the terminology just slightly and refer not to "distributed generation," but to distributed energy resources. I want to make that slight terminology change. The resource I'm adding to the equation is the ability of customers to be flexible in their consumption patterns to curtail their load basically in response to a correct price signal, and we'll get into what is a correct price signal in a little bit.

There was some discussion this morning, but if you understand that customers can be flexible and curtail when the grid needs them to curtail, that could, in fact, be an enormous resource available to the grid, which will have both economic and environment implications, all of which will be positive. It will reduce the peak load on the grid, leading to a better load factor, which is a pretty good measure of having a more efficient electricity grid. You will, in fact, avoid dispatch of the most expensive units because they won't be needed as customers curtail in response to a price signal, and some of that curtailment will be of fossil fuel generation, undoubtedly, so, there will be an environmental benefit, as well as an economic benefit of tapping into customers' flexibility.

A follow-up on something that's been said previously, this is very similar to this focus on customers and their ability to be responsive to price signals or other signals is very similar to the evolution of the telecommunications network. Telecommunications, the intelligence, the controls initially, very centralized in these block-long buildings that the telephone companies called central offices. As we all know now, there's more intelligence in your PC at home, there's more intelligence in your cellphone than there is in the central office switches that existed 20 years ago. The intelligence has moved to the edge of the grid, the telephone grid, if you will, and the network, meaning it's moved from centralized control to customer control, and if you think of a customer's ability to control their consumption, in similar terms, it's a function of moving intelligence to the edge of the electric grid. That intelligence takes advantage of 21st Centruy telecommunications opportunities. That's in essence a big part of what we mean by the

shorthand phrase smart grid. It's a two-way exchange of information so that when a customer fills up his shopping cart, he actually knows what he's paying for the items, and, in fact, he can respond to that price signal.

So, we've heard a good deal of conversation about the difficulty of doing this at the retail level, and I don't mean to minimize that, but, in fact, there are perfect price signals emanating out of the wholesale market, the market that's regulated by the Federal Energy Regulatory Commission. Prices in the wholesale market change every 5 to 10 minutes to reflect the fact that the cost of generating electricity changes every 5 to 10 minutes, and customers can, indeed, tap right into that wholesale market and sell their ability to be flexible and the value of what they sell is the value of electricity on that wholesale market at the point in time when they sell it. In other words, that price reflects the price of power at 5:00 p.m. as opposed to 9:00 p.m.

So, we talked about the need for good policy some this morning, and I will say the Federal Energy Regulatory Commission has adopted a number of very good policies to allow customers to participate in this wholesale market I just described, to sell their flexibility into the market and to be paid for their flexibility to curtail at whatever the prevailing market price is at that time, meaning the marginal price of electricity, which I think all of the economists in the room will tell you is the right price. So, I mention this as at least one example of a very good policy that's been adopted here in Washington, and the rules for the wholesale market are governed by one agency, the FERC. So, at least in that market, you don't have the tangle of having to deal with 50 conflicting policies.

If you understand how the electric grid operates, it's unique among all the industries we have. It actually requires an instantaneous physical balance between demand and supply. Unlike every other product out there, if there's an imbalance between demand and supply, there's a price effect, but there's no physical effect. If there's a shortage of scotch on the shelf, the scotch market doesn't come crashing down; the price of scotch changes.

In the case of electricity, it's far worse. You need instantaneous physical balance, and that balance can be achieved by either an incremented generation or a decrement of load. So, in many ways, a customer's ability to manage their consumption is the functional equivalent of a generator increasing load, and for that reason, we need policies, and courtesy of the Federal Energy Regulatory

Commission, we have policies that treat those two functionalities the same in terms of their access to the market and in terms of what they get paid. So, while we search for good policies, I will point out that at least in the area of demand response or load management, we've made tremendous strides this year in making that a reality, and that will be at least one distributive resource that I expect will be ballooning dramatically in the next 12 to 24 months.

MR. FOX-PENNER: Thank you, Allen.

Pedram?

MR. MOKRIAN: So, my name is Pedram Mokrian; I'm from the Mayfield Fund, and I just want to start off by saying it's an absolute pleasure to be here. I'm kind of representing the investment community on this panel, and I just want to recognize the works that Jeremy Carl and Commander Slayton from the Hoover Institute for spearheading this, and obviously, Kevin Massey from Brookings, who kind of spearheaded the effort and sort of championed it internally, and, obviously, the leadership of Secretary Schultz from the Hoover Institute.

So, just one thing that I wanted to point out is that the work is actually titled "Distributed Power Systems" specifically because of the fact that, as Allen was pointing out, it is a much broader discussion that we're trying to address right now outside of just generation. It is a more holistic approach to looking at distributed power policy in the U.S.

So, I just wanted to start off by saying a little bit about Mayfield and sort of the role of venture capital. Mayfield Fund is one of the oldest venture capital firms in the U.S. It's actually based in Menlo Park, California. We have over $2.8 billion under management across funds in the U.S., in China, and in India. I represent the energy or the Clean Tech Team at Mayfield, and our investments have varied across both the energy efficiency side looking at Next Generation Lighting from the technology level through to the demand response.

We had a company similar to Allen's called CPower, which was acquired last year by Constellation Energy, and one company which was actually mentioned both in the report and earlier today by Nancy Fund named Solar City, and I'll talk a little bit about Solar City going forward. But let me just provide a quick overview of the investment landscape just to kind of put things a little bit in perspective.

The venture industry spent roughly $7.8 billion in 2010 globally on energy-related technologies, and the bulk of that was focused on generation, on energy efficiency, and on the smart grid. And, so, you can see that all the investments that we're making on the energy front are specifically around the topics of discussion for this paper and this conference here. And, so, to answer the question: Do we see that there is an opportunity for that, unequivocally yes. That's actually why venture investments are made in this sector because of the fact that we do see large return potentials and large mechanisms for change going forward.

So, to put the venture dollars in perspective, if we're looking at just the transactions in renewable energy, the venture dollars were roughly $2 billion globally of the $211 billion spent last year. So, the bulk of that is actually in project finance, and that is around technologies that exist today, to which echoes the point that it's not necessarily a technology issue that we're trying to get at. The venture capital community is targeting the next generation of technologies, which is just a sliver of investment, but the bulk of that is actually made around the technologies that exist today. Sixty billion of that investment was around technologies that are distributed in nature, which includes waste energy, solar, and wind. So, that's sort of the global investment perspective. So, there's a huge amount of potential from that point on.

One person who I forgot to thank was Andy Karsner, because he basically stole all my thunder. I had six pages of notes that I wanted to talk about, but it's all now redundant and obsolete. (Laughter) So, I'll just try to keep it at a very high level and just talk to you a little bit about sort of the VC perspective of distributed generation.

And one of the things that we do is we invest in entrepreneurs, and entrepreneurs are like star athletes; they figure out what to do if given the right circumstances and the right rule sets to play by. So, if you just put people in a right, stable setting and offer them a market opportunity, they will figure out what to do, how to execute on those opportunities, how to create the jobs and how to create those and expand those markets.

So, in terms of policy, I think one of the key things that we look for is stability in the policies that are made. Unstable policy or nearsighted policy does not create room for growth, and that's one of the key things that we shy away from as investors is looking at that market risk and that regulatory risk and making sure that it's stable enough to make that investment.

I won't take credit for making an early stage investment in Solar City because what I will say is that when Mayfield decided to make that investment, it was clear that the ITC for solar was going to get it extended to the end of 2016, and, so, what that did was created a federal, stable policy environment where we thought that the company had ample room to grow not just in California, but across the U.S. So, stable policy, I think, is going to be the critical thing for creating the demand in these markets.

And to the other point where that was mentioned where distributed generation is almost competitive, I'd argue that it is competitive if you look at it from a retail perspective. And, again, I'll use the case of Solar City in particular. Solar City has expanded outside of California, and is now looking at businesses across 17 states in the U.S. and growing, and it won't enter a region unless it is 15 percent cost competitive to the prevailing retail rates, which means that not a single solar panel goes up on somebody's roof unless it's saving them money. So, the environment exists for distributed generation to actually be cost competitive today, it's just a question of making sure that we have stable policy to expand that market going forward.

MR. FOX-PENNER: Thank you very much. Last but not least, Steve.

MR. CORNELI: Thanks. It's great to be here. What a fantastic dialogue. Secretary Schultz, thank you so much for setting the tone and reminding us of the history of creativity and bipartisan effort in this town. Let's all work to get it back.

The point I want to make really follows on Pedram's almost perfectly, but from an NRG perspective, let me just tell you what we think about distributed generation and distributed power systems. First, they're here. In fact, we've got one in Washington, D.C., at the FedEx Field, which if you haven't seen, you should look at it. It's distributed solar deployed here up and running every time the sun is shining, powering all the non-game day needs of that field and 20 percent of the game day field. There's lots more deals like that happening with lots of companies around, and they're happening because customers want them.

The second thing, there's going to be a lot more DG and DSP because the costs are coming down. As Solar City is doing, people are buying these because they're cheaper, not because they think it's the right thing, not because they are concerned about melting icecaps or because they're

concerned about energy security, but because it's cheaper, and, oh, by the way, it looks pretty cool on somebody's house to be able to say I'm independent, I'm making my own energy, and it's clean.

And a third thing is that this is going to be a huge, huge, major transformation of a very, very silent disguised, unnoticed sector called the utility sector. The last big transformation was deregulation, which you may recall from the 90s, led to a lot of hoopla, it led to some notorious news that California's electricity market kind of blowing up and not working. It led to some degree of choices in other places, it led to a lot of power plants being built 200 gigawatts of competitive power plants being built without putting rate payers at risk anywhere, almost all of them high-efficiency, clean, natural gas, many with cogeneration built in. That's going to look like a minor, minor preview of what's going to happen in the next decade or so as the costs of distributed generation and distributive power systems come down on the cost of regulated utility rates go up, as Jim Rogers talked about.

Now, the key piece in driving this change, policy is usually important, I've got policy in my title, I work on policy all the time, but the key thing in our view in driving this change is something that really I think only Pedro and Commissioner Morgan talked about, which is customers. Customers liking to be on dynamic pricing, customers choosing Solar City's because it's cheaper than the utility rate. That is going to make a huge change. People will not be saying how much do I pay per kilowatt hour in the future, they'll be saying I went on the Web site with the guy from Solar City or the guy from Sungevity or the gal from all the other leasing companies, and they told me what my utility rate is and they said I can beat that by 15 percent, and they're looking at my house on Google Earth and telling me I've got a great location because it's south facing and they can put so many kilowatts on my roof, and I don't have to pay anything upfront because they'll lease me the system, and my lease payments will be less than my utility bill.

Now, that's happening today. It's happening in some part because there's policies like solar, renewable energy credit price in places like New Jersey or California, it's happening because visionary leaders like Governor Brown are calling for 12,000 megawatts of distributed solar, and his team is working as busy as beavers to figure out how to make all that happen in California. But, tomorrow, when these things get even cheaper, consumers will be saying what do you mean I can't put it on my roof if the policies aren't there? What do you mean I can't put something that costs 10 cents a kilowatt hour on

my roof when my utility rate is 20 cents? And that's going to be a very big, big driver that I think we're not really anticipating enough as a country.

Now, to me, there are two issues that in the transition between now and when that reality breaks, almost like a wave of creative destruction, as Peter Trumpeter used to talk about. Not incremental change, but things that just kind of wash away the old system and make an entirely new system, like those central switches. The issues that are going to help define that, I think there's just two, and I think they're pretty simple. One is rate design. What do utilities charge in their rates? And the second is interconnection. How do you interconnect a distributed generation resource to the grid?

Let me just give you an example from my utility bill, which I didn't know what it was until I looked at it a while ago thinking about this issue. I get electricity from Public Service Electric and Gas. My rate is 18 cents a kilowatt hour. That's a rate that Solar City can beat thanks to New Jersey's SREC Program and the federal ITC. Of that, six cents a kilowatt hour goes to Public Service Electric and Gas's distribution system. It recovers the cost of the pole in my yard, the transformer that turns my electricity into a voltage I can use in my house, the cost of the truck that goes up and down my street, the cost of the meter, the meter-reader, Ralph Izzo, the CEO, everybody, they get paid out of that six cents a kilowatt hour. The other 12 cents goes to buy power from PGM's power market that is just a pass through. When I put that solar panel on my roof, which I would do if I didn't have three, big trees in my neighbor's yard shading it, every time the sun is shining, Public Service Electric and Gas is not going to be collecting any of those 18 cents. The 12 cents, it's a pass through, and the 6 cents, it pays for all their costs.

And when that happens very much, people like to get paid in the utility business like everywhere else, but even more so, people in the utility business who are providing a regulated rate have a legal right to have an opportunity to recover their reasonable used and useful costs or reasonable costs for using useful equipment, and what often happens is if I put this thing on my roof and I pay less of that six cents, the utility that serves me as a customer is going to go to their PUC and they're going to ask for a rate redesign that will shift costs to other customers or otherwise recover that, and at some point, that becomes untenable because then, typically, the costs are shifted towards lower-income customers, and

people just don't like paying for stuff that's on their neighbor's house anyway. So, that's going to get to be a bigger and bigger problem.

Meanwhile, if you go and connect a lot of DG onto a feeder line or you put it on a big roof or in a big parking lot someplace, there's a very real chance that you're going to be creating enough of a perturbation on the distribution system which was designed to trickle little bits of electricity out, kind of like the branches and the twigs on a tree, the trunk is where the juice comes from that goes out on all these little twigs. You put a great big root system out on the end of a twig, the tree can't really absorb all of the water and nutrients through that little bitty twig. And it's the same problem when you put a big DG system out on a small feeder line, and it needs to be reengineered and somebody needs to pay for the cost of that and somebody needs to make sure that it meets all the applicable safety and reliability provisions, and that is not cheap, that's where some of the frustration and resistance to DG from some utilities comes from.

So, looking at these things today, they're just problems. Tomorrow, the first one, the rate design is going to become a question of what is the role of a distribution utility? Is it a utility? Can it still have a monopoly relationship with its customers? Can it decide what they put on their house and what they have to pay for? And the second question is going to become how do we redesign this distribution network so it actually supports the utility of the future, which is going to be largely located on and in people's houses and parking lots and churches and schools and warehouses. And those are very big issues.

So, to get there, I think we can just look right now at two different responses. It just came up in the press in the last 10 days, Austin Energy in Austin, Texas, which is a municipal utility and is an extremely green utility, just recently proposed a new rate design, and a week or two before that, San Diego Gas and Electric, which is in probably the ideal city in the U.S. or one of the ideal cities for solar penetration proposed a new rate design and they go in two very different directions.

So, what San Diego Gas and Electric said was well, because people who are putting solar on their roof are not paying in that kilowatt hour charge for some of their transmission and distribution system, including like the pole in their yard that they use, that they use when it's cloudy, that they use at night, we're going to put a demand charge, a fixed fee, not a per-kilowatt hour fee, on

customers who have DG on their roof. And if I recall the press article, it would add up to about $120 a year for the average solar installation, which just might be enough to make people question whether the Solar City's lease is really going to save them money or not because they have to pay that $120, even they're getting a deal of per kilowatt hour over here. And Sempra said that this might go up to $250 or more as the size of their DGB grows, which it's growing very rapidly.

Austin Energy, by contrast, decided to put on a fixed charge, but not just on people who used DG, but on everybody, and at the same time, they were having a higher tail block and a lower lifeline block to try to make electricity affordable for low-income people and for higher-income people who use more volume to make an incentive for doing DG and energy efficiency, the verity or just changing the light bulb approach, and at the meantime, the fixed charge brings in enough money to pay for the transmission and distribution cost. So, two very different approaches, one sort of an exit fee on people who are putting on DG and another saying look, this is a system resource, let's charge people across the system for it in a way that helps encourage it, but doesn't disadvantage anybody particularly, and I think we'll see a lot more of that kind of thing as we go forward.

MR. FOX-PENNER: Thank you, Steve.

Fantastic opening, analysts. Thank you very much. Let's release you all from the obligation to answer every question and let me throw out a question that you all have really shined a spotlight on, and that is I'll say it this way, rather than say what are the key barriers, which is such a common way to ask it, if you were king or queen of the energy policy in the United States, what are the top three policies you would change, the top three barriers you'd like to remove? And for the benefit of the audience, I'm sure many of us understand that energy is unique in that there are overlapping set of rules between localities, states, which still do quite a lot of regulation of the utility industry, there are regional organizations that are increasingly important, RTOs, and so on, and then finally, of course, there's our friends, the federal government. So, as you talk about them, maybe you could make clear to all of us what sort of level you're talking about and how the problem interacts with those levels. And I'll just throw it out to any of you who want to comment on it.

Allen?

MR. FREIFELD: I'll just start with one basic one, and it may have been mentioned this morning, but when you develop any form of distributed generation, you have to interconnect it to the local distribution company, and, obviously, there are necessary engineering requirements that have to be observed, but you'll find that there's a wide range of some utilities, fairly easy to interconnect your distributed generation to other utilities, that it can be quite a process, an 18-month process of getting the engineering approvals. So, I hate to characterize it as a barrier, but depending on the distribution utility you're dealing with, interconnecting your distributed generation can be relatively painless or it can be a major process that delays you for quite a while.

MR. FOX-PENNER: Tom?

MR. CASTEN: It's hard to list it to three barriers, but let me try to get the three biggest ones, and, therefore, the ones that are impossible. Let's start by eliminating all of the subsidies that distort every single market in the energy space. National Academy of Science has showed that the average coal megawatt costs $32 in health and environmental benefits excluding global warming and excluding mercury. That's just from sulfur and other things. The worst coal plant, $120. Those subsidies plus fossil fuel subsidies make everything a little bit crazy. If you're building efficiency and you're getting paid for what you're saving and what you're saving is being subsidized by the taxpayers. So, that's number one.

Number two, let's recognize that, in fact, there is a natural monopoly of the distribution and figure out a way that we can reward the utilities for improving their efficiency and penalize them for not improving their efficiency. Show me any other business that hasn't improved its efficiency by a single percentage point in 50 years. You'll have to find it in the history books because they're dead, but that's what we're doing and we need to solve that one.

I think that I would -- can I have four instead of three because the three --

MR. FOX-PENNER: Yes, you can.

MR. FREIFELD: Okay. So, the third one in no particular order is that the environment protection, which is so important, needs to be converted to an output-based standard. It's an input-based standard. The inefficient generator gets twice as much pollution as the efficient generator because it's all based on parts per million. If I burn twice as much gas to make the power, I get twice as much pollution.

This is really stupid. Nobody wants to reopen it because they're afraid the other party is going to gut the whole thing, so, we're dying with a bad formulation. It was a smart formulation when it was done because that was all the technology would let us do. We now know how to do continuous emissions monitoring. So, number three, fix the EPA.

The fourth thing, which I alluded to before, is lose the idea that all electricity is the same and Amy and I talked before. It's extremely difficult to figure out what the delivered cost is and where it's coming from, but we know the answer's not zero, as Ken says, and we're penalizing the technologies that are distributed by trying to compare them with the base load and ignoring this thing. So, there's four I'd like to see gone.

MR. FOX-PENNER: Okay, I saw Steve and then Amy, and this is good.

MR. CORNELI: Yes, I've got three, and I think these should be doable. I don't know if they are doable, but maybe they will become doable.

So, the first would be at the federal level a clean energy standard. I think something that's as complex as a price on carbon and as divisive is not going to work, it's not going to happen at least for the short-term or the near-term policy environment, but a clean energy standard could get broad bipartisan support if it was structured properly. Senator Bingaman is doing a lot of investigation into this now, and I think the ideas are thrilling. It has a couple of great things; it doesn't pick winners. It can be cast broadly, so, that really incents the best combination of market-driven innovation to solve environmental problems, it can delivery on national security issues, and it can help bridge the gap in a very natural, market-driven way between this slightly out of market cost period for clean technologies and deepen the money that I think a lot of experts are seeing coming quickly, and it doesn't hit the federal budget at all necessarily. So, that's number one.

Number two, at the state level would be, and the report talks about this in some deal, a kind of rate decoupling provision not just in examination of it, but a little more actual implementation of it, and the idea of rate decoupling is really to solve the problem of utilities like the one I get my wire service from in New Jersey. They have this -- I mentioned the six cents per kilowatt hour charge. If there were a way to restructure that so they are less at risk in terms of the throughput or the volume of their sales in terms of their cost recovery, then there'd be much more positive and much more supportive, and PSEC is

already quite positive and supportive, but they'd be able to be even more supportive of energy efficiency and distributed generation because they wouldn't lose sales volume, and there's a trick in making this work, that they have to be measured on outcomes that really matter to consumers than reflect economic efficiency, and that has to be done by each utility commission; it can't be done federally. So, that's a job for the states.

And, finally, something that Jim Rogers said, quoted Thomas Edison, saying it's just "around the corner." Storage. Storage will make all this a lot more profound and a lot more easy and storage is just around the corner, it's coming around the corner on four wheels. It's called the electric vehicle, and when everybody buys a fantastic storage device optimized for putting electricity into and taking electricity out of it and parks it in their garage overnight and in a parking ramp all day, nobody has to pay much to access and utilize that free battery sitting there because it's already been paid for, it's being paid for to provide mode of service to the vehicle owner and if it can create a little bit of incremental value providing energy storage and grid reliability service to the power system, that's just a win-win-win situation all the way around. So, the third policy would be continued federal and state support, very low costs for rapid deployment of electric vehicles, and specifically continuing the tax incentive for people to install home chargers or remote commercial chargers like in parking lots, and once the current incentives which run out at 250,000 EVs per manufacturer for the tax credit, renewing it.

So, those three things would probably really help solve this problem effectively at a low cost in a way that everybody could get behind in Washington and the different states.

MR. FOX-PENNER: I'm getting quite a list here. This is very good.

Amy, I think you were next.

MS. GUY-WAGNER: So, I have a few comments to make regarding comments that other people made in response to the first question, and then I have a policy that I think would help spur DG development.

So, first, I want people to understand the reasoning behind our economic analysis. We did not use a retail cost effective comparison, A, because there are so many different rate structures around, but also because of this issue that has been highlighted on the panel where it's a transfer from people that are participating in the distributed generation, have PV on their roof or have a CHP unit and it

transferred from the non-participating rate pairs to those that are participating in the program the distribution and transmission charges, which they are no longer paying.

So, because retail grid parity, if you will, is based on the rate structure and the rate structure can change, it's not the basis of which to look at the whole system as whether or not the distributed generation is more cost effective than centralized. So, what we did instead was look at the avoided costs. That is not to say that we ignored the benefits of the distribution benefits, the transmission benefits, et cetera. So, when you use avoided costs, what you're doing is you're calculating the costs that the utility would otherwise have to pay if the distributed generation system was not in place. So, that is energy benefits and capacity benefits.

So, energy benefits include the cost of the generation and the transmission losses all the way to where the load is located, et cetera, all the costs to capital that is involved in that, and the capacity element is actually the very interesting part because it's locally specific; that is the ability of the distributed generation to provide peak power. And, so, by providing peak power, you're able to shave off what the utility would have otherwise had to purchase both for distribution upgrades, transmission upgrades, and generation.

So, that's included in our analysis, both the avoided cost of energy, which is sort of the low end of the range, and the high end of the range, which stacks all of those different values up together to be the high end where you're able to defer the investment that the utility would have made in this congested node. So --

MR. CASTEN: Could I comment on that before you go on?

MS. GUY-WAGNER: Sure.

MR. CASTEN: My comment and sort of a question is our studies indicate that if you make 100 kilowatts at the load, you displace the 6.5 percent average line losses and you lower the line losses on the rest of the powers. So, with no utility interference, 100 kilowatts at the load displaces 113 kilowatts at the generator. If you're comparing the avoided cost of the two, you've left out 13 percent. At the peak load, our indication is that you can avoid up to 200 kilowatts of peak generation because of the compounding effect of line losses. So, I don't think you can get across an accurate representation of where you are without taking account of the fact that you're displacing more kilowatts than you're making.

MS. GUY-WAGNER: So, that's partly taken into account in the analysis. I'd say that the additional losses during peak hours, it's an average transmission loss that we include in the model. So, we have something in the range, I don't remember the exact number, but 6.5 percent usually in between 5 and 8 percent is what line losses are.

And, so, I guess to go back to the policy question now that I think I've given a little bit more background in terms of why we did what we did, it was not to sort of make distributed generation look bad necessarily. There are tons of retail applications, customer applications where distributed generation is cost effective, but what we're trying to look at here is the wholesale shift from a centralized infrastructure to a distributed infrastructure and whether or not that is right now a current snapshot cost effective, and, so, that's a different question than asking whether or not in somebody's particular rate structure if that customer can make money off our their distributed generation system, and we thought that the broader question was the more fitting question for a policy type discussion that we're having today.

MR. COLBURN: I actually have a question and a comment/question about that. I respect that approach and it has a lot of sort of intellectual virtue, but there's two things about it that strike me as worth exploring a bit further. One is what about the customer, like the people like me when I talked to him company while we're looking at my roof on Google Earth together on the phone and they're telling me how much money I can save over my utility rates? That's a pretty strong motivation, and I'm not breaking any laws or rules or ethical precepts by saying yes, I just have to get rid of those three trees. (Laughter)

MR. FOX-PENNER: Well, some might consider that unethical.

MR. COLBURN: Yes, that's a pretty strong driver, but more important than that, if you look at IHS, CERA, PIRA, but all these other folks, as well if you just look at I think in your report, the projected price of the trend line in them in solar PV is going kind eating through this 20-cent competitive with all-in rates, heading for the 12-cent, 15-cent, competitive with energy only costs, even bundled and average. Forget the peaking and the line loss and the emissions allocations and all that sort of stuff. So, if we don't deal with this issue now when people are sort of incentivized to bypass the transmission and distribution system, we're going to have to deal with it in a few years with they're incentivized to

bypass the whole darn thing and are more powerfully incentivized, especially if the battery storage is there. So, to me, it's like when do we start actually gearing up for that policy discussion and how do we do that? And I don't want to sound antagonistic because I know the report actually makes recommendations in that area.

MR. FOX-PENNER: Okay, well, please no more interruptions, and my apologies. And let's turn it back over to you to complete your statement.

MS. GUY-WAGNER: Sure. The one policy suggestion I had is related to this local capacity value and the benefits that accrue to the generation depending on where it's cited, and I think that there could be a benefit in much like how we looked at renewable resource zones for larger-scale, centralized renewable generation. We could do the same for distributed generation and focus on those areas where distributed generation has particular value to the system and can support the system. So, you build up areas where there's micro grid potential right now and use that as a learning tool to get more knowledge, drive down prices, work out some of the issues in terms of the smart grid and the distribution siting issues, interconnection issues, et cetera, and it would be sort of a little microcosm of RND for distributed generation, while focusing on the areas that's the most value to everybody in the system.

MR. FOX-PENNER: Excellent. Okay, Padram?

MR. MOKRIAN: So, I just wanted to kind of answer the question and hit on three topics. One is security, the second is consumer choice, and the third is awareness, and I'll just start off with security.

I think one of the fundamental drivers for distributed generation and sort of the smart grid principle is going to be around grid security and grid reliability, and, unfortunately, that's something that does not have a price today. I can't tell you the number of companies that have come and pitched to me in terms of having a next generation technology that makes the grid self-aware and introduces intelligence down to the distribution system, and I ask them where are you right now, and they say oh, we're in a pilot phase, and that's, unfortunately, the case. It's death by pilot. There is no stable market for grid security, and until there is a sort of national level realization of the need for actually introducing something like this, there's never really going to be mass adoption of these technologies, which do exist today.

Consumer choice is sort of a topic which I think you and I are the only ones that are really hitting on here, but it's a theme for investment for us is actually looking at how do you enable consumers to choose their fate in the electricity and in energy markets at large, including energy efficiency? And one of the unfortunate situations right now is all our discussions are really focused on rate-based arbitrage around the utilities, and there's been recent increased activity from levels of FERC in terms of allowing market mechanisms for participating at a high-level market level with the goods and services that a consumer might have to participate in the energy markets, one of which was demand response that we were participating in in our company CPower, which was actually getting compensated for the line losses in addition to the megawatt hours that it was reducing. So, there is a line loss adder that was already factored into what it was doing. But more mechanisms that allow this in sort of the alleviation of the barriers for those such mechanisms.

We talked a little bit about storage, but one thing that I just wanted to highlight right now, in California, there's this thing called Low Generation Boundary, and what that means is that a provider cannot cross that boundary, it cannot look like load and generation within the same hour. And, so, what does that do? That basically annihilates any potential for electricity storage to participate in the market.

And, so, it's simple things like removing some of these restrictions that are already in place that limit the demand side to participate in these markets, opens up a whole new realm of mechanisms by which market participation can occur.

And the last thing I wanted to really touch on was sort of an extension on this, which is awareness, and the reason I highlight awareness is not necessarily just a policy measure, but I think it's one of those things where if dollars are spent correctly on awareness, it becomes such a huge weapon against sort of the wasteful nature of the energy consumption in the U.S. And I highlight that by the hotel that I was staying at last night, which was cranking out 60-degree air-conditioning out of the vents in the hallways, and I had to go and crank up the heat in my room to compensate for that. And it's just a simple matter of, one, the building not being aware of what it was doing in and of itself, and, two, the operators of that building not necessarily being aware of the ability to counter that measure.

And, so, awareness at large does two things: One, it reduces the customer acquisition costs for these companies that have these goods and services, like, for example, Solar City that we

talked about, right? If there's more market demand because of increased awareness, now you have the ability to address that market more cost effectively. And the second thing that it does, it obviously creates market pull, and I think serve any policy measure that can increase the awareness in the system without having that burden squarely on the shoulders of the entrepreneurs and the companies, it's sort of a step in the right direction.

MR. FOX-PENNER: Excellent.

MR. COLBURN: Peter, just one really additional comment because these remarks have all been such great segues, as a precursor though, let me just indicate to Amy and Tom's point about line losses, RAP's recent research indicates that at the margin at peak, line losses are on the order of 20 percent. So, essentially at those times, you're running 5 power plants to get the work done of 4. Not a good way to approach life, and that's only the line loss costs, not the other associated costs.

Amy mentioned "avoided costs," and my three policies would have been decoupling, which Steve covered, and output-based, which is an unheralded, but absolutely essential change. Tom covered that. My third is what avoided cost tests are used. So, ultimately, you get implementation at the state level. The states don't have a whole lot of guidance or at least can pick their paths in terms of what utility avoided costs are factored into energy efficiency, CHP, and other DG. That test should be much more wide ranging, either total resource cost test or societal test, something that includes the other benefits explicitly, then you'll get into wrangling about what those costs are, how much, how big, how small, but the point is those debates should be held, not just ignored.

MR. FOX-PENNER: Allen, before we go to you, let me just see if I heard a disagreement here. I thought I heard you, Steve, arguing for a customer-centric cost benefit test where I think I'm hearing Ken and I thought I heard Amy talk about total sort of net economic benefit and costs to the whole economy test. Did I hear you correctly?

MR. COLBURN: I think there's a --

MR. FOX-PENNER: Yes.

MR. COLBURN: It's not so much like an ideological conflict, as just awareness of a significant tension that I think to make this work will have to address well, and I think the tension is that if the consumer says gee, I don't know what a kilowatt is and I don't know what a kilowatt hour is and I don't

know what that ugly thing on the pole in my yard is, but I wish I didn't have to use it as much and pay for it as much, and I can avoid all that by putting these solar shingles on my roof, lets fast-forward five years, that cost half of all that, why should I keep paying for that stuff? And somebody's going to come back and say well, there's a peak coincident load and there's a 1 and 10-year LOLP and all that stuff, and to me, kind of the way to avoid that, I don't know what the answer is, but I think the process starts with utility policy people, utility regulators saying what if the cheapest, best power plant of the future after the one that is not using anything, avoiding using unnecessary kilowatt hour, what if the next best one, considering security, air quality, future generations, long-term costs, short-term costs, what if it's putting stuff on people's roofs and in their garages? If that's the cheapest thing after energy conservation or energy efficiency, how do we incent all that and how do we pay for that infrastructure that's needed?

That transformer in the consumer's yard, he's not the cost-causer of that because he needs his voltage stepped on to get the cold beer and the hot shower, he's actually avoiding using some of that and he's turning around and he's becoming my power plant of the future, and that's sort of a part of my transmission cost instead of building a line out to North Dakota. So, how do we figure that into a new hybrid thing, especially where somebody like Solar City is building the thing and owning it, not the utilities? So, it's a big challenge, but I think that's the way to think about it.

MR. FOX-PENNER: Amy?

MS. GUY-WAGNER: I would agree with almost everything that you said. I guess the part of it is recognization that the wires are sort of a system-wide cost, and your scenario where people are slowly leaving the system is the scenario that was mentioned in the first panel. Those people are usually the rich members of the system, the people can first afford to put solar on their roof, and everybody else that remains on the system is paying more for their electricity so that somebody that then makes $150,000 a year can put solar on their roof. And, so, the system benefit, doing it from a systems perspective and the sort of wholesale perspective and focusing on areas that have high value for the full system and adding the additional benefits would make the system have distributed generation benefit everyone versus distributed generation benefiting particular customers.

And, so, that's part of the reasoning, I think, that adding additional benefits on top of the benefits that are valued today, looking at the fact that different regulatory commissions value avoided

costs in different ways. Those types of issues, I think, are the key to this, and distributed generation is very valuable because it's connected to the grid, because it's connected to a system that is already in place. And, so, we didn't value standalone distributed generation, we value distributed generation that's interconnected with a grid that already exists. And, so, there's a huge opportunity and I have a positive vision of what the distributed generation future will be. I think that it's something that you should build on a system perspective so that it's sustainable and you can create benefits for everyone.

MR. FOX-PENNER: Tom then Allen, then let's go to the audience.

MR. CASTEN: I do think we have some disagreements up here, and I'd like to focus on it. We're falling into the trap of trying to say what's the best thing after subsidies, and the standard of what works gets really confused. The state regulator doesn't have the cost of federal tax credits. So, that's a free to the state, but in a societal level, the last time I checked, we had a little deficit problem. I said my number one problem was get rid of the subsidies. All of the subsidies. Wind gets $20, $23 a megawatt hour. That changes where the wind gets deployed. Solar gets up to $80. Coal gets up to $120. You may not agree with my logic, but CHP gets $1.30. Energy efficiency gets nothing. We get all this distortion and we need to recognize the distortion is there.

My second point of disagreement is that I think this business of saying the grid is already there, and, therefore, everybody has to pay for it, I have a different take on that. Your book, Peter, I think you say we need something like 30,000 miles of new transmission lines, if I'm remembering right. Putting in distributed generation does avoid new transmission lines. Putting in distributed generation that gives the grid control over the power factor and allows you to load the lines up by 20 percent more power is enormously valuable at a social level, and you heard me right, studies at MIT and Carnegie Mellon say that if you put in distributed generation 10 percent and you give the grid control over power factor, you can push 20 percent more power through existing transmission lines. That's a real savings to everybody. I think this business of the rich guy going off and the poor guy coming back, we get away from that. If we talk about really getting tougher on ourselves, is this going to save the system money, and you're going to get it passed through.

MS. GUY-WAGNER: So, the avoided cost analysis does account for those benefits. We may argue about whether or not the deferral benefits are calculated at the value you would calculate them

at or the losses are calculated where you would calculate them, but those benefits in terms of deferring additional investment in the infrastructure are accounted for in the value streams. What is the problem is that when you're just looking at it on a retail perspective or from a customer perspective, you lose the value of the existing system.

MR. FOX-PENNER: As existing assets. Okay, and then the last word, Allen, and then we'll look forward to some questions.

MR. FREFIELD: Well, this may be relevant to something you've all said. When I think of the cost effectiveness of distributed generation, I don't at all focus on avoided retail costs or retail rates, and the reason is retail rates are full of inefficiencies and subsidies. Having set retail rates for 30 years of my life, I can testify to being guilty of that myself. We create subsidies between classes, commercial versus residential. We create tremendous subsidies and inefficiencies because we don't reflect the time variance at the retail level. We do that for good, political reasons, but, nonetheless, it is inefficient.

So, and I think of the value of DG at a wholesale level. Prices at the wholesale level are set by a competitive bidding process that the grid operators run every five minutes. This area is served by about 1,200 generating stations, and of 1,200 generating stations, bid every 5 minutes for the right to serve, and the result is a very competitive price. So, the way I look at the value of DG is if I install it, I will integrate my distributed generation into that very competitive wholesale market, and as long as I cost less than some of those 1,200 units, I will be dispatched, and not only will I avoid the cost of buying from the grid, I'll actually be paid the market clearing price of electricity on the grid, so, I not only have an avoided cost, I actually have a revenue stream because I'm providing a service to the grid and I'm providing it at a price which is the result of a very competitive auction that happens every 5 minutes. So, I don't know if that is encompassed or not in the study, but it seems to me that's a pretty rational way of looking at the actual cost effectiveness of DG.

MS. GUY-WAGNER: It is the same way we look at it. So, the energy portion is based on market rates.

MR. FOX-PENNER: Wonderful. Well, on that note, we'd love to hear some questions and comments from the audience. The microphone is in the back. If you wouldn't mind identifying yourself, we'd appreciate that. And it looks like we have one right here.

DR. CARL: Hi, I have a quick comment leading to a question.

MR. FOX-PENNER: Please identify yourself.

DR. CARL: I'm Jeremy Carl from the Hoover Institution.

I sort of led the study from our end, which Jamie and Pedram were enormously helpful with. The comment was in general one of the sort of broad overarching things that I think was implicit in a lot of what Amy said, we really wanted to avoid being DPS advocates in the study. I mean, we talked about it many, many times, sort of like let's see what the data shows. I think congenitally, we're not people who tend to think that there are $20 bills lying in the street in large numbers that nobody's picking up for no reason. So, to really be sober and to look at that and that kind of informed our analysis not being quite as aggressive, and you can see different people, whether it be with their technology or their particular political view kind of may push, say this is really wonderful, and we really wanted to steer away from that type of analysis, and that was something we really with Brookings, a commitment to that right from the start.

That kind of leads to a question. I spent a miserable summer about seven years ago doing nothing but reading papers on the externalities of electricity based on different economists' estimates and trying to figure out what I could say that really made sense in my own right about that. And the bottom line is some might say oh, coal has an externality of 2 cents per kilowatt hour and another one says it's 35 cents per kilowatt hour. Totally both defensible methodologies.

If each of you looking at this from a DPS perspective actually said yes, we agree, it's not on zero, had to kind of quantify that, how would you as a regulator potentially attempt to quantify these things about which there's just a lot of political and technical contestation?

MR. FOX-PENNER: And before you all jump in, Dr. Carl, if I could just add one small footnote to that, I came across news report of a brand-new paper on externalities associated with coal fire generation from William Nordhaus and others, I think, at Yale. So, if I might add to that, in the context, if you all have any insights into that.

Yes, Tom, please.

MR. CASTEN: Change the Clean Air Act to an output based standard, give every generator of megawatt hour any place in the country the average pollution allowance of the average

generation in the whole country, set a thing in place that says we're going to drop these allowances year after year, if you're making more sulfur than the allowance, you go to go buy it from somebody. If you're making less, you can sell it. At that point, we get away from economists arguing methodology and we get a market that says if I build a solar plant, I have no sulfur dioxide, what is somebody going to pay me for my allowance for sulfur dioxide? And if I've got a utility-central plant and I decide to go make a CHP instead, now I'm going to get credit for all the heat I displaced, and, so, now you have that externality being dealt with by a simple rephrasing of the Clean Air Act that says everybody gets the same. The difficulty we play with is that 50-year-old coal plants are allowed to operate at the level they operated 50 years ago, and all new plants have to meet today's levels. So, the playing field is always stacked in favor of the old guy and then we have to change it and say new rules, the old guy can't do that anymore, and it's disruptive, move to a system that lets the market see that number.

MR. COLBURN: You had a summer of reading those papers. Back in a few jobs ago, I was a consumer advocate for an attorney general in Minnesota, and I spent like 11 months going through a PUC hearing about this issue that had witnesses being cross-examined and lots of testimony, and I came away with the conclusion that sort of like the joke about the econometrician, the guy goes to a mathematician and says what's two plus two, and the guys says well, are you talking about base one or base two? He goes to the accountant says what's two plus two. He says well, what's your tax bracket? He goes to the econometrician, and he says what's two plus two, and the guy looks up and down the hall and says what do you want it to be? (Laughter) So, to me, I think what's behind your question is if we're going to think about socially valuing through some sort of administrative process, like what Chair Weisenmiller and his colleagues are going through or Chair Morgan, what is a good number? It seems to me zero is a bad number. It seems to be a number that has everybody sort of lining up at the Oklahoma border with a mule and a wagon to go get 40 acres worth of DG is probably not a good number, and, so, a number that has the desired result of sort of a -- I can't say what the guy on the previous panel said, those five adjectives, but efficient, reliable, clean, innovative, DG, DR kind of stuff. I mean, it seems to me, that's the right number. There's plenty of room in there to have it if that's how we're going to set these incentives. Not to be too results-oriented, but.

MR. FOX-PENNER: Other questions? Yes, ma'am.

MS. RYAN: Thank you. I'm Margaret Ryan with AOL Energy.

I wanted to ask something that really comes from a part of the discussion the last panel where people mentioned that many utilities, consumers don't have a lot of love for the utilities, and I think you especially see in California, you hear people talk about I want to get off the grid, I want to get away from the utility, and a lot of the work in distributed generation has been, in fact, on those lines to help people use their utility less and less, and ideally, in some people's minds, to break away from it. with the new technology, the developments you see coming, I mean, do you see a breakthrough technology coming where what we're going to be dealing with is a lot of consumers actually finding a way to do that and where does that leave us policy-wise?

MR. FOX-PENNER: Amy?

MS. GUY-WAGNER: So, I think that storage is actually the big player in that off the grid application of distributed generation or just demand response resources, you really need a storage solution that's really very, very cost effective, must lower price than it is today, to have a renewable system that is completely divorced from the grid today because the grid right acts as a backup system to all the distributed renewable resources. Thus, that sort of paradigm, I think, really requires a massive breakthrough in storage.

MR. FOX-PENNER: Allen?

MR. FREFIELD: Yes, I would tweak your question just a little bit and say actually, the ideal scenario for a customer is to be integrated into the grid, meaning selling to the grid when it's in their interest to do so and buying from the grid when that's in their interest to do so. We had a lot of talk this morning about micro grids islanding themselves from the grid, and that's one of the values of a micro grid, being able to island yourself if there's a disturbance on the grid. Well, the ultimate value is to be able to island yourself when you want to and to be able to sell to the grid when that makes sense, because by doing that, you actually minimize the cost of building that micro grid for yourself. So, it's not quite separating yourself from the grid totally; the idea is to optimize your operations, vis-à-vis the macro grid.

MR. FOX-PENNER: Tom?

MR. CASTEN: Your question implies a conundrum that explains how I wasted the last 30 years of life fighting utilities. It's a bad fight.

There is nothing in the world that says you can't put solar on your roof and sell it to the utility and that we can have the utility providing the highway for stuff to move both ways. In fact, it's magic because we build a radial system that's only getting the value of moving one way and by going to distributed, we can go both ways with it and make it much more valuable.

But here's the issue: The reason we, in the DG community, have taken retail away is because the regulators and the utilities won't give us more than about 50 or 60 percent of the value we create because we're supposed to compete with an old central coal plant. So, you take the load away, and now the utility's annoyed, and the regulators spend many, many months and years listening to the standby cost arguments and all this stuff. Can't we find a way that everything gets sold and it gets reflected for what it's worth locally? And now the utility says I have this kind of cost to provide the service to any customer, and it's the same for everybody, and we don't have all these arguments.

That's what I meant earlier when I said we have to recognize that there truly is a monopoly here that's hard to break. It's pretty difficult to figure out how we're going to run two sets of wires down the street and be cost effective. So, separate that service off and do the other thing. I worry that if you're going to move to trying to take more load away from the utilities, you got to remember that these people have enormous vested interest and enormous lobbying power, and the fight will just go on and on while the world burns. We have to work together.

MR. CASTEN: I would just add that I think the question isn't really is there new technology that is going to allow everybody to be an electric hermit. I'm not sure that we want to be hermits, but I do think what we want is control over this aspect of our lives, and that as much as anything, what this market will do is create that kind of opportunity, much like Allen just referred. Steve said earlier major transformations in the market. We'd be an unworthy panel if we didn't use the word paradigm shift at some point. (Laughter) So, I'll fulfill that role, but I think that's where we're headed.

MR. FOX-PENNER: Yes, go ahead.

MR. MOKRIAN: So, to echo Amy's point, I think the biggest technological innovation that's yet to come is going to be grid scale storage. I think it's going to be the one defining thing that's actually going to change the face of the way that energy is handled on a distributive fashion, especially

when you talk about things like solar because at the end of the day, solar is not necessarily producing power for you when you're at home watching television at night, it's you have to be connected to the grid.

To your question, I just want to kind of put things in perspective. Fourteen years ago, I worked at a facility with Ford Motor Company that provided power to a couple of its engine and casting plants, and what we did there was every single day, we ran optimization where we either bought natural gas or we bought electricity and it just depended on which one was cheaper. If gas was cheaper, we'd buy gas and produce power and we'd feed the power into the two plants. If electricity was cheaper, that turbine would just be idle that day. The plant that I worked at was built in the 1920s by Henry Ford, and that was because he wanted it to be completely vertically integrated. He wanted coal to come down the Detroit River, put coal inside of this power plant, pulverize it, crush it, produce power, and send it off to his own units completely self-enclosed and completely independent of any local incumbent utilities, right? That model shifted because of the fact that it's cheaper to buy power than it is for you to produce it on your own, and there's a cost of capital issue.

What Jim Rogers was saying, his cost of capital is cheaper than anybody else's. It absolutely is, and it makes a tremendous amount of difference when you're looking at that.

So, I don't think there's going to be ever a situation where we're going to go back to that independent, islanded, 100 percent independent from the grid scenario, but the technologies exist, and combining heat and power is a fantastic technology that's been around for decades that I think should be used a lot more, but do I see one particular technology completely changing the face of what we do outside of storage? Probably not in the near future.

MR. FOX-PENNER: Steve, did you have a comment or you --

MR. CORNELI: I think it's been --

MR. FOX-PENNER: It's been said. Okay. Good.

Charlie?

MR. EBINGER: Charlie Ebinger from Brookings.

I was wondering, Tom or any of you, with so many CHP systems running on fossil fuels, how high would a carbon price have to go before that would start hurting a CHP system running on fossil fuels in terms of competitive role?

MR. CASTEN: Well, first of all, a factual comment, we claim we have 80,000 megawatts of CHP, but anything that met the real minimum PURPA qualifies, and it's probably about 25,000 megawatts of real CHP and the rest of it is just a combined cycle plant that sits there and makes it. So, that's point one.

Point number two, a little quick set of numbers. On a delivered basis, electricity from a coal thermal plant puts out about 1.1 metric ton of carbon, 1 plus the distribution losses. Natural gas, simple cycle puts out about 55 percent of that CO2. If you go to the best current operating combined cycle gas turbines, it drops it to 35 percent of the coal. If you go to good CHP, it drops it to 20 percent of the carbon that came from the coal.

Now, what's interesting, because I think we all want to gravitate right towards solar and wind, but we don't know how to integrate the variability. The two go together. If we were to move 100 gigawatts to real CHP and set the rules that you only get rewarded for real CHP, remember, we're cutting the gas use in half. Now, we're going to burn more gas because you can't do that with coal unless you gas fire it first. We don't have the technologies to take lumps of stuff and do it locally, but if we gas fire it, we can do it. So, what's interesting to me is that we set a goal of trying to get to 20 percent of present CO2 by 50 years from now. We can get there in the next five years with CHP, and then that'll give some time for the rest of the technologies to keep coming on.

My second point to that is that to a great extent, CHP can help the wind. Example: 100 megawatts or a 100 tons of carbon apparently saved by the wind is really only 80 tons because we got to go run standby stuff. CHP can take away that penalty and actually make it more.

Another example: CHP can take power at the very high wind times and power an electric boiler using the same equipment, and, so, when we're throwing wind away, instead of throwing it away, go ahead and use it to displace boiler fuel. It's not as attractive as displacing electricity, but if you got more than you can use, don't feather the blades. So, I think what we're working on at A Corps is trying to figure out how we can get good quality CHP and good quality waste energy to complement and work with good quality solar and wind and make it all work.

MR. FOX-PENNER: Any other comments? Other questions from the audience?

Mr. Secretary?

MR. SHULTZ: I'd like to panel to comment on a different kind of distributed energy. The focus seems explicitly or implicitly all have been on solar mostly and a little wind with intermittency, but out where I live, we're conscious of something called the Bloom Box, so, the costs seem to be coming down pretty well. They can configure it in varying sizes. Right now, it's a fuel celled type system with natural gas filling over it. I keep telling them, why don't you try hydrogen, because you can make hydrogen from any kind of water, salt water, brackish water, anything, and it's storable. So, you can go 24-7, and what you get out of it is your electricity and you get potable water out of it. So, this is distributed energy, and potentially down the road, it can be varying in size, and it isn't intermittent. So, how about this?

MR. COLBURN: That's a fantastic question, Mr. Secretary. A lot of criticism, I think, has been sort of leveled at the Bloom Boxes being kind of like a combined cycle machine in a box that has about the same efficiency. It burns natural gas, but it costs a lot more, and it might not last as long, and that's probably legitimate criticism for the current phase of the technology, but one of the most exciting fields of research that we see coming kind of down the pike is some people call it the artificial leaf, but it's essentially like nanotechnology that can use sunlight much more quickly and cheaply and in higher volumes, lower cost, make hydrogen and other fuels out of sunlight and out of water, and when you have that, a fuel cell is a fantastically attractive way to convert it to energy.

And there's a lot of people in the science community that we try to keep in touch with as a company looking at where the technologies are going, who say the real future for our energy security and environmental constraints depends on converting solar into portable gases and liquid fuels, and if and when that happens, fuel cell technology, especially a cheap and durable one, which Bloom Box claims to be on the path towards, would be very important and avoid a lot of these questions that we're dealing with today of intermittency and integration. Have one in your basement, your water heater, your furnace and your air-conditioner and your power supply all in one. That's a very exciting future.

MR. FOX-PENNER: Okay, Tom then Amy.

MR. CASTEN: We used to have three ways to convert gas to power, thermal plant or a combined cycle or whatever. A fuel cell is just another way to convert. There are physical limits to how much of the energy and the gas that you can turn into electricity, and we're not going to break those

physical limits. So, to me, this is not something magic; it's another option. The end issue is what is the overall efficiency of starting with the gas, how much useful energy do we get out the back of it?

I was on the board of Fuel Cell Energy for six years, and if we put those fuel cells next to a place that could use the heat, we could get up to 75 percent overall efficiency, which is twice the grid could deal. If we just ran a fuel cell alone with no heat recovery, we've got 33 percent. We haven't changed anything. The fuel cell people claim oh, yes, but I have lower emissions. Well, let me tell you, anything you build today has very low emissions because nothing else is allowed. So, there are Caterpillar people here that have got turbines, we've got reciprocating engines. We have a lot of ways to convert gas and let the market figure it out. There's nothing special in a fuel cell. It's just one more way to convert. We're still left with the question of how much useful energy do we get back in?

MR. FOX-PENNER: Amy?

MS. GUY-WAGNER: I would agree with your points in terms of the current technology. The question in terms of whether or not fuel cells powered with hydrogen is a potential future that I think is still up for debate. In a way, you could think of the hydrogen as a different form of storage. And, so, we have previously talked earlier about the importance of storage for a renewable distributed generation infrastructure. Similarly, the hydrogen would be sort of the storage for a fuel cell based or any sort of engine that would burn hydrogen. So, it's not necessarily the technology itself, I think, it's the question of whether or not hydrogen efficiencies of producing hydrogen and using hydrogen or more or less than creating electricity and storing it using some sort of storage device. And there are various people who have various opinions on that. I think I lean more towards the side that thinks that the batteries are going to be the cheaper alternative.

MR. CASTEN: But, at the end of the day, no matter what you do, you're going to produce electricity and heat and you have a simple choice: use it or lose it. And I don't care whether it's a fuel cell or a gas engine or whatever else, use it or lose it. The only you can use it is to distribute the generation next to the guy that needs the heat because it won't travel very far. So, it's use it or lose it, and if you're going to use it, you have to be local.

MR. FOX-PENNER: Well, ladies and gentlemen, I think we must turn our attention to lunch now, although, I want to ask the panelists one very quick last question. If localvores are people

who prefer to eat locally, what is the name for people who prefer their energy to be generated locally? (Laughter) Local watts?

MR. CASTEN: Smart. (Laughter)

MR. FOX-PENNER: Thank you. Please join me in thanking the panel. (Applause)