

Quadrennial Energy Review
Second Installment
Electricity: Generation to End Use
Stakeholder Meeting #2

April 15, 2016

Boston, MA

Boston Marriott Long Wharf, 296 State Street

Salons D, E, F, and L

Meeting Transcript

[Contents](#)

Opening Remarks 1

Panelists:

- Charlie Baker, Governor of Massachusetts
- Dr. Ernest Moniz, U.S. Secretary of Energy
- Dr. John Holdren, Director of the White House Office of Science and Technology Policy
- Melanie Kenderdine, U.S. DOE, Director of the Office of Energy Policy and Systems Analysis and Energy Counselor to the Secretary

Panel 1. Bulk Power Generation and Transmission: How Can We Plan, Build, and Operate the Appropriate Amount for Future Needs?..... 12

Panelists:

- Stephen J. Rourke, Vice President-System Planning, ISO New England
- Richard Dewey, Executive Vice President, New York Independent System Operator
- Gil Quiniones, President and Chief Executive Officer, New York Power Authority
- Carolyn Browne Anderson, Director, Transmission Policy and Insurance, Green Mountain Power
- Dan Dolan, President, New England Power Generators Association
- Camilo Serna, Vice President for Strategic Policy & Planning, Eversource

Panel 2. Electricity Distribution and End-Use: How Do We Manage Challenges and Opportunities?..... 33

Panelists:

- Ed White, Vice President, New Energy Solutions, National Grid
- Karen Lefkowitz, Vice President, Smart Grid and Technology, Pepco Holdings
- Dena Lee DeLucca, Vice President of Corporate & Member Services and Chief Financial Officer, New Hampshire Electric Co-op
- Roxanne D. Brown, Assistant Legislative Director, United Steelworkers
- Micah Remley, Senior Vice President, Product, EnerNOC
- Ned Bartlett, Undersecretary of Energy and Environmental Affairs, Commonwealth of Massachusetts

Panel 3. Ensuring Resource Adequacy 53

Panelists:

- David A. Cavanaugh, Director, Regulatory & Market Affairs-ISONNE, NRG Energy
- Edward Tatum, Jr., Vice President Transmission, American Municipal Power
- Craig Glazer, Vice President – Federal Government Policy, PJM
- William Berg, Vice President Wholesale Market Development, Exelon Corporation

Public Comment Period 65

Opening Remarks

CHRIS KELLEY: Good morning. I'd like to welcome you to the second Public Meeting for the second installment of the Quadrennial Energy Review, focused specifically on electricity systems from generation to end use. Welcome to those of you here in Boston. I would also like to welcome those of you who are joining us by live stream on the web. My name is Chris Kelley, I'm with Energetics. We are a contractor supporting the Department of Energy on this QER effort. I have the distinct honor of being today's facilitator.

We will be hearing from a number of speakers today, but before we get started I'd like to refer to a few housekeeping notes very briefly. First, the QER Task Force welcomes comments from the public. If you wish to make a comment and you have not yet signed up at the entrance desk, please do so. And for those who are joining via live streaming you may submit comments via the web form that can be found at www.energy.GOV/QER. I'd also like to note an item in the agenda today, at 2:49 PM today we will take a moment of silence and reflection in memory of those affected by the attacks three years ago and in honor of One Boston Day. So we have an outstanding set of speakers here today. Their comments and presentations can be found after today's session at www.energy.GOV/QER.

Before we get started I'd like to read a short statement about the purpose of this meeting. Pursuant to the Federal Advisory Committee Act, the purpose of today's meeting is to ask for your individual input or your organization's input, regarding electricity from generation to end use and provide a forum to exchange information. To that end, it would be most helpful to us for you to provide these recommendations and information based on your personal experience, your individual advice, information or facts regarding this topic. The object of this session is not to obtain any group position or consensus, rather, the U.S. Department of Energy is seeking as many recommendations as possible from all individuals at this meeting.

So with that, allow me to introduce Melanie Kenderdine, the Special Advisor to Secretary Moniz and Director of the DOE's Office of Energy Policy and Systems Analysis at the USDOE. In July, 2014, Miss Kenderdine was named one of the top five women in Washington shaping energy by the National Journal. Ms. Kenderdine will then introduce our next speakers. Melanie?

MELANIE KENDERDINE: Thank you, Chris, and thank you, all, for coming. Welcome to the first of several regional stakeholder meetings that we are going to have across the country. I'll talk about where those will be in a minute. It's great to be in Boston. That was from its earliest history, it stood for invention, innovation and free expression of thought. My own career as well as the Secretary Moniz's career, whom I'll introduce him in a minute, has roots in the academic institutions in this area. I worked at MIT for six and a half years. The Secretary worked there for a lot longer than that. And then -- and so, it's great to be back, it's like coming home again. The second installment of the QER is focused on electricity from generation to end use. This reflects the findings in the first installment of the QER that the electric grid is perhaps our most critical infrastructure on which all others rely. The system is however

undergoing enormous change. The QER will analyze these changes and make findings and recommendations to help guide the development of a 21st century grid.

I mentioned that this is the first of several regional meetings. We have others planned in Salt Lake City, Des Moines, Austin, L.A. and Atlanta. Each of these meetings will address bulk power generation and transmission, as well as distribution and end use. In Boston we also want to focus on the three Eastern wholesale electricity markets reliable capacity and electric gas and oil interdependencies. And before I introduce Governor Baker, let me note that this is a solemn day for Boston, we've already discussed that and the nation's thoughts are with you. Secretary Moniz and I were up here three years ago today. He was at that point the nominee to be the Secretary of Energy, and we were working on re-organizing -- thinking about re-organizing the department and personnel issues, and my son was a student at MIT. And his fraternity was right next door to where the bombing occurred. And he was greatly affected. We were all greatly affected. And, again, our thoughts and prayers are with you.

Now let me introduce the 72nd Governor of Massachusetts, Charlie Baker. He has a substantial background in both government and industry and we are excited that he is here with us today. Governor Baker.

(Applause.)

GOVERNOR CHARLIE BAKER: Well, thank you very much. And I will be exceedingly brief. Let me just start first of all by thanking the Secretary and the Director and their teams for engaging in this public process. I was saying earlier to them that there are very few issues in public life that you can come up with that are as technologically and as logistically and as financially complicated as energy, yet it's very hard to come up with any issues that are ultimately as fundamentally important. Both from an environmental point of view, an economic point of view, and a security point of view. And as somebody who's spent a good deal of the past several weeks being briefed and discussing the security around the marathon with folks from the Federal Government, the state government and the local government, that's just one event. It's 26 miles long and involves 30,000 runners and several million spectators. But the security issues around that, particularly as all the issues around security have gotten more and more complicated as technology has gotten more and more sophisticated and become more and more accessible, simply remind me that almost everything associated with the management and distribution of electricity and energy have enormous security overhangs associated with them which ultimately become part of how we think about all this. Here in new England, just to give you an idea of how important this stuff is. I got elected the Governor on November 4th, 2014. By November 10th, I had gotten unsolicited phone calls from the Governor of other five states, one of whom was also a newly elected governor like me and four of whom were serving governors at the time, Democrats and Republicans. And I had actually also received calls from three former governors in New England. All of them said to me, there's probably no issue that's going to be more fundamental to the success of the New England region and to the success of Massachusetts than energy. And if you haven't put people on this one and considered the fact you're going to need to spend a good deal of time talking to all of us, you're going to need to. Now, Massachusetts represents 50% of the market in New England, so I get why I got those phone calls, when you're the biggest buyer and participants in most markets people tend to

reach out. But the fact that literally within a week I heard from a number of former governors, as well as all the current governors who surround me and surrounds Massachusetts, just speaks to how high up on people's priority list the environmental and economic issues associated with energy supply, energy distribution, and sort of the future of the region are tied together. And within that context, I'll just say two things, one is every governor in New England region believes that some sort of expansion of our current relationship with Canadian Hydro is fundamental to our ability to succeed economically and environmentally going forward. There is no other proposal, no other solution, no other opportunity that presents a better chance for us to do the sort of work we need to do on our carbon footprint and to improve our competitive position relative to other parts of the country, and indeed, in many cases other parts of the world, while at the same time delivering on base load capacity that we're going to need to deliver on as other sources of base load capacity go away, then some sort of expansion of the region's current existing relationship with Canadian Hydro.

The second thing I'll say is, that one of the things we are very interested in here in Massachusetts is storage. We, as an administration are going to spend many millions of dollars in conjunction with others to see if we can't come up with solutions and plans to expand on both the applicability and the capability of storage technology as a way to expand and build on a whole series of sort of early stage initiatives that involve many sources of power where either the power sources are intermittent or the -- or if not intermittent, limited with respect to what they can do, and I think we believe that storage has tremendous possibilities to support a lot of different issues and opportunities in the energy and electricity field going forward. I'm very anxious to hear from the people who actually know what they're talking about. I said earlier to them that I swim in the shallow end of the pool, they play in the deep end. And since these issues are among the most complex that we in public life have to deal with, I'm thrilled to have so many folks from the great, great institution of MIT worrying about this stuff on behalf of this country and this region, and thanks again for the chance to be here today.

(Applause.)

MELANIE KENDERDINE: Thank you, Governor, next we are going to hear from Dr. John Holdren. John is the Assistant to the President for Science and Technology and the Director of the White House Office of Science and Technology. He is also Co-Chair of the President's Council of Advisories on Science and Technology. Prior to joining the Obama Administration, Dr. Holdren was a Teresa and John Heinz Professor of Environmental Policy and Director of the Program on Science and Technology and Public Policy at Harvard. As the Secretary likes to refer to it in his MIT centric mode, the Divinity School up the river. Here, I want to mention that the QER process is run by the White House. Dr. Holdren is one of the Co-Chairs in the White House. The other is Dan Utek with the Domestic Policy Council in the White House. So the secretary, John and Dan run the QER. My office and DOE runs the secretariat, manages the interagency process, and DOEs the analytical work for the QER. So, John?

DR. JOHN HOLDREN: Well, thank you, Melanie. And after that mention of my affiliation with Harvard, I do have to, in my defense say that I got two degrees from MIT. So, I'm not all bad. I'm really pleased to be here. It's an honor to be here with Governor Baker, Secretary Moniz and all of you to talk about the second installment of the quadrennial energy review. As

many of you know the initial proposal for an interagency quadrennial energy review came from a report of PCAST, the President's Council of Advisors on Science and Technology which I co-chair, and that happened in November of 2010. That report was requested by then Secretary of Energy Steve Chu in concert with President Obama and it was entitled Accelerating the Pace of Change in Energy Technologies Through An Integrated Federal Energy Policy. It turns out that the members of PCAST who led that effort, were Dr. Ernie Moniz, then a professor at MIT and a member of PCAST and Dr. Maxine Savitz, another member of PCAST, who at the time was the Vice-President of The National Academy of Engineering.

The study that doctors Moniz and Savitz led, recommended a set of steps that were lead to a quadrennial energy review designed as an interagency effort overseen by the Executive Office of the President and supported by an analytical secretariat at the Department of Energy, which is the office that Melanie Kenderdine has run. A lot of work was done through 2011 and 2012 both at the White House and at the Department of Energy and with the engagement of PCAST. In thinking about how this quadrennial energy review would actually work, including carrying out at DOE in 2011, an initial quadrennial technology review which looked at the technical options for future energy supply and end use sufficiency, their capabilities, their efficiencies, their costs and so on. I would note that a second and even more comprehensive quadrennial technology review was completed by them last year. But to get back to the genesis of the QER itself, when PCAST reported to the President on energy and climate change a second time in March of 2013, the group reiterated its recommendation that full-fledged quadrennial energy review be launched, and the President did so a couple of months later in June of 2013 as part of his Climate Action Plan. The QER process has been vigorously underway ever since then, using a moving spotlight approach. The first focus of that moving spotlight was the nation's infrastructure for energy transport, storage, transmission, and distribution. And that first QER report was released in April of last year. It was an effort of extraordinary depth, rigor and balance. And part of the credit of that work, I think, goes to the series of stakeholder engagement meetings, like this one, which we held around the country in 2014. For me, personally, there's a sense of deja vu all over again around these events. That is because for me, the relevant history goes back in time even beyond the PCAST reports of 2010 and 2013, to earlier reports by President Clinton's PCAST in which Secretary Moniz and I were both involved in our earlier professional incarnations. I was a member of the Clinton PCAST and served as Chair of three PCAST studies in the climate and energy space. Those reports came out in 1995, 1997 and 1999. And in the first Clinton term, Ernie Moniz was the OSTP Associate Director for Science, and he helped with the 1995 study. In the second Clinton term, of course, he was under-Secretary of Energy providing moral and staff support as well as financial resources and personal insight into the 1997 and 1999 PCAST energy report.

During President Obama's first term, as I noted, Ernie co-lead the 2010 PCAST report that I mentioned earlier, which proposed both the quadrennial technology review and the quadrennial energy review and now in President Obama's second term he is the Secretary of Energy, we all know that, who is implementing those recommendations. Having had such a big role in planning and execution of these quadrennial energy reviews, I think Ernie is a little bit like a quarterback who throws a pass and then runs down the field to catch it. And we are, I think, very fortunate to have had him in both of those roles. Of course there have been significant changes in our energy landscape in the 20 years that have elapsed since the first Clinton

Administration's PCAST energy studies in 1995. Some of the most remarkable of those changes have happened in the last decade. Those changes affect the full spectrum of energy supply, sources and end uses, but I want to focus just briefly on a couple of examples that relate to the electricity system, the current focus in the QER's moving spotlight. In electricity generation, coal consumption, as most of you know, declined by about a third between 2008 and 2015. The 2015 data are now out from the Energy Information Administration. And the numbers are a one-third decline in coal consumption over that period. Natural gas in the same period has gone up by about a third. Since 2008 the amount of electricity generated by wind power has more than tripled and the amount generated by solar energy has increased more than 30-fold, really astonishing number. In electricity end use, lighting based on light emitting diodes or LED's was still in its infancy when Congress passed the last major energy bill in 2007. But today LED's are found everywhere and they have resulted in a huge improvement in energy efficiency in lighting worldwide. We're witnessing the advent of the practical use of electricity in vehicle transportation. Today there are 26 models of plug-in electric cars on the market offered by more than a dozen manufacturers. And starting later this year we'll begin to see the introduction of cars from more than one manufacturer with upwards of 200 miles of range on a single charge. I think that's going to be transformative and while it takes a while for new technologies to penetrate vehicle markets, the introduction of electric drive vehicles and passenger vehicles, is ultimately going to facilitate a significant degree of decarbonization in the transportation sector.

These changes are occurring in a broader context that is dominated by an increasing understanding of the scale and the impacts of global climate change. Global climate change, of course, being brought about by human activities. Most importantly, the emission of greenhouse gases and black carbon particulate matter from the global energy systems. As the third national climate assessment pointed out succinctly in 2014, climate change, once considered an issue for the distant future, has firmly moved into the present. I would emphasize that the basis for that conclusion is not theory alone or computer models alone. It is, in fact, a tapestry of evidence. Weaving together basic understandings from physics, chemistry and biology, many decades of observations by thousands of scientists at tens of thousands of locations around the world, studies of natural variations in Earth's climate over the millennia based on sediments, tree rings, fossil pollens and ice cores and computer models that help us put it all together in a coherent way. What we now know about climate change beyond a reasonable doubt can usefully be summarized I think in five fundamental understandings. First, the climate of the Earth is changing at a pace and in a pattern that is not explainable in terms of natural influences. Second, we know what does explain these changes. The cause of those changes is an increase in the atmospheric concentrations of carbon dioxide and other heat trapping substances that we know were caused primarily by fossil fuel burning and by land use change. Third, the changes in climate are already causing harm to life, health, property, economies and ecosystems. Fourth, the harm will continue to grow for decades, no matter what we do, because of the momentum in the climate system and the inertia in the energy system. But fifth, and crucially, the amount of future harm will be much smaller if we take prompt, strong, evasive action than if we do not. All of this was already clear enough when President Obama took office. And in his first term, the administration took a variety of significant steps to address the climate challenge. Those included working with Congress to pass the recovery act that had in it \$80 billion for cleaner, more efficient energy supply and use. It included the first ever combined

fuel economy greenhouse gas standards for light duty vehicles. It included a large batch of new energy efficiency standards from DOE for both residential and commercial appliances and included the President's announcement already in 2009, of a U.S. target for national greenhouse gas emissions of around 17% below 2005 levels by 2020. All that was augmented in the second term, as I have already noted, with the President's June 2013 announcement of his three pillar Natural Climate Action Plan. And I think as you all know, those three pillars are first reducing U.S. domestic emissions of the greenhouse gases that are driving climate change, second, increasing the nation's preparedness and resilience against the changes in climate that can no longer be avoided and third, leading internationally. Encouraging and helping other countries to do their part for global emissions reductions and to take the needed steps to increase their own resilience and preparedness.

Since the June 2013 roll-out of the plan, the United States has made significant progress on all three of those pillars. In the first category, the progress has included EPA's Clean Power Plan aimed at reducing greenhouse gas emissions from the electric power sector. It has included a new national methane strategy and of course continued progress on energy and use efficiency. With respect to increasing preparedness and resilience against climate change, the administration has launched a climate data initiative and the climate resilience tool kit. It has embedded resilience properties into the missions of all departments and agencies across the Federal Government. And it has reached out to state, local and tribal governments and to the academic, private and civil society sectors, building collaborations to advance climate preparedness and resilience. As for international leadership at the Paris Conference of the Parties to the U.N. Framework Convention on Climate Change last December, President Obama played a major role in brokering commitments by 195 nations to reduce their emissions of greenhouse gases between now and 2030. The agreement includes a mechanism to review progress on those commitments and provide opportunities for countries to increase the ambition of their efforts to combat climate change as new technologies become available. Closely related to that agreement was a separate agreement by major emitting countries to increase the size and scope of their research and development on new, clean energy technologies, coupled with commitment by leading entrepreneurs to match that with billions of dollars of new private investment for bringing the new technologies to market. The United States was a key leader throughout in those discussions and commitments.

The work of this second installment of the Quadrennial Energy Review is going to be highly relevant to the task of helping our electricity system lead the world in reliability, affordability, and environmental performance. The climate challenge clearly cannot be met, except with the help of advanced technologies for energy supply and end use, certainly including the electricity sector.

So let me close by thanking Secretary Moniz for his excellent work in helping us craft the first installment of the QER. Those thanks go, as well, to Melanie Kenderdine and her staff for the work that they have undertaken and continue to undertake to help deliver the second installment of the Quadrennial Energy Review and finally let me thank the panelists that we'll be hearing from later today at this stakeholder meeting for their insights and cooperation in helping us to make this second installment of the QER as robust and useful as the first one was.

And let me thank Governor Baker not only for his remarks but for staying here for mine. Thank you very much.

(Applause.)

MELANIE KENDERDINE: Thank you so much, John. As I noted earlier, John helps lead the White House effort on the QER. And this process, which to the Governor's point about the importance of energy to our economy, to the environment, to our security, the interagency task force for the first installment of the QER included 22 agencies. And we received on that QER from the agencies, 1,500 comments. So they're enormous equities in energy across the government, across the Federal Government, also across the country, that's what these stakeholder meetings are all about. And I can tell you, I'd like to do a callout to my staff, managing -- adjudicating 1,500 comments from Federal Agencies is a major undertaking. April Salas in my office runs the secretariat. That's what we do in part in our office. And I did want to illustrate to you how critical energy is across the government. We did transmission storage and distribution infrastructure in the last installment. This one is electricity from generation to end use. Maybe a little bit more focused, I think, complicated and critical, however, as I said earlier.

Finally, let me introduce Dr. Ernest Moniz, the 13th Secretary of Energy for the United States. In this instance, I think the Number 13 is lucky. He is the fourth Secretary of Energy that I've had the pleasure of working for. Don't tell the other three, but I think he's received a lot of press for being the best Secretary of Energy ever. And he is tasked at DOE with implementing the department's critical missions in support of President Obama's goals in growing the economy, enhancing security, and protecting the environment. And nuclear safety and security is another huge undertaking. I'm sure you've read a lot about secretary Moniz and his efforts on Iran. We were here yesterday, where he discussed those. Prior to his appointment as Energy Secretary, he was on the faculty at MIT. He's a Stanford grad, not an MIT grad, John, and so I need to tell a Stanford joke there, too. He was on the faculty on the MIT where he had been on the faculty since 1973. This meeting today is a homecoming of sorts for both him and for me, as I mentioned earlier. He was the Director of the MIT Energy Initiative and went directly from that position to become the Secretary of Energy. I've had the good fortune of working with Secretary Moniz off and on for about two decades. I think people would agree that he is an incredible Secretary of Energy and we look forward to hearing his remarks. Thank you.

(Applause.)

SECRETARY ERNEST MONIZ: Well, thank you, Melanie. And also, I want to note that as has been said, the Energy Policy and Systems Analysis Office that Melanie heads is kind of the point of the spear in terms of moving this whole process, a complicated process, but important one, along. But I also note that not only the Director of the office but actually the Founding Director of the office and putting together a terrific group of energy experts and analysts, and so we couldn't do -- I think John would agree, we couldn't do the QER without this -- without this incredible effort. John Holdren, of course, I also want to thank. We go back many more decades than we like to admit. He described some of our actions together but I think it's worth noting with incredulity that he is well on his way to doing two entire terms in the White House

as Science Advisor, and I have to say that I think I can understand his hanging in there, because the President is so engaged in this. I think I can say that the President was like his own scheduler to make sure he got to PCAST meetings in the middle of obviously enormous set of responsibilities. But John has done an incredible job in terms of keeping science in the forefront of this administration's activities.

Governor Baker, good to see you again, and I really want to thank the Governor, not for coming here, but most especially for his commitment to clean energy and energy efficiency. As a homeowner and resident in the Commonwealth, I have to say that it was great a few years ago when Massachusetts nudged California out of the number one spot in the ACEEE energy efficiency ratings, and holds onto that spot. But also in the regional context it's worth noting that four of the six first ranked states are New England states. So it's a strong regional and of course strong Commonwealth commitment in this arena.

Let me say a few words. A lot's been said. So I don't want to repeat what's been said, but first of all, again, we very much appreciate the panelists and all of your attendance here. What I want to emphasize, I believe, there's every reason to expect that this will be time well spent. And that your input will be important. John mentioned how that was important, the first QER, but I think it's worth saying that the QER, the construct that we put together, as John described several years ago, was based on the premise informed by some key members of Congress that a putting together an administration wide, integrated, highly analytical document would provide a new basis and an important one for discussions across party lines, across administration Congressional lines, with stake-holders, and that has proved to be the case. The first installment to the QER has been acknowledged explicitly, and shown to be in various pieces of legislation that were passed at the end of 2015 and are pending right now in the Energy Senate Bill. Very explicitly drawing upon the infrastructure recommendations made. And in one case, in particular, having substantial resource implications by authorizing \$2 billion for modernization of the petroleum reserve. We also understand that the QER kind of sits on most state energy office desks, and so, again, I think we are fully anticipating commensurate impact from this second installment focused on electricity. And so your input, I think, is very important to help guide us.

I do want to emphasize that as you've seen from the program, the focus is on the Northeast. There are clearly very important issues that span the entire discussions of electricity, but we also know that our significant regional variations, and that's why we want to address these questions in all the regions of the country. And this one, this kickoff meeting, outside of DC, is specifically aimed at looking at the Northeast set of questions around generation, transmission, distribution, storage, as the Governor mentioned, and end use. There's been a discussion about the stakeholder engagement and the organization. So I think we can leave any further discussion of that for the question period. But let me just say that some of the framing questions, I think, clearly are how the changing generation mix affects grid operations, planning, liability, and system performance, including the ability to provide affordable electricity. How we should address growing concerns about cyber and physical security risks, whether our current market structures allow for adequate investment in grid marketization, whether we will see future challenges from new technologies to the increasingly blurry line between Federal and State jurisdictions, and what the implications are of increasing customer

connectedness to the grid. So those are just some of the questions, but some of the challenging questions that we know we face, as we think, not only about new technologies, but new policies and new business models that are going to be needed for the electricity system of the next century. Of this century, this is already the 21st century.

Let me add a few words about climate change as providing so much of the context for our discussions. Again, John clearly covered a lot of the drivers. Just to add a few remarks, resilience is an important word as we look to the electricity system. Clearly, reliability, economic performance are important, but resilience is also important. There are a variety of risks to the system. We mentioned cyber and physical already. But also the anticipated, continued extreme weather risks, for example, are all part of a resilient strategy that we need to elevate. I would note that a couple months ago, I went to Florida and looked at what Florida Power and Light is doing in the resilience context. Clearly, they are in a situation where, with rising sea levels and being prone to some extreme weather events, it's a major issue for them. And it was encouraging to see the extent to which they are combining what I would call hardening and smartening of the grid going forward. But we need to think about that more broadly, and also with an even greater integration, in my view, of information technology into the whole system.

John mentioned the shift in coal and natural gas use. Largely market-driven, although obviously policies coming in, in particular through the Climate Action Plan, quite important. But I would just make one more footnote to what John said, and that is that 2016, the Energy Information Administration projects that 2016 will be the first full year in which the market share of electricity generation will be greater for natural gas than for coal. So, really, quite a dramatic shift over these last decades. Let me elaborate slightly as well on something that Jon alluded to, and that was the outcome of the Paris meetings, COP 21. I think clearly extremely important as a big, first step to addressing the challenges of global warming and climate change when virtually every country in the world has an at least reasonably ambitious plan for lowering carbon emissions. At the very beginning of the meeting is when the so-called Mission Innovation Initiative was announced, which is 20 countries, including the United States, seeking to double energy R&D, energy technology, science and technology R&D over a five-year period. Those countries representing nearly 85% of global energy technology, R&D investment. So essentially we're talking it doubling in five years, opening up the innovation pipeline, providing more investable opportunities. And then on the investment side, Bill Gates leading the development of a parallel coalition, called the Break Through Energy Coalition. Twenty-eight investors from ten countries, very deep-pocketed, looking to capitalize on the increase in investable options, but by combining three characteristics that are all challenging for the energy sector, one extreme patience in any returns. They're prepared to wait 20 years. In the energy business we know 20 years is maybe kind of what you need often. They are prepared to invest with a high degree of risk tolerance in terms of looking for some of the transformative technologies, and they are willing to use their resources for the most promising candidates to go end-to-end. The early stages to the typically large resource requirements of deployment at scale.

So this is a very exciting public/private kind of partnership, even though the coalitions are independent, but clearly, clearly linked in their Genesis and in their intent. What I want to

emphasize is that this innovation theme, and the United States played a major role in advancing this, the innovation team, number one, was placed really very squarely at the center of the world's discussions about addressing climate change. And the reason is, I think pretty straightforward and articulated for example by the Prime Minister Modi, where you have a large emerging economy, namely that we know that we have seen dramatic cost production in a number of managed technologies just in the last six, seven years; wind 40%, PV 50 to 60%, storage 70%, LEDs 90%. But we need to keep that going through innovation, continued cost reduction, not only of those technologies, but of other clean technologies, as well as a critical underpinning for the increased ambition that we will need going forward. So I think Paris, great step, lot of commitments into the 2025, 2030 time scale. We know the challenges will not get easier after that.

And so this innovation theme is essential to keep marching forward in ways that especially emerging and developing economies can exercise even greater ambition in the future. I would say in our own case, in the United States, the Department of Energy, our budgets of the last couple of years and our proposal for the budgets going forward, places a very large emphasis on modernization of the grid as a key enabler for all we want to do. And that's everything from the technology components to the system kinds of developments that one needs in moving forward.

So those are the kinds of things we'll be looking forward to hearing about from this and from other regional meetings, we want to make it very clear that the opportunity for input does not end this afternoon. We will be continuously open for input as we pull together this electricity installment over this next half year or so. So, thank you for that.

And, before we turn to I think at least a short question and answer period, I would like to make one special announcement presentation. One of our staff that has played a lead role in organizing this meeting is Matt McGovern, who I would like to come up here, please.

As we've already heard, the Boston marathon presents a very important backdrop to all that we think about here in Boston, at this time of the year, around Patriots Day. This has been a very, very long important tradition, of course, but in the last three years we also are always reminded of the tragedy that occurred here then.

Matt, no doubt, coincidentally chose this date to be the marathon weekend. He will be running in that marathon. Not a bad choice of date. We'll go with that, but what we want to do is to present Matt with his special marathon shirt. This is the QER 1.2 shirt.

(Applause)

Matt why don't you come over. We're going to have a picture taken. You get to hold it. Okay. Thank you. Good luck.

(Applause)

GOVERNOR CHARLIE BAKER: I actually have to go to a marathon meeting.

MELANIE KENDERDINE: Thank you, Governor. The governor said he had to go to a marathon meeting. I'm going to turn this over to the Chris Kelley now, for questions, just a couple of questions. Thank you, the governor, Dr. Holdren, Secretary Moniz, the EPSIS staff, and note that the staffs of Congressman Kennedy and Moulton are here and Mayor Martin Walsh's office is represented here today. Look forward to all of your comments and questions and thank you again for coming.

CHRIS KELLEY: Thank you Melanie. As she stated, we do have time for one or two questions. We have a microphone set up here if you can just be—so we have a question here. Please step up to the mic. State your name and ask your question.

KATE DeWOLF: I'm Kate DeWolf, an Army contractor. I'm concerned about the vulnerability of our military bases when the electric grid goes down. What plans does your department have to improve the energy security and resiliency of our military bases?

ERNEST MONIZ: Thank you for that question. We are working quite closely with the Department of Defense for energy needs—actually both for fixed assets like bases, and also for the war fighter where energy issues are paramount but for the bases, we are, for example, our Sandia Laboratory has worked to design micro grids for quite a large number of bases and some of those are now being implemented. Secondly, we worked with the Navy for major supply of renewable, specifically solar energy, for our Navy base in southern California and although this is not a base per se, but an important energy issue as well, we work in partnership with the Department of Defense, again, the Navy in particular, and the Department of Agriculture in terms of advanced drop-in biofuels which can be used for military operations.

JOHN HOLDREN: Let me just add a couple of quick points. One is that there has been and continues to be a very substantial increase in the deployment of onsite renewables at military bases. Second thing I would say is that the preparedness and resilience thrust, which is being pursued all across the government is being pursued with great energy in the Department of Defense and perhaps that's not entirely by accident. The second of defense, Dr. Ashton Carter, is yet another Cambridge physicist.

MELANIE KENDERDINE: If I could say, too, in that regard, I just last week spoke to a gentleman, Paul Stockton, he was an assistant secretary at the Department of Defense. He spent a lot of time while he was there and in his subsequent life focusing on the reliance of the defense footprint, the military footprint on electricity and broader national security issues associated with electricity as well. We hope to include him on an upcoming panel that we have for a technical workshop we have going on, so we are focused on that issue in the QER itself, too.

CHRIS KELLEY: Any other questions? We have time for one more.

CHRISTIAN HOEPENER: I have a question for the secretary. What can you do today, what are you able to do and what can you do, what are you doing to keep this great momentum which you described going beyond the end of the current administration?

ERNEST MONIZ: Well, obviously, the next administration will make its own choices but what I've always said at the department, I have many witnesses in this room, as we think about trying to institutional, if you like, those activities that we think have added value, whether it be in a QER or in other areas of the department, the number one criterion is value added. So I think if there's demonstrable value added then that's the best recommendation to the next administration to continue and I think, as I said in my remarks, the QER first installment, I think, answers that very, very positively from the demonstrable impact it is having in legislation and in other arenas. So I think it's really about performing, and that's the best thing that we can do.

CHRIS KELLEY: Okay. That's all the time we have. Please take a moment for thanking our distinguished speakers.

(Applause)

Panel 1

Bulk Power Generation and Transmission: How Can We Plan, Build, and Operate the Appropriate Amount for Future Needs?

CHRIS KELLEY: So I would ask our first panel to come join me on here up on stage as we change everything out, and while we're doing that, I just want to remind folks, if you have a comment that you would like to present at the end of today please make sure you have already signed up, or you do sign up in the signup sheet at the front entrance to the auditorium. And for those of you who are joining via the live stream on the web, again, the place to submitted comments is www.energy.gov/QER. We'll get started in just a moment.

(Brief Recess)

CHRIS KELLEY: We're going to get started here in about 30 seconds. Our first panel is on bulk power and energy transmission—how can we plan, build, and operate the appropriate amount for future needs?

I've already discussed the game plan with our panelists, here, but just a reminder what we'll be doing is we'll each have five to seven minutes to provide a presentation. We'll run through those and give everyone a chance to provide their presentation and then I'll come back and ask a few questions.

I would like to remind everyone here the views expressed by the panelists are their own views and not the views of the Administration, including the U.S. Department of Energy.

So our first panel, I'm joined by Stephen J. Rourke, who is the Vice President, System Planning for ISO New England; Richard Dewey, Executive Vice President, New York Independent System Operator; Gil Quiniones, President and Chief Executive Officer of New York Power Authority; Carolyn Browne Anderson, Director of Transmission Policy and Insurance, Green Mountain Power; Dan Dolan, President, New England Power Generators Association; and, Camilo Serna, Vice president for Strategic Policy and Planning for Eversource. And, just a reminder for the speakers, we have a timer out there that you should be able to see, I'll turn on in a moment, and I will also be up here to remind you of your time.

So why don't we go ahead and get started with Steve.

STEPHEN J. ROURKE: Well, Chris, thank you very much. As Chris said, my name is Steve Rourke. I serve as Vice President of System Planning for ISO New England. I first want to thank all of our hosts, certainly thank the first panel. It's an honor to be here with all of them, and as a region, we appreciate the efforts at the DOE with their focus on us and the issues that we face up here.

So just to start with, very high level, the ISO has three main functions. We operate the bulk power system for the six New England states. We administer the wholesale power markets for New England. My group has the very fun assignment to do long range planning for the region and in this state of change, a lot of great work for us to be involved with.

I do want to just take the next few minutes to give you a sense of what is going on with the change in the generation mix here in the region, so that will be our focus. Back in 1999, the advent of the wholesale power markets here in the region, a lot of enthusiasm when the market started. We've seen over 13,000-megawatts of new gas-fired power plants that have come forward. When you combine that with the development of shale gas and what is now, you know, many times in the course of the year fairly low prices for gas, it's had a profound change here for the region.

On the flip side of that we certainly heard that from the work done by the DOE on the first release of the QER and we sort of live it in real time when there are constraints on getting gas. We are faced with a region with reliability issues, with environmental issues, and economic issues that are substantial. So there have been some growing pains with this. I think this slide will give you, for those of you who don't know it, give you a really good sense of what has gone on, if you look backwards, for 15 years on the change in the energy mix. Back in the year 2000, we got 40% of our energy from oil and coal and in 2015 we got 6% of our energy from oil and coal. So a huge change there. The big shift, of course, has been to natural gas with nearly half of our energy in 2015 coming from gas fired plants.

Sort of on the good news side of the ledger, as we have moved away from some of the older gas and coal units, there's been really a profound change with the level of NO_x emissions, SO₂ and even CO₂ emissions from the generation sector here in the region, you know, NO_x down by two-thirds, the SO₂ emission down by 94%. So very big changes there. So what does this mean? We certainly have seen a lot of the new natural gas plans come forward. I would say the older fleet has not been standing still while that's happened. From 1997 to roughly 2012, we

saw 3200 megawatts of older oil and coal units choose to exit the market. In 2012, we actually did a study as we were seeing, you know, how fragile the market conditions seem to be for the oil and coal units left, which of those were sort of at risk. At that point in time, we identified roughly 8300 megawatts of oil and coal units that appeared to be struggling in the markets, sort of faced with environmental challenges going forward.

Just to give you a sense of it, the newest of the stations was built in 1978 and the oldest goes back to 1952, so these stations are getting older. Since that time, we have seen a number of them shut down. We've also have had two nuclear units, one is shut down and one is going to be shutting down. So we're seeing really big changes here in the fleet.

So when we look forward, what takes their place? They're still about, as I said, about 5,000 or 6,000 megawatts of the older oil and coal units left. Certainly gas is out there. But states have very aggressive rules in place for their renewable portfolio standards, sort of those green to the blue bar on your left, and also very strict targets for reductions in greenhouse gasses.

So what's next? Well, what's next for us is we look out for five or ten years is really heading to a hybrid grid. You know, I'm a bit very reliant still on the transmission system here in the network, and the old bulk power plants, but a lot of smaller Gen, solar panels, other forms of DG, etcetera. I would say if we have our toe in the water on this right now, five or ten years from now we will be waist deep in this, so that's where we are headed as a region.

So, some changes. We had 850 megawatts of wind in service right now with 4200 megawatts of wind under study in our study queue. Solar has been, perhaps, the biggest change here in the region. We just crossed over 1400 megawatts of installed solar PB in New England. In 2010 there was 40 megawatts of solar, so it's really kind of gone vertical, and we just updated our forecast this spring to move it along. So lots of changes here. Lots of changes with efficiency investments from our six states.

Just to be able to reach out to wind and to be able to reach out to the hydropower up in Canada, a number of projects under study for big transmission lines to go get that. Clean energy, we worked with the region to update our tariffs, to make it more friendly for these types of resources to participate in our markets.

So you know, lots of big changes coming. Shut down of the older fleet, moving much more to solar, wind, etcetera. I would say we're on the frontline of change here in the region, and we look forward to continuing to work with the DOE on these efforts. Thank you very much.

CHRIS KELLEY: Thank you, Steve. Rich?

RICHARD DEWEY: Thank you Chris and I want to thank the DOE staff for the opportunity to talk to you today. My name is Rich Dewey. I'm the Executive Vice President of the New York ISO, very similar in scope and function as Steve just described, responsible for the reliability of the power grid, the administration of markets, and planning for the future in New York State.

I want to talk a little bit about the value of markets in terms of how we solve some of our problems in the past and how it's very, very valuable tool we believe in following some challenges of the future. When we look back over the 15 years of competitive markets in New York State, we look at the efficiency of the generation fleet, the improvement of the heat rate, and we can translate that into about a 6.5 billion dollar consumer savings for energy consumers within the state.

We also look at reduction in the reserve margins from an efficient operation of the grid. That's about half a billion dollars. And then, when you translate that fuel efficiency and that power plant efficiency into carbon measurements, you're really looking at a 40% reduction in carbon emissions just from the New York State fleet, and we feel that's a reflection of the competitive forces that were introduced and the overall efficiency of the operation of those assets.

We also like to look at markets as the right kind, sending the right kind of signals that incentivize the introduction of new technology, whether it's renewables and wind. We've done a lot of innovative wind forecasting and wind on dispatch market features within New York that have driven the amount of wind in New York from 50 megawatts in 2004 all the way up to 1800 megawatts now, and another 3,000 to 4,000 sitting in our connection queue.

We really believe that the value of the locational signal drives that wind and those valuable resources to be located where we need them, not where it's most economic for the developer to build, and we think that that's a very important component in terms of how we position ourselves for some of the challenges that are coming at us.

I also want to talk a little bit, sitting here with ISO New England and with PJM on a panel later, interregional coordination is absolutely vital to be able to maximize the efficiency not only of how we move power between the regions for economics, but also from a reliability planning standpoint in terms of how we can lean on each other to solve critical, tight situations, so we think that that's something that we need to encourage to further develop and to continue.

Challenges that are upcoming, I think Steve touched on them quite a bit and we're really looking at flat to declining energy consumption but increases in the peaks. And that results in a situation when you combine that with very, very low natural gas prices and subsequent low energy revenue, the economic viability of conventional generation is really being challenged. Certain types of resources are finding it hard to stay in operation. When you look at the intermittency of the wind and the solar resources and the reliability requirements to be able to balance that wind and to balance that solar, we really need to continue to work to find a way to keep the conventional generation within the market. It's going to be a significant challenge. It's an economic challenge, it's also a reliability challenge, but it's something that we need to be able to recognize and come up with innovative solutions.

We also looked at the effect of all of this intermittency, the conventional fleet. We might need to start looking at different products to incentivize different types of behavior or characteristics out of these assets. We talk about the low carbon objectives but also you need to start looking at things like quick start characteristics on some of this conventional generation and we really

are recommending, we've got to look hard at coming up with products that incentivize that type of behavior.

Also, looking at the industry is changing. New York has been progressive in terms of incentivizing distributed energy resources. And the New York REV program is something that's out at the forefront, but it's really the industry that's going that way. We talked about micro grids and resilient distribution networks. We need to figure out how to send the right price signal and the right operational rules so that those resources can be sighted where they're most valuable and then that can be compensated in a way that reflects the value that they bring to the grid and that's something where the grid operators, like New York ISO and ISO New England need to work very closely with the distribution companies to come up with a way that makes the system as reliable as possible and also benefits consumers to the maximum amount possible.

And then finally, as I turn it over to Gil, I'm going to talk a little bit about transmission is something that we need to continue to invest in. A lot of these renewable resources are being located far away from the load centers. Our infrastructure, our transmission infrastructure, is aging in its own right and we need to continue to find ways to be able to move that power around from where it's being sighted today to where the consumers really need it and keeping reinvestment on our transmission infrastructure is a vital component of that. Thank you.

CHRIS KELLEY: Thank you. Rich. Gil?

GIL QUINIONES: Good morning. My name is Gil Quiniones, I'm the President and Chief Executive Officer of the New York Power Authority. Thank you very much to secretary Moniz, Dr. John Holdren, Melanie Kenderdine and her team for inviting us here today.

First, you know, this is an important day on behalf Governor Cuomo. All New Yorkers are with the people of the city of Boston and of this great state. We understand the significance of this day and we honor your strength and your resiliency.

I want to talk a little bit about NYPA, our transmission initiatives, what we're doing in terms of keeping our system flexible, resilient, and connected. The role of NYPA, and especially public power, and the role of New York in this is equation, as we talk about the Northeast.

First of all, NYPA is the largest state-owned public electric utility in the nation. We have produced about 25% of all electricity in New York State. Seventy percent from large hydroelectric power plants; the other 30% from high efficient natural gas plants, mostly in New York City and on Long Island.

The New York Power Authority also owns a third of the high voltage transmission grid in New York State, including all of the interconnections to Canada, both to the province of Ontario, Québec, and Vermont. It is our 85th year anniversary coming at the end of this month. We were formed by then governor Franklin Delano Roosevelt in 1931 and I'm happy to say that states have always been the incubator of federal and state partnership as NYPA's statute was used by

FDR to be the model and the creation of the Tennessee Valley Authority and Bonneville Power Authority systems.

In terms of transmission, New York is interesting in that two-thirds of the supply is upstate, and only one-third of the demand; whereas down state there's two-thirds of the demand but only one-third of the generation sources. So the main issue really is there is a bottleneck in and around the Albany area, which is the central part of the state, and those bottlenecks are the ones that we are trying to address.

In 2012, Governor Cuomo formed an energy highway task force. I co-chaired that task force with the primary purpose of addressing those bottlenecks. As Rich mentioned, New York also has embarked on a very innovative process called Reforming the Energy Vision, in trying to figure out how can we maximize the value of distributed energy resources in synchronicity with our bulk power system. And as technology evolves and invasion advances, we also need to innovate the regulatory process and the business models that have to support that transformation.

The congestion that I mentioned between upstate and down state costs New Yorkers about \$9 billion between now and 2024. That's the recent estimate and so it means a lot to the state of New York. So for NYPA, being the owner of third of the grid, we are doing a lot to not only bring our system into a state of good repair, but to really advance the technology and to make our transmission system as effective and efficient as possible. We have partnered along with all of the other utilities in New York with the Department of Energy in putting a lot of measurement units and capacitor banks during the era's contribution by DOE, a much-needed investment that we had to do. NYPA itself, we are investing over 730 million dollars in life extension and modernization of our grid. And under the FERC-1000 process there are currently two solicitations to unbundle that congestion between Albany and the lower part of our state, about a thousand megawatts of competition amongst utilities, private developers, and companies like NYPA, and also another one in western New York to address the retirement of a couple of coal plants in the Niagara and Buffalo region. So there is a lot of transmission investment currently being contemplated in the state of New York.

NYPA itself, we have been in the process of installing smart grid to one of our 345kb transmission lines that starts at Utica and goes all the way down to the lower Hudson Valley of the state. It's called Series Compensation to our MARSII south transmission line. By not changing the line at all, just applying smart technology, we are going to increase the transfer capability by 440 megawatts and bring more power from upstate to down state.

We are also involved and working closely with DOE and its national labs on cutting-edge technology. I'll give you a few examples. Dynamic line ratings. We are putting technology so that we actually know how much power our transmission systems are carrying and that we can push them higher and, if needed, during the hottest days of the summer. We are also upgrading and investing in our convertible static converter. That's basically a fast switch that addresses the congestion point in the middle of the state and shifts power in milliseconds from one transmission corridor to another, up to about 200 megawatts which really helps the New York ISO in maintaining the reliability of the grid. And, in northern New York, we are building the

first ever, one of its kind, large transmission substation of the future under IEC61-850 standard. It will be the first of its kind in the United States. It will give us better situational awareness and better integration of renewables, as most of the wind farms in New York are located upstate and connected to the NYPA transmission system.

CHRIS KELLEY: Gill, can I ask you to move to your conclusion?

GIL QUINIONES: And so, to close, you gave me the right segue there, you know, New York has a rich history in innovation. The first power plant was built in Lower Manhattan by Thomas Edison. The first transmission of electricity occurred from Niagara Falls to Buffalo by Nikola Tesla and we are now, again, poised to lead that innovation in the next generation of our electric system. Thank you very much.

(Applause)

CHRIS KELLEY: Thank you, Gil. Carolyn.

CAROLYN BROWNE ANDERSON: Thank you, Chris. Hi. I'm Carolyn Browne Anderson, I'm Director of Transmission Policy and Insurance at Green Mountain Power. I'd like to thank you, Secretary Moniz, and Dr. Holdren, and Miss Kenderdine for inviting me. I'm really honored to be here.

So Green Mountain Power is a small electric utility serving over 265,000 customers in Vermont. While we've been serving customers since 1893, we don't consider ourselves a typical electric utility and we'd like to call ourselves the energy company of the future. And one of the reasons for that is because we think the traditional electric utility is changing and may even be vanishing and so we're trying to change with it. We're the first utility in the country to get a B certification and we're very proud of that fact. So, we also consider ourselves customer obsessed, which means we are constantly trying to exceed the expectations of our customers and the way we're doing that is to try to offer them new products and solutions for their energy needs that are saving them money and bringing down our carbon footprint.

So we're talking about the transmission grid and there's no question that we need a reliable cost-effective transmission grid, but that grid, I think, is facing challenges, with security, reliability, the need to integrate storage, and distributed generation. And we see, in the future, a very different grid, and I think everyone else does, too, that will incorporate at a more distributed market platform that leverages things like battery storage. And, so with the challenges facing the grid, we believe that every decision related to cost that go into the transmission grid need to be informed by a series of considerations about whether the cost is truly needed and whether it could be met in another way through efficiency or a non-transmission alternative, or whether we really even could be better spending our money on equipment and technology like storage and automation that could actually increase the resiliency and efficiency of the grid.

Obviously, where there's challenges there's opportunities and we've taken these opportunities to come up with a new business model which will have less focus on the bulk transmission grid

with centralized power sources and more reliance on a customer-focused distribution grid with energy located closer to load. We've advanced three strategic imperatives to do this, and that would include changing the distribute grid model, engaging customer value, and increasing our reliance on local resources. So we hope that by doing this we can reduce our reliance on the bulk transmission grid and deliver the energy future that our customers keep telling us that they want. So I want to take an opportunity to discuss what is going on at Green Mountain Power and in Vermont.

One of the biggest things happening is solar penetration on our distribution grid and it's growing exceedingly rapidly. Just to give you perspective, in our service territory alone, at the end of the February, we had 109 megawatts of solar and we expect to have 120 megawatts, which is more than 15% of our annual peak demand. So we are small but we do have a lot of solar. So the high penetration is certainly causing some system and operational issues. I think, has been mentioned here, sort of the easiest, cheapest spot to put in wind and solar tends not to be exactly close to load. So we're trying to use tools to accommodate the distributing generation and encourage folks to locate closer to load.

A couple of the tools that we've got right now are the Vermont Weather Analytic Center, and that was developed by Velco. As many of you are aware, Velco is a transmission-only company in Vermont and the Weather Analytic Center is truly remarkable and it using advanced weather analytics and modeling tools to improve renewable generation and load forecasting. It's still being tested but the results have been fairly phenomenal.

We, at Green Mountain Power, have developed an interactive distribution generation map. It's still in the development stage but you can use it and it's available on our website right now. It's going to be a tool for developers to sort of self-serve and obtain the information about technical grid information that they're looking for to optimize the location size and details of their distributed resource products.

One of the most exciting things, obviously, that everyone's talking about is storage. And Green Mountain has several initiatives going on right now with storage. We received a Department of Energy grant several years ago to do a solar—to incorporate storage in the solar facility. At the time, the grant, the RFP went out, we were working on a 2.2-megawatt solar facility on a capped landfill and it was the perfect spot to incorporate solar because it was next to the Rutland High School. So we obtained the grant and the solar facility with the storage is up and running. It's 2.5 megawatts of solar and we have 2 megawatts with 1-megawatt hour Lithium ion battery and 2.4 megawatt hour LED acid battery and four 500 kilowatt multi-port inverters.

The project is going extremely well. We're able to island an emergency shelter at Rutland High School and we anticipate seeing system reliability benefits, reduced transmission costs through peak shaving, and it certainly provides educational value. We also are working on new control software to manage behind the meter devices on this very same circuit. We have about four megawatts of peak load there and on that circuit we have battery storage, controllable water heaters, and home energy storage units. The goal is to better understand how to choreograph distributed energy resources like those water heaters and residential energy storage units in ways to help us manage a grid with energy generated close to load.

We have a line – I see my time is almost up so I'm moving along, Chris. We have a line of innovative products. One of the most exciting is our partnership with Tesla so we're providing a home battery storage system for our customers. And we also have some innovative breaks that go along with that. If the customers want to pay less and turn over some control to us we will be able to use that battery, again, to reduce transmission costs.

So, thank you very much for allowing to us speak, for allowing me to speak here and let you know about Green Mountain Power's vision for the future.

CHRIS KELLEY: Thank you, Caroline. Dan.

DAN DOLAN: Thank you Chris and, again, thank you for the invitation here, particularly on this important day for the city of Boston and given my hometown, it certainly has some meaning there.

My name is Dan Dolan. I'm President of the New England Power Generators Association. We're the trade association that represents 85% of the installed generating capacity here in the six states of New England. We also work closely very with our counterparts in New York and, PJM, the independent power producers of New York, the PJM Power Providers Group, as well as the Electric Power Supply Association at a national scale. And I think this discussion, particularly the comments that we heard earlier this morning, provide an opportunity to take a little bit of a step back as we look at what is the grid going to be constructed with and for over the next several years and the decades to come.

Very clearly, we're seeing changes between further integration of distributed resources, implementation of renewable standards, and tremendous growth on that scale as well as the retirement of some of the older, less efficient power plants and the changing system overall. These innovative and potentially disruptive technologies will absolutely have an impact as we move forward, but they will have that impact in an unpredictable way and in an uncertain future. And so, as we look at what is that uncertain future going to look like, I think it's important to also look backwards and remember how we've gotten here and what is the history associated with that. And given that we're now more than 15 years in to the restructuring of the electricity industry, I think it's also important to recognize what has occurred over that decade-plus.

There were three core tenets to what we think of, at least from my perspective on energy policy: cost, environmental performance, and reliability. So when we look at those, and start with cost, despite February 2015 having been the single coldest month in Massachusetts and most of New England since at least 1960, year-over-year when we look at the 2015 wholesale electricity prices in New England they were 30% lower than they were in 2003, adjusted for inflation. And just last month, March of 2016, was the single lowest wholesale electricity price month in New England in the ISO's history. We're seeing remarkable pricing. At the same time, within that competitive pricing framework, we've seen carbon reduction off of a 1990 baseline used for the clean power plant and all of the other state mandates, of decreases of 40% from the generation sector here in the region, matching what we have seen in New York, and

we see very similar trend lines in PJM. We're also seeing a dramatic increase in the amount of investment that's coming into the region as older power plants are being retired. We're replacing that capacity with new investments, both at existing facilities and refurbishments, and environmental upgrades, as well as new power generation resources coming in with thousands of megawatts being financed and developed through the marketplace and an additional thousands of megawatts of units that are bidding into these auctions and not clearing. And I think that's an important component because it signals two things. Number one, we're seeing only the most cost competitive units actually clear; and secondly, we're seeing a tremendous amount of investment that is waiting in the wings to the degree that we have further retirements and we inevitably will. And so, when we do have those further retirements, we know that there are billions of dollars poised to enter the marketplace, come in, finance, develop, and move forward.

And so as we look at this overall, I think it's also important to recognize that this is not a market without threats and challenges to it, and the single biggest challenge that we see across the Northeast market is the potential for out-of-market intervention and the picking of winners and losers. Whether it's the examples that we see in Ohio, with an attempt to support utility affiliate generation and provide it out-of-market revenues, or what we've seen in some instances in New York State of providing support for individual types of resources, or here in New England, as we've seen from a number of states, of trying to contract for provincially owned hydropower outside of the marketplace. That undercutting of the energy market revenues, at this key moment when we are seeing the inflexion point of resources coming on, older resources coming off, and the potential for new innovative technologies to emerge, undermines the marketplace overall. And yet, because of this uncertain future, I think our job right now is to figure out what is the right architecture. How do we best position ourselves so that when the new technology that is being thought of at MIT or across the Bay here, comes in that they have a marketplace to come into. And one of the best things about an open competitive marketplace is it creates that open architecture. It allows for whoever can do it best, cheapest, and meeting all the environmental mandates to win, and those resources that can't do that, will drop off the system.

And, so, as we move forward, within this context I would encourage either the Department of Energy and all of us to try and keep that open level playing field as competitive as possible. Thank you.

CHRIS KELLEY: Thank you, Dan. And, finally, Camilo.

CAMILO SERNA: Good morning, everyone. It's great to be here. Thank you for the opportunity to speak today to the DOE. My name is Camilo Serna. I'm the Vice President of Strategic Planning and Policy at Eversource Energy. Eversource Energy is the largest energy provider in New England. We serve 3.6 million customers in Connecticut, Massachusetts, and New Hampshire. We also run the region's largest energy efficiency programs. We're very proud of being number one in Massachusetts, number six in Connecticut, we hope New Hampshire will get there. We also are the largest integrator of renewable energy in New England. So I want to look at the challenges and opportunities that we have when we look at

the bulk power system. But before we do that, I want to step back and look at the last ten years and what we have been able to accomplish.

Over the last ten years, the New England transmission owners, including Eversource, have made significant investments to construct the needed transmission upgrades that have eliminated many of the existing and potential reliability problems on a timely basis. As a result of these projects, New England has a much more robust and flexible transmission system with an increased level of reliability. Most importantly, our customers have been able to see the savings. Congestion charges, daily reliability payments, payments associated with reliability-must-run agreements have dropped from almost 800 million dollars in 2005 to less than 100 million dollars in 2015.

Eversource has been the largest player in the construction of these upgrades, and the transmission improvements have produced great reliability benefits to our customers. We're proud of what we've accomplished and we look into the future for additional investments to ensure the reliability of the system.

Moving forward, we see that the region will need to address four different challenges that are interconnected, again at the bulk power level. First, a size from New England indicated the system is transitioning. It's moving to natural gas. The numbers that you saw, from 15% in 2000 to close to 50% and there is more natural gas power plants coming on the way. But the second challenge, and one of the key challenges that we see, is that we have a constrained gas pipeline system coming into New England that has led to incredible market volatility. When our pipeline system is unconstrained, we see lower prices in the electric generation sector. But when the system is constrained, that's not true. For example, the energy market value in the winter of 2013 to 2014 was 6.8 billion dollars. That's more than 4 billion dollars compared to the average over the prior three years which was 2.8 billion dollars, and we think that 3 billion dollars of those was associated with the constraints in the pipeline system. This uncertainty has created the prices of electricity to go up. For example, in 2015, the prices went up by 40% to 60%. We get the calls of those customers that see those energy bills going up significantly. And the third challenge that we see, so we see the aggressive goals that we have to reduce carbon emissions. We have both Connecticut and Massachusetts have aggressive targets to reduce carbon emissions by 80% by 2050 from 1990 levels. The region is committed to renewable energy and increasing investment in energy efficiency. So, that's the third challenge. The fourth one is the retirements of generation capacity. Steve talked about all the numbers—3,000 megawatts, or 2,000 megawatts over the last four years. We see 3,000 coming up by over the next few years and we have another 6,000 megawatts of potential requirements by 2025. That would be 30% of the existing resource availability today.

So those are the four challenges that we're focused on today. Let me talk about the opportunities to fix those. One of the success stories in New England has the ability of the region to plan, finance and build electric transmission through the regional network service tariff, or the RNS tariff. Into the future, we see the need for new investments in transmission infrastructure and we see the need to continue to use that tariff. Eversource is confident that we can meet the challenge under the current RNS structure as long as the appropriate incentives to make those investments remain in place.

Second, to address the pipeline constraint challenges, we really need to expand the region's capacity. We have not seen capacity added for generational purposes for the last 20 years. Multiple attempts to address this issue through market pricing designs have failed, so it's time to look at different approaches. Eversource has already entered into contracts for gas transportation capacity with interstate pipelines. In order to get these contracts approved, collaboration with our policymakers is critical.

New England also has significant renewable energy potential but it's mostly located remote from load in the form of hydro and wind to the north and offshore wind to the east. Tapping these resources will require additional investments in transmission. Since these do not readily fall into the regional network service tariff, we will need to find new ways. The clean energy RFP that Connecticut, Massachusetts, and Rhode Island are running may be such a vehicle. And finally, looking out into the future, we also see the need to focus on solutions that provide large-scale renewable energy that is close to the electric loads with lower intermittency and higher capacity factors than traditional renewable solutions, and where major upgrades are not needed. To that end, we believe that offshore wind holds great promise for New England and could be a key element to address the carbon emission goals and the impending generation retirements. We are heartened by the important experience gains that technology has gained over the last recent years in Europe and the cost improvements that offshore wind is further expected to experience into the future.

Yes, we have challenges, but we also have opportunities. I look forward to discussing these with the fellow panelists and questions that I might get and thank you for the opportunity.

CHRIS KELLEY: Thank you, Camilo. So, before we move into the questions, I want to give Gil a chance—we didn't put your slide up, so if you'd like to take a minute and discuss it or do you think you covered the topics?

GIL QUINIONES: Just very quickly. That's the State of New York and the grid. The red lines are the transmission system owned by the New York Power Authority. As you can see, we are really the backbone of the state's transmission system. And I mentioned already in my remarks the various projects that we have—we are currently undertaking, so that's enough. Thank you.

CHRIS KELLEY: So, Melanie, did you want to ask the first question?

MELANIE KINDERDINE: I just wanted to make a comment and I wanted to make it before the Governor left but he left earlier, in that, because he raised hydro, made me think of the QER. We had a North American chapter in the last QER. We certainly will have one again. But there are a couple of other things that we are also working on that this panel, in particular, should be aware of. We have been tasked, and we're working with DHS and the National Security Council, we have been tasked to do a US grid security strategy. We have also, as a result of the joint statement from President Obama and Prime Minister Trudeau, have been tasked to do a joint U.S.-Canada grid security strategy. And so, we are organizing to work off a common analytical baseline for the QER. The U.S. grid security strategy and the U.S.-Canada grid security strategy, so we're working from the same set of facts and assumptions and but

what you all are talking about on this panel reminded me of how important your input is going to be in all three of those products.

The Secretary had a meeting, trilateral energy ministers meeting in Canada with Canada and Mexico. This was a big issue there. We had a QER meeting in Canada and we had one in Mexico, as well, so that's going to be a big focus and I think a lot of your input is going to be critical. So, thank you. Just wanted to let you know that.

CHRIS KELLEY: Thank you Melanie. So, with that, let's move right into questions. We did hear a lot from pretty much all of you and our previous speakers as well about reductions and greenhouse gas emissions due to base load generation retirements but also the significant impacts of intermittent generation. So this potentially occurs at the expense of reliability and availability. So what actions are needed or what challenges do you think we're still facing to address this challenge? I'll open this up to whoever would like to take it first.

RICHARD DEWEY: I think that we touched on it, a number of us touched on it across the way and I'm glad Melanie brought it back up, the Canadian hydro. You know, that's one of the things where you look at hydropower as having such clean characteristics as well as such a high capacity factor. It's an increasingly valuable tool in meeting our emissions goals while still maintaining reliability. The wind and the introduction of wind is great when the wind is blowing and is a significant challenge when the wind is not. I'll tell a little story. I've got a screen in my office. We have 1800 megawatts of nameplate wind capacity in New York state. On Monday, when I came back from the weekend, it was just under 1400 megawatts and that was a really good day, good wind day. The next day, on Tuesday, it was 11. Now, not 1100—11. So you can see that kind of variability in the onshore wind, and when you're experiencing that from a reliability standpoint you really have to have those tools in place to either provide a revenue stream for that conventional generation to be available to balance it, or start thinking about higher capacity factor resources like hydro, and Canadian hydro is plentiful. We've just got to be able to tap into it and move it effectively and get it to toward the load centers.

DAN DOLAN: And, Chris, I think on it, you know, one of the important characteristics also is making sure that, as we set the reliability standards, that there's a comparability among the resources of having to abide by those standards. I assume New England, as PJM has recently done, has put in place an aggressive new mechanism through the capacity market in New England—pay for performance—and as we see new resources come in, whether that's Canadian hydro, whether that's some of the other distributed resources, making sure that those reliability standards are maintained and that they're coming in through those mechanisms and have the same obligations, I think, is going to be important.

I also think how these new resources come in is going to be important. Canadian hydro is certainly a fascinating resource for us so close in New England, and I don't dispute the fact that we're likely to see more of it come in. We already receive about 15% of the megawatt hours used in the region coming from those existing interties. The question is how does the next incremental amount come in? And our concern is that if it gets financed outside of the marketplace, not coming in with the comparable requirements through the capacity market, that the expectation that the rest of the system will exist under the status quo, I think, doesn't make

sense. One of our concerns is do we end up bringing in Canadian hydro outside of the market that then displaces nuclear, and then from a carbon and emission standpoint and a reliability standpoint, what have we done?

And the final point that I'd make here is this is also where it's critical to making sure that the pricing is right, that we are pricing all of the actions needed to keep the grid reliable and keep all operations moving, particularly as we move to a spikier system with some of the distributed resources coming in.

CHRIS KELLEY: Thank you, Dan.

CAMILO SERNA: Quick four points. First it cannot come at the expense of reliability. I think we are working to make sure that doesn't happen. One at the transmission level, but to support wind and make the investments needed so we can accommodate that wind without impacting reliability. At the distribution level, we're also seeing a lot of solar, as Caroline indicated, but we're working to make sure that the solar is not impacting reliability to all customers. That doesn't sometimes mean for us to make additional investments and each of our states is exploring with us what are those investments. Will it be storage or other technologies to really manage those impacts?

And finally, that's what I was saying. We also need to look at larger scale, clean energy resources that perhaps can complement those more spiky renewal resources. Hydro from Canada, and that's why I was saying also we need pay close attention to the offshore wind here in the coast of Massachusetts.

CHRIS KELLEY: Thank you. Carolyn.

CAROLYN BROWNE ANDERSON: In conjunction with the larger scale base load power, there's also small scale base load power that we can be looking at. We're working on a community digester in Vermont that will use technology to extract phosphorus from the manure stream and generate renewable power, and this one project along is going to achieve about a third of the EPA's goals for phosphorus reductions in the St. Alban's Bay in Lake Champlain. So there's storage, there's small scale base load power, and there's ways to integrate and deal with the challenges of intermittent resources, and I think all of those things need to be looked at.

CHRIS KELLEY: So, we'll go with Gil and then Steve.

GIL QUINIONES: I believe in New York we're looking at it as a system. We need to make flexible, we need to make demand more flexible and that's the purpose of reforming the energy vision. So not just on the bulk side but we need the end use to be more flexible to what's happening on the bulk side. And so, distributed energy resources should be a source of trying to help balance the system. NYPA is currently the shock absorber of the grid in New York because we own all of the hydro, or at least the large hydros in New York.

From that perspective, what we're doing is, we're really needing to digitize the generation and transmission system, and NYPA is investing in a lot of that because we need to be able to see exactly what's going on in our bulk system and be able to, for the New York ISO's, or for the ISO's, and the utilities to be able to control it much, much more tightly.

STEPHEN J. ROURKE: Since 2009 for us we've really had to expand our outreach to some different stakeholders. Prior to 2009 we did almost no work at all with the distribution utilities in the region. Since that time we've had to work with them and the states, first on coming just to a common set of data on how to analyze and predict, going forward, what the investments and energy efficiency we're going to do for the region. Our states are investing about 1.2 billion dollars a year for this region, and it's making a huge difference. But without that linkage to the distribution utilities and getting the data, we really wouldn't have had a very good idea of what was going on.

The same is truly for solar PV, though. We're a little behind the curve. For replanning, I think, we're at a stage now where we're getting good data. And operations, since most of the of this is very small scale, it's 10 kilowatts on somebody's roof but there's 80,000 of them. The lack of observability of that data, actually for us, is a significant issue we need to work on. As I said earlier, we have about 1400 megawatts of solar PV on the system. We observe 14 megawatts of the 1400 megawatts in the control room at the ISO. So it's a challenge for what's going on in the system, how to forecast it going forward. So that's an area where we're going to need to work more closely with each other.

CHRIS KELLEY: Thank you, Steve. So now let's turn market. Dan, you made a comment earlier, and I think a few of you touched on this as well. You mentioned the importance of efficiency in the market and brought up some good points and challenges facing the market, but I'd like to hear from some of the others. Do you feel that the markets themselves are structured efficiently or are they moving in the right direction? Can you just comment on the structures? Anyone care to take that?

CAMILO SERNA: Well I did elude to a couple of pieces. Generally speaking, the markets are helping and some of the points that Dan brought up are true, but there are instances, two instances where I see things that we need to work on. The first one is related to the availability of gas. And the markets have been able to incent the generators to secure these long-term capacity agreements for gas, so you're exposed to volatility when you have cold winters or you might not have gas. We are using more and more gas on the residential commercial industrial sector to heat our homes. We still have a lot of fuel oil in New England, so we've been adding more gas, as gas prices have come down, but we haven't built a lot of pipeline into the region, so that gas goes first to those gas LVC's that have long-term commitments. So there is less gas available to the generators so we're exposed when there is constraints in the gas pipe and capacity. So we do believe that the markets have been able to fix that and that's why we have proposed methods to fix that.

And the second one is how the markets incorporate the aggressive carbon goals that we have as a region. And I think that's where we see clean region and RFP's and other methods to secure those resources that otherwise will have a hard time competing, even if we have REGI in the

market, at least in New England where we're already pricing carbon. That hasn't been enough to incent those resources to come into market, so I think that's where you look at other avenues to get to those resources and meet the goals that we have as a region to aggressively reduce carbon emissions.

CHRIS KELLEY: Thank you. Other comments?

RICHARD DEWEY: I touched on this in my opening comments about the value of market efficiencies that we've seen in New York for consumers, and we feel very strongly that markets did accomplish what they were designed to do and what we set out to do in the late 90's. What we're seeing now is some changes where different types of resources are valued a little bit differently. And we need to really stick to those market principles to achieve those goals. So if certain types of attributes are more valuable than others then we ought to first consider how do we use the markets to achieve that and try to do it in a market friendly way because the economics we have seen will yield those longer term benefits, and the hesitancy, or the attractiveness maybe of going to a blunt force mechanism to achieve a policy, might get us there faster but from a sustainability standpoint we really feel that we have to stick to those market principles and not abandon what's been successful for us for the last 15 years.

CHRIS KELLEY: Thank you. Steve, did you have a comment?

STEPHEN ROURKE: Quickly, Chris, and I would agree with Rich. I think there's several layers with the markets. I think if you look across either New England, New York, or PJM that the energy markets have been in place for a long time, I think running very, very well, even more dynamic joint interchange with each other, thanks in large part to the lead set by New York ISO on that. So that's gone really well. We all worked hard on capacity markets. They have come a long way. I'd say in New England the build out of the transmission grid and sort of being able to do good zonal modeling in that market has led to the ability to send some healthy price signals to address needs from a reliability perspective on the network and we've seen really robust competition in that market. So I would say the early signs are working well, but certainly more work to follow.

CHRIS KELLEY: Thank you.

RICHARD DEWEY: If I could end the thought on this as well, certainly there's been a lot of attention focused on the capacity markets over the last several years. But I think it's also important to recognize, in some ways, that's the tail that wags the dog. The bulk of the revenues and what drives the performance for the vast majority of the fleet is the energy markets and it's because of that that we have been so supportive of the efforts at FERC and our national counterparts at the Electric Power Supply Association, to drive the energy price formation and really ensure that the actions taken to, again, preserve reliability on the grid, are getting priced in; that we're able to remove, uplift, and make improvements there. There have been improvements, but I think it's critical for FERC and some of the other agencies to get it fixed and get it fixed quickly.

CHRIS KELLEY: Thank you. Any other comments?

GIL QUINIONES: I just think that, you know, it was mentioned that our load profile is becoming more peaky but the consumption is flatter or declining. That is, in the short-term, a challenge for the, you know, market participants and the market operators to design or redesign the right price signals because I think that's going to continue at least in the short-term.

Now, if we truly want to decarbonize and achieve our climate goals we need to do that on the transportation level and the industrial level. Hopefully beneficial electricity growth will happen because that's going to be the best way to decarbonize the transportation and industrial sectors, so that may balance it out. But at least in the short-term, this peakiness of demand and flat consumption is a big issue. I'll give you an example. In New York state the system has a 54% capacity factor. You know, it's built for those two weeks and the hottest weeks of July or early August. But it's not really used most of the time. In industry, if you have a 54% capacity factor you won't make it. So we need to figure out how to increase system utilization. That's why in New York we're looking at it holistically. I think demand and the flexibility of demand, energy efficiency and flexibility of demand, in synchronicity with the bulk power system has to improve dramatically.

CHRIS KELLEY: Thank you, Gil. Carolyn did you have any comments? Okay. So I'm going to ask one more question and then we will have one final question where I'm just going to give you a chance to address the QER group with your final comments, so this is the second to last question.

So we heard from the Secretary and Dr. Holdren earlier about innovation and the U.S. leading in this space and working with other countries that are leaders in innovation in the energy space. As you look to the future, do you see our investments in generation and transmission, specifically in the innovation space, as sufficient, say, for the next ten years? I know a lot of you talked about some technologies so maybe I'd ask, you can address technology innovation, but perhaps there's other spaces of innovation that you see an opportunity as well? So I will open that up to whoever would like to take it.

GIL QUINIONES: Well I would just like to commend Secretary Moniz. I think that has been his goal in the past budget process at federal level which is arguably not an easy thing. I also wear a different hat. I used to be the chair of the Electric Power Research Institute. In fact, when the Secretary was also, at the time, member of our board. I don't think there's enough investment in innovation. I think we can do more. But I think currently we are headed in the right direction. There's a lot to be done just to bring our systems to be hardened and resilient and we need more investment to make them more flexible and connected and smart and then harmonize it with the distribution system. There's still a lot to be done but I'm optimistic with American inventiveness and ingenuity, I think we will get there. The states are very good incubators and test beds, but it requires partnership with our federal government as they provide the overarching policy and support across our nation and that's the best way for us to move forward. So, again, I just want to commend the Department of Energy for taking the lead in this QER initiative.

CHRIS KELLEY: Thank you.

CAMILO SERNA: We can always say that we want more innovation, for sure, so that's never going to be enough, I would say that would be the first point. But I do think we've been doing a great job, either through the DOE efforts, the electric industry, through EPRI and many other venues, the universities, research institutes that I see here—there is a lot of effort going on there. There's a lot of new technologies. Costs have come down significantly, especially as you look at some of these distributed energy resources. So there is great opportunities. I think that the place where we don't see enough innovation, actually I would say, is into our rate design, so what I mean by that is we still have a system by which we charge on a volumetric basis. For a system that is built, at least looking at the transmission and distribution system that is from early fixed costs and we just talked about some of the capacities, just the peakiness of the system is just going to continue to be there, which means you need to continue to make investments to handle those peaks, but we still go back to the sign where we are recovering things on a volumetric basis. So, I think that's where we don't – and rate design takes time. It's difficult. So I think that's where I see we need to work more together to figure out is there better ways, or ways that we can accomplish some of the goals and bring some of these new technologies into the system by changing the way we price the electricity and how customers pay for it.

CHRIS KELLEY: Thank you. Carolyn.

CAROLYN BROWNE ANDERSON: I agree. There's never enough innovation and this probably opportunity on end use control and things along those lines. I mean, I think just transformative technology with the ERA grant and our smart grids and things along those lines, those are those first steps that just bring us to a whole different level, but that may have, you know, now we have all sorts of data that really is a challenge to actually use and implement. And so I think that we're on that next stage moving forward and there's probably some great opportunities between states and the federal government to sort of take that next step.

CHRIS KELLEY: Great. Thank you. Rich, did you have a comment?

RICHARD DEWEY: I think we've seen amazing strides in innovation in the last decade or so. I mean, when you—Gil talked about Thomas Edison building the first power plant, just a little bit over 100 years ago, you think about happened in the last decade. The Department of Energy really led the way with the ARRA funding and the grants that significantly improved situational awareness on the grid. New York state is being very innovative right now in pushing at the distribution level, through the REV initiative, a lot of demonstration efforts that are producing some very early but creative innovative opportunities at the distribution level. So, I think we've seen tremendous progress.

The one area where I think—and the governor mentioned it this morning—is in the area of storage. A lot of the problems we talk about with the intermittency and trying to integrate more renewables into the system all get better with storage. And right now we're just not seeing that requisite level of improvements from the technology standpoint. It's more than investment. It's going to require some research and some innovation and I think that that can go a long way towards solving a lot of these problems.

CHRIS KELLEY: Thank you. Other comments? Yes, Steve.

STEPHEN J. ROURKE: Chris, real quick. And this is on us right now, as we see more inverter-based technology want to interconnect to the network—so wind farms, solar, batteries, fuel cells—what we're finding, as sort of the newer the technology is, that wants to come forward, they try to get in early, which is fine, but on our side we need to make sure that they're interconnecting to the network in a reliable manner both for the power system as a whole but for the project. And they're coming forward with really bad models to sort of do that with. So, I think the industry, being able to work with each other, the developers of the resources with the folks like the ISO's that need had to do the studies to interconnect into the network, to have a good starting point from which to do their analysis, speed the analysis up for them will be really helpful.

CHRIS KELLEY: Thank you.

DAN DOLAN: Very quickly. I think it's also important to recognize some of the blocking and tackling that goes on on the innovation front, the fact that we've seen, since the dawn of restructuring, the real deployment of the combined cycle which is a relatively young aspect in the system overall. The capacity factors and the best practices of efficiency, the fact that we have a nuclear fleet that now regularly runs at 90, 95 percent capacity factor, was certainly not the case 10, 15, 20 years ago. And then, also, what we're seeing more recently on the environmental side, with certainly the lower our emissions but also lower water use, and the new technologies coming in where power plants are the largest consumer of water in the country. And, as that is changing, and certainly some of that is regulation and policy driven, some of it is, frankly, just market based. It becomes more cost-effective to more efficiently use some of these resources. We're seeing these things happen on a plant by plant basis. It's not the homerun or holy grail that we see on storage or some of the others, but have critical impacts to the system overall and certainly cost in efficiency for consumers.

CHRIS KELLEY: Thank you. Any other comments on innovation? Okay, so let's turn to the last question here. So you have the members of the QER task force in front of you. At the time let's say, a minute apiece, give us any final comments, anything you'd like to address directly to the QER task force. And we'll start here at the end with you, Steve. Put you on the spot.

STEPHEN J. ROURKE: Thank you, Chris. As I can stall for the first ten seconds of my minute. Boy, you know, I really looked at just going through the issues here for the region, you know, just huge changes in the generation mix going forward. We are very nervous going forward on the availability of natural gas to the region. Looking backwards, a lot of the focus has been on the winter. When I look forward and I look forward in the next, five, six years from now, if that five thousand, six thousand total megawatts of oil and coal that's left over choose to retire, most of that void is going to be filled by natural gas, which will require roughly another BCF of gas. At that point, I believe our need for natural gas during the summer on the peak day will outstrip the need for natural gas for heating during the wintertime. And that's a really different space for us to be thinking about natural gas problems as a year round

problem and not just a winter problem. So continued focus on where we're going with infrastructure for natural gas will be very important.

CHRIS KELLEY: Thank you. Rich.

RICHARD DEWEY: I guess I'll wrap up my comments like I started them, and really to talk about the lessons we've learned with the value of markets in terms of how it has impacted this industry.

I was involved, when we were starting it up, some people, some skeptics called it the grand experiment. There were some folks that felt like it was going to be a short-lived exercise and what we have learned is we've overachieved in terms of the efficiencies we wanted. You talk about innovation, Thomas Edison was not only the father of power generation but he was also a pretty good inventor, and he's got a quote out there that I'll get wrong if I try to, but it talks about how innovation without markets really is sort of a dead end endeavor. And when you start talking about where we want to get to and these problems we have to solve, and they're real problems with respect to a turnover of the fleet, with real disparity in terms of fuel prices, with real honorable policy objectives to address the environment and climate change we all have to focus on. These are real admirable goals and we've got to work together to achieve it and if we try to do it without the benefit of markets I think we're going to be disappointed in the results, so I encourage everyone to continue to focus on that and not abandon something that we started that's working really well.

CHRIS KELLEY: Thank you, Rich. Gil.

GIL QUINIONES: I believe that we should accelerate and continue and have a structured way to communicate, to collaborate. There's a lot going on at the federal level, and its national labs. There's a lot going on at the state level in terms of demonstrations, in terms of actual initiatives. And if we continue, we accelerate, we really focus that partnership between the federal government and the states, I think that that will be the formula for finding the different paths that maybe different states need to ride this transformation in our industry. So again, thank you very much for inviting me here at this event.

CHRIS KELLEY: Thank you. Carolyn.

CAROLYN BROWNE ANDERSON: Thank you. I mean, I think that, you know, there's a federal/state partnership here that we can really accomplish a lot if we don't tie our hands too much and we don't make things too expensive. So some clarity on, you know, the federal and state jurisdictions is always helpful. Encourage the appropriate amount of investment without putting too much on the backs of our customers. And I think it's really important, just like we did with the advanced meters and smart grid incentives and grants, to start focusing on what we can do with that information and all of that data and bringing us to investment in ways to actually use that data, to get that smart grid where we promised it would be. And again, I think that storage is probably one of the most important things that we can be focused on.

CHRIS KELLEY: Thank you, Carolyn. Dan.

DAN DOLAN: Again, thank you. I think the important element here for any policymakers, whether federal or state, is lay out the standards, what are the policies, whether that's from an emissions standpoint, a performance metrics standpoint, and then allow the innovation of the marketplace to meet it. And don't prejudge how that gets done, whether through individual types of resources or technologies themselves. As the competitive generation industry we welcome the competition, whether it's from the disruptive new technologies or Canadian hydro or anything else that we haven't thought of yet. The question always comes back to how, making sure that it comes in on a comparable basis, that we're getting the price signals right, and that we're moving forward on an open level playing field for all to come in.

CHRIS KELLEY: Thank you. Finally, Camilo.

CAMILO SERNA: I want to then say let's focus on the customers at the end of the day. What is it that the customers want from their energy system? And we survey them. They tell us. Reliability is number one; price; and then, I would say, clean energy options is emerging and moving fast in the list. So let's focus on that. Let's invest, maintain or improve the reliability of the system. Let's focus on solutions that, at the end of the day, help those customers lower their energy outlays, not only the rates but the total energy costs that they are facing. Help them during tough economic times.

And, third, when we look at the clean element, cost effective, large scale clean energy solutions, whether it be hydro, wind, perhaps offshore wind, but let's not forget about energy efficiency, which is kind of the first line of defense. But, again, let's go back to what our customers want. They're not talking about the mechanisms, how we get there. They just want the ultimate outcome of high reliability, low prices, and a clean system.

CHRIS KELLEY: Thank you. Please join me in thanking our distinguished panel.

(Applause)

CHRIS KELLEY: So, with that, our agenda has us taking a quick lunch. It will have to be quick because we are going to reconvene right on time at 12:30. For those of you who are joining via the web, we'll get started back at 12:30. If you didn't see it when you came in, there is a list of recommendations at the front table, the registration table for quick places to grab lunch. And if you're here for the next panel, I would encourage you to be here just a bit the early so we can get you up on the stage. Thank you.

(Break)

Panel 2

Electricity Distribution and End-Use: How Do We Manage Challenges and Opportunities?

CHRIS KELLEY: Okay. So I would like to welcome everyone back. We will get started with our second official panel of the day. This panel is focused on electricity distribution and end use. How do we manage the challenges and opportunities? Again, before we get started I want to remind folks, if you haven't had a chance to sign up at the front to provide public comments, you are welcome to do that at any time. We will be holding a public comment session at the end of today. This is the second panel. We will have one more panel and move into public comment.

I would also like to remind you at 2:49 p.m. today, which is scheduled to be at the end of the third panel, we will be holding a moment of silence in reflection and memory of those affected by the attacks three years ago today. So I have spoken with the panel here, so just a reminder, our plan for today is that we will go through, have everybody have a chance to give their presentation, you will have five minutes. I might allow you to slip to seven. So you do have lights in front of you that indicate -- when they turn red, that means your five minutes are up. And then we will move right into questions. There will be questions that come from me and I will ask based on what I hear from you today. I also would also like to remind everybody that the views expressed by the panelists are their own views and not the views of the Administration including the U.S. Department of Energy.

On the stage I'm joined by a distinguished panel. We have Ed White, the Vice President New Energy Solutions National Grid, also based on in New England. Karen Lefkowitz, Vice President, Smart Grid and Technology. Dena DeLuca, Vice President of Corporate and Member Services and Chief Financial Services of New Hampshire Electric Co-op. Roxanne Brown, Assistant Legislative Director for United Steelworkers. Micah Remley, Senior Vice President, Product, and Ned Bartlett, Undersecretary of Energy and Environmental Affairs for Commonwealth of Massachusetts. Welcome everyone. We will go ahead and get started here with you, Ed?

ED WHITE: Great. So I want to thank the department and all of you for attending today. I probably won't need my five or seven minutes, but I will go quickly with regard to the state of play where National Grid operates. And we're fortunate. Oftentimes we describe ourselves as poles, pipes, and wire company. I have started to change that. We are actually a customer-focused company and we're very much excited about the future of energy and where it's going and I am privileged enough to lead a team called New Energy Solutions, it is a group we started back in July of last year. Really in response to a lot of the activity that had happening here in the Northeast. So we're running a lot of pilot programs, a lot of demonstrations. We're doing work in New York with REV, Grid Mount in Massachusetts, SIRI in Rhode Island. There's a lot of activity going on in each of our states and I consider

myself fortunate that we have such progressive leadership in each of those states. Each of the states may not always agree on the best approach and the best way to go about things, at least we're moving forward and that's one of the things that most excites us about what we're doing. The approach that we have been taking is really to demonstrate and to look for opportunities to really engage with our customers on a much more direct level and I guess if I think about the QER and one of the things that we could do at all levels of government, it's really how do we engage consumers and focus on consumers and I think sometimes we get too hung up in the technology, the policy, the regulations and what we're trying to achieve and we're not engaging consumers. At the end of the day we need to make it easy, we need to make it simple, and we need to make it frictionless and all of the things that go with that, really needs to be what we are focused on. And so that is a lot of the work that we are doing and if I just quickly go state by state, here in Massachusetts, in the Commonwealth we're doing a number of things with regard to utility-owned renewables and we're not doing the renewables here with solar because we're trying to capture the entire market. What we're trying to do is really demonstrate that utility ownership can be part of the solution as well as market-based solutions. And in that case, even the solar that we're developing is built by those same participants in the market. So oftentimes when you paint utilities with a broad-brush, you know, it's utility versus the market sector, well those same participants are actually building a lot of our facilities.

We're also doing a Smart Grid pilot like most of the panelists up here, and most of the folks that you have heard from before. Those pilot demonstration projects with Smart Grid are really learning -- we're really learning as much as our customers are learning in the best way to engage and talk about energy and I think at all levels of government we can do a much better job at talking about energy and what consumers can actually do. So those are just a couple of things that we're doing in the Commonwealth. In New York, you hear about REV and what is being proposed in REV is an extremely ambitious vision and I will tell you that working toward that vision is going to be a challenge, but it's a challenge that we need to undertake and it will probably come up during some of the questions and answers during the discussion of this panel with regard to how we value, how we operate, how we plan for and how we deal with distributed energy resources not necessarily owned or operated by the entity that is in charge with operating the grid.

And then really most exciting or one of the most exciting areas that we're operating in is Rhode Island. And in Rhode Island we've got an opportunity both from the gas perspective as well as electric perspective to really invest in energy of the future in the most efficient way possible. We have got a leadership from the government down there, very supportive. We're also very excited with the ability to really influence the direction and work with our customers in all of the different stake holders to come up with that efficient answer and be very well coordinated more so than what we are seeing in some of the other states.

So I'm going to pause there and defer any remaining time to somebody that goes over on the panel. But look forward to the discussion, look forward to the questions and everything that we're doing here.

CHRIS KELLEY: Thank you Ed? Karen?

KAREN LEFKOWITZ: Good afternoon. First I would like to thank the Department of Energy for inviting me to be here and more importantly for convening a forum where we get to talk about these great challenges facing our industry. So at PEPCO Holdings we represent the Washington, D.C. area. So Washington, D.C., the Maryland suburbs, and most of the state of Delaware and in southern New Jersey and that's notable because we live in a part of the country where we are seeing explosive growth in renewables and we are seeing a wide acceptance or beginning of a wide acceptance of electric vehicles and it's an area that is filled with customers who are technologically sophisticated. And so while we have deployed smart meters and a lot of distributional automation throughout that territory, what we're seeing are customers starting to actually push us to understand how they're using energy or not using energy more and more. So while we are facing a change in the industry, we need to recognize that there is a fairness doctrine that is potentially undermining the way that we interact with our customers and maintain the electric system. So today customers choosing to put solar on the rooftop and doing it in a way that minimizes their spending through the electric utilities, essentially shifting those costs to customers who can't afford to put solar on their rooftop. We have historically called this a cross-class subsidization. We are increasingly seeing it not only as an income differentiation, but a differentiation between renters and home owners. But there is a new movement that we are seeing pick up steam and that is around community solar and cooperative solar. So we think as the future will reveal, people are less and less income constrained in the future. So you have to ask yourself, if I have solar on my rooftop, I have reduced the amount of money I'm spending on my electric bill, why should my neighbor increasingly have to shoulder the burden of the O and M costs, those very routine costs that we have to spend to maintain our infrastructure? Even more importantly, why should my neighbor have to spend money to invest to allow greater penetration of solar energy to upgrade distribution transformers because of increasingly heavily burdened transformers with electric vehicle charging? How are we going to address this? There was a time in history when we saw really explosive growth and if we think about it, when the move for central air conditioning came around, particularly in our neck of the woods where companies invested heavily in increasing our capacity. And we did ask all of our repairers to share in that expense, and not all of them put in central air conditioning. But the utility could absorb those additional expenses because there was an enormous amount of growth going on. We had load growth and capacity growth. It was exploding. We're not in that situation today. And so we have to really rethink how we do redesign.

My personal background isn't in billing and rates. My personal background is in operations. And I would like to take a moment to talk about an issue that I think is going to increasingly become a problem. We have a lot of distributed renewable energy in our territory. We see it growing exponentially. When I saw last December, 2500 applications for rooftop solar in one month, and that's only growing, we know that we're facing a future of increasing rooftop solar. I used to run system operations. In order for us to really effectively operate the electric system in a safe way, and maintain levels reliability that everybody wants, we need a lot of visibility into all of the things that are happening on the grid. So this new grid of which we are, as the utility becoming the integrator, no longer do we have visibility into what is happening at all points on the grid. It makes our ability to operate the grid compromised. And

people can say, and they would be right, well, it really doesn't matter, a little energy being injected at points you're not aware of isn't important. That's probably true. But there is a point where it is important. There is a tipping point where I need to know. There was a story not too long ago in central Europe where there was an emergency condition where the utility had a shed load. And when they shed load, they were faced with the consequence of having actually so much behind-the-meter generation, it was as if they shed generation. That is not an operating condition that we want to have moving into the future. We need to make sure that we know how to operate the grid effectively and that that knowledge is based on telemetry and real data that we have got so we can take the right actions. So I think that we need to think about how are we going to be held accountable for operating a grid when we don't have the tools with which to do so.

CHRIS KELLEY: Thank you. Dena?

DENA DeLUCCA: Thank you for the opportunity to participate and I appreciate being able to have the conversation. As Chris mentioned, I'm Dena DeLucca, I'm the Vice President and CFO with New Hampshire Electric Cooperative. We're an electric distribution company. We have no generation or transmission. I do have a slide that is just a visual of our service territory because it plays into the challenges that we face. What it will show you is a couple of things. We have a non-contiguous service territory, so we can stand a couple hour drives between territory to territory to serve our members. We have 86,000 members across 115 communities in the state of New Hampshire. Of that 84,000 members, 86% of that is residential and 36% of that is seasonal. They come to enjoy our lakes and mountains in New Hampshire, but they're only there part time. So that alone can be a challenge. We serve an average of 14 members per mile line and for some of the other large utilities, they are between 30 and 60 members or customers per mile line. That again feeds into some challenges and issues with affordability.

So our members made it clear there are three things they want. These are in order. They want lower cost. They want reliability. And they want help managing their energy use. How do we do that? A fundamental strategy for us on how to answer those three things that they asked for is through technology. So we continue to identify, explore and deploy technology to improve our operations and improve our value proposition to the member. This is not easy given a noncontiguous territory. And the other thing, so the red portion is our service territory and you can see where it gets really choppy down in the southern part of the state and then there's a way little piece up North towards the Canadian border. It's a challenge to serve all of that territory in the same way and with the same cost. So it's also an official challenge in that New Hampshire leads the nation with 89% forest cover. So now you are dealing with reliability issues in terms of trees and many people don't want their trees cut down. So coupled with a noncontiguous service territory it's a significant challenge to deploy technology and a classic example of this is our \$35 million communications and automated metering infrastructure project that we did, which was funded in part by a DOE grant.

That was an example of the challenge because it took us a year of planning and designing and permitting for that project. It required over 150 federal, state and local permits, just to get the project off the ground and what we built was a microwave in fiber backbone communication

system which enabled a wireless mesh metering system. So it provides significant opportunity to capture data, which is at the center of this new utility model that everybody is talking about for utilities. The smart part of this is not the actual equipment or the software. It's actually the consumer and what they're going to do with the information that this system provides them. Part of our project included a web portal so that members can go online and look at their usage and daily and hourly integrals and about 25,000 of our members are currently taking advantage of that feature. So for the cooperative, the data allows us to have a responsive and a robust relationship with our members, we can be more flexible and less one size fits all.

So the challenge for us, is the access to a wireless infrastructure, the permitting process alone is arduous and at all levels it can be drawn out by unnecessary delays and it impacts affordability. Members look at the bottom line of their bill. They don't care whether a significant percentage of that bill is taxes, access, surcharges, energy efficiency or low income surcharges. All good well intended public policy issues, but it drives up the total bill. So we have to consider that as we move forward in terms of the cost to the consumer. They look at the value they receive and we need to deliver that value. And it has societal issues as far as economies, businesses cannot compete with other regions of the country that have lower electricity products. And then fixed income has trouble just paying from their own usage. In New Hampshire we are within the bottom five for consumption in the nation.

So these are some of the challenges that we face. We think technology is at the forefront of helping us address those, but that alone brings its own challenges particularly when it comes to data, the storage and the security of that data, but in essence we're moving towards and we are doing it now putting the power in the members' hands so they can make more informed choices with what they do with their energy businesses. Thank you.

CHRIS KELLEY: Thank you. Roxanne?

ROXANNE BROWN: Good afternoon. My name is Roxanne Brown. I'm the Assistant Legislative Director for the United Steelworkers. Our union is actually the largest industrial union in North America. We represent 1.2 million active and retired members. We have members in pretty much every single basic industry that you can think of. I'd like to say we are the union of everything. Our steelworkers obviously, but we have a long name that no one can remember, so I will spare you that and just tell you that we're in steel. We're in all other metals such as aluminum and copper mining, we are in pulp and paper and refining and brick and cement, you name it, our members make it. But we also have members at utilities such as National Grid. We represent about 1,200 members here in Massachusetts at National Grid. And so you know, clearly for us, the end use piece of this discussion is a big deal because manufacturers in the United States and really industrial use about a third of the electricity consumption in the United States, and so for us reliability and affordability and electricity is very key.

You know, over the past five years, the manufacturing sector has begun shifting fuels from traditional fuels like coal and oil, more to natural gas and you know this is due in part from, EPA rules that have really helped to drive a shift in fuels from coal and natural gas. Also the

shell gas boom. And we saw as a result really of the shell gas boom that in 2014 there was a ton of investment happening at a lot of manufacturing facilities. We saw because we are also in chemicals, I failed to mention that, we saw that there was a ton of investments happening at the chemical and fertilizer facilities and some of our steel facilities as well, in many regions across the country, except for New England. We saw that there were some companies were making investments and some companies were benefiting from the low cost of energy, but we had pulp and paper mills closing in New England or temporarily closing during the winter months because it was too expensive for them to operate. There's one mill in particular, Great Northern Paper in Maine that laid off about 240 of our members because they could not afford the cost of natural gas. It was almost quadruple the cost of natural gas for pulp and paper facilities and other regions of the country, like Pennsylvania. And so it was unsustainable. So for us this is a crisis, because that was one mill of four or five that had to close permanently or temporarily and we haven't seen much improvement from there, so for us it's key for New England to really build out its capacity. There's been a lot of work in this region of the country to shift towards, you know, cleaner sources of energy and our union is convinced of that, but there has to be a thoughtful plan for how consumers in this region are going to be served. Obviously residential consumers have also struggled with the cost of energy but you want industry in this region of the country. And when industry is lost, the tax base is lost, and that impacts communities greatly and particularly with pulp and paper companies which are normally in rural areas where it's really that facility, that is the major driver of economic activity in that city or town and then it's gone. So you know, for us, this is the something of real critical importance and I know that the first QER was held in New England and in large part because of the crisis that is happening up here in the infrastructure challenges and so we look forward to being part of that conversation as it moves forward. The other piece that I wanted to mention is something that I don't think I can speak in great detail about because we're all very much aware of this, but the infrastructure lapses that exist in our natural gas pipeline system, I particularly wanted to mention it here, just because our members at National Grid do a lot of work on the national gas pipelines here and the Boston region and they see firsthand the lapses that exist throughout the system. So there's so much work that needs to be done to update and repair our natural gas infrastructure system and on the side of our members who are actually doing the repairs, we want to make sure those are done safely and that you guys at National Grid are doing what you need to do to protect not just our workers who are going to jobs, but the communities making sure they are done by the best skilled workers and the best processes to make sure that we're really limiting the fatalities that have occurred as a result of some of the lapses in the system.

Then on the other side for those that make the materials that go into these products, whenever there's infrastructure investment in the United States, there's a ripple effect through the economy, because the materials used in these systems like the steel pipes are actually made here in the United States, and the pipe and tube industry in the United States is a really critical sector, but it's a sector that is significantly hurting at the moment and our steel sector over the last year, we lost about 13,500 jobs, and the pipe and tube industry has been significantly hurt. So we have a huge opportunity through the work that is being done by our members at National Grid and other cities and towns across the country that are updating these systems to actually have an added benefit of economic activity by making sure that whatever materials are used to upgrade these systems are made here in the United States.

Because when you do that, you actually create 33% more jobs in the manufacturing sector and that is key for manufacturing United States. So I think I will stop there. I don't think I took seven minutes.

CHRIS KELLEY: You did well. Thank you.

ROXANNE BROWN: Thank you very much.

MICAH REMLEY: I'm Micah Remley. I work for EnerNOC, we are a technology provider to both utilities and to large commercial and industrial customers to help them manage their energy costs and their energy consumption. Since we're a technology company I'm going to talk about the technology that some of the other panelists have touched on. When I think about energy and energy technology I like to look at parallels in other industries. So today I'm going to draw the parallel between navigation, mobile apps and social media and you might be saying what do these have to do with energy at all? Let me tell you. Next slide.

Does everyone know who this is? Angela Merkel, Chancellor of Germany, Time Magazine Person of the Year in 2015. Turns out Angela Merkel is on social media a lot and connecting with friends and posting photos all of the time. For anyone on social media knows that it's hard to tag those photos. People tag hundreds of millions every day because they want to see their friends in those pictures. How does social media handle the problem of tagging photos and the difficulty and the time consumption it takes with that? They use facial recognition algorithms. These machine learning algorithms to do something that is very hard for a computer to do, recognize someone's face, break it down into the component parts, learn every single time someone tag's photo, it's learning and training and the algorithms are getting better to make suggestions of who you're tagging photos of. The next slide please?

Similar with the GPS mobile navigation apps, what they're doing is taking all of the cars on the road, every time you use Google, you're part of an information network that is informing how traffic is moving, where everyone is going and what route is the best to take home so you save time when you drive home and save gas. Next slide. When it comes to energy, one of the most important things failing our country, facing our region and facing the world, this is how most people interact with their energy data. This is obviously where we see huge ability to apply recent advances and machine learning in algorithms to make energy simple, easy to understand and easy to manage. Next slide, please.

So it turns out energy profile is like a face and you can actually apply the same exact types of algorithms that social media uses, the same facial recognition algorithms to break an energy load pattern into its component parts, and then you can do all sorts of interesting things with it and tell what types of loads are behind the meter. You can give very high specific recommendations for energy efficiency for targeted programs. Next slide. You can tell two businesses that might have the same exact name, apart from each other, and what the end loads are. We're actually doing this today with the same algorithms to tell the difference between a dry cleaner and laundromat and target them with very specific energy efficiency recommendations just for them. Next slide.

The other thing that has driven me nuts is that energy management is always happening looking at the past, especially at the individual customer, business and residential level. Go to the next slide. So this is the typical energy consumption pattern of a typical large building, starting on Sunday, high usage during the day, lower usage at night. But for most customers, as some of the other panelists discussed, energy usage isn't what matters to them. Energy costs are matter to them. If you go to the next slide, what we can do is apply machine learning against that data, and we start making a prediction of what the consumption is going to be, not what they used last year but in the future when they still have time to make changes to address that and address those costs, just like they do with the rest of their planning. Next slide.

So with that electricity prediction, we can combine with the cost data. This is where we make things complex. So this is the tariff database for one utility. I didn't use a New England utility to spare everyone in this room. So over 90 tariff types for one utility. Next slide please. If you look at the tariff, it's 15 pages of this. We counted the number of tariff pages in the United States. 80,000 tariff pages in the U.S. alone. If you were a large customer trying to understand your tariffs, you would have to read 80,000. So once again, this is a place we can systematize this information. Next slide. The orange, is their energy usage and green is their energy cost. They go from spending a couple hundred dollars an hour on energy to \$8,000 an hour in energy, because of good conditions or because of their energy tariff. Next slide?

So the whole point is, we can use these advances in software in machine learning, in big data to make energy simple. To connect the customer to what is going on to the grid. Connect the customer what is going on with cost to make the system more efficient, to make the system more reliable and reduce cost for everyone. But you have to have the data and the software in place to do it. With that I will pass it on to Ned

NED BARTLETT: Thank you. Ned Bartlett here from Massachusetts Executive Office of Energy and Environmental Affairs. I wanted to take a minute to thank the Department of Energy, thanks to all of the folks before us on the panel, guests here today, for the opportunity to speak. And try to grab some of the threads that have come forth from this panel and the prior panel as well. For this panel, obviously the government view, what are the policy goals of many of the issue brought up, whether it's application of technology, a consistent team that I agree on and the administration in Massachusetts agrees with us, take a look at this from an end user perspective. The goal and what are they trying to achieve, what are the goals and how does the combination of these companies, utilities and government serve to meet that consumer need, that citizen need?

With that in mind, I thought I would step back and touch on some of the perspectives from the administration, what we see as regional challenges and opportunities and then a little bit about how we're approaching them and some of this is familiar for folks, but trying to hit this quickly and move into Q&A. So you heard some from the government earlier. A very simple theme for the administration but the tools to get there are diverse and can be at times complex. The goal is a balanced and diversified energy portfolio for the Commonwealth. It's simply to achieve those goals that the Governor stated so simply and so eloquently earlier. Energy is at the forefront of continued economic success and growth. It's at the core of our

environmental condition and environmental needs. It's at the core of security, be that personal, state or national. What are some of the regional challenges? We heard here consistently from everyone on this panel, you're looking at cost and reliability. I would add to that the concern that we heard in the earlier panel, comments from Secretary Moniz and others this morning, about greenhouse gas and climate concerns as well, certainly those that emerge here. So in cost, Massachusetts we tend to have a clear concern on cost and clear constraint around it, fifth highest cost on unit cost of energy basis in the nation according to the EIA, top ten electric cost in the United States compared to other states and you can imagine the immediate drive that has in our system base our businesses base, our communities to have statistics like that.

Next, there have been changes and a positive changes noted earlier. We heard about the opportunity that we saw in some of the lowest wholesale prices, since 2003, and even perhaps in track history, remarkable change, remarkable health, market condition, but also in a very cyclical market; the energy market. So a constraint that none the less while there has been some positive change, there is also in recent history some remarkable winters that causes us folks here concern in cost and reliability when you see that winter spiking and you see that demand for some of the primary fuels here, gas being among them, the competition between heating, thermal demand as well as electric generation demand. We have had variability to a negative effect to that drive with reliability in the region.

Retirements; frankly viewed as an opportunity and a challenge by the Commonwealth. Anticipated loss of just under 10,000 megawatt of generation or approximately 10,000 by 2020, 3500 anticipated offline by 2018. Another roughly 6,000 by 2020. What do we replace it with? This was something that was spoken to a lot by folks on the prior panel. But it presents both an opportunity and a risk. We heard from New Hampshire concerning that presents the steelworkers, what you see in gas with the supply and opportunity. There's also frankly from the state's perspective, that concern over reliance. We could end up with too much reliance on a single fuel and how we replace the existing generation and what supplies we do or do not bring in and what tools we use to manage their consumption.

So again I think that the opportunity side of that retirement story is quite positive. There's actually an opportunity for both efficiency and resilience and resiliency in what we bring on line, the types of the fuels we use and how we use that fuel. And on the greenhouse gas and the Commonwealth, we have a fairly aggressive statute, Global Warming Solutions Act, targets a 25% reduction against 1990 levels for 2020, and 80% reduction against 1990 greenhouse gas submission levels for 2050. That looms present as a third concern here in addition to the consistent theme on cost on reliability that others spoke to.

So what do we see as the tools to cure that? I guess turning this back to the panel, kicking out some of the themes they had, energy efficiency critical to our success. Expansion of new resources, new supplies and additional supplies of gas and electric transmission infrastructures. So we need to increase the supply to the region. We continue to see solar having a valuable role, hydroelectric power, the Governor spoke to eloquently, this is something we're targeting in legislation. Looking to, like our clean energy RFP, with other state partners in New England. The opportunity that large scale wind has brought and

continues to have as potential on and offshore in the future, and then more distributed generation resources and opportunities in energy storage opportunities in micro grids, opportunities in combined heat and power anaerobic digestion. Earlier today there was actually a great facility opened in Massachusetts run by Stop and Shop at one of their facilities in the state; how that can integrate into our waste management issues, generation of energy from waste streams, remarkable resource and one that we explore and are excited about here in the state and I think regionally. A lot of other states in New England also using those resources. So at the end of the day, I'm running out of time, I will come back to that concentric theme – really how do we look at this opportunity, where we are, the tools available to serve citizens in our electric and our space. So turn it back to you, Chris.

CHRIS KELLEY: Thank you, Ned. So with that we will turn to the question portion of our panel. Let's start with a question I heard of maybe differing opinions. Karen, you started your comment touching on the fact that you have an educated customer base who utilizes information and are motivated by environmental or other factors when it comes to making electricity consumption choices. At the same time, we heard from Roxanne and a few others about the importance of affordability and reliability and that being key to industry. So how do utilities or how would you suggest if you're not a utility, how would you serve these opposing views as customers? And how do you address those challenges? Anyone care to take that?

KAREN LEFKOWITZ: I will start with one very important comment: Utilities have an obligation to serve all customers, so we don't have the option of cherry picking and saying if you have money and you can afford to do these things, we're happy to sell you our product. We have to provide services to everyone. And then that becomes a challenge in how do you serve equitably, the comments made about the rates and infrastructure investments.

ROXANNE BROWN: To be honest, I don't know if there is quite a difference of opinion, because one of the things that I didn't mention but what I said earlier today and just mentioned by Ned, energy efficiency plays a huge role in all of this for our industries. Right? And you know, a lot of manufacturing facilities have made a ton of investments and things like combined heat and power and waste heat to power, but to be honest, I'm really intrigued by Micah and this presentation you gave and how you engage with customers like our member's companies to pinpoint these technologies. Because one of the biggest barriers is cost. They do want to operate more efficiently and that is the easiest way for them to get at cost, but they don't have the money, especially I mentioned the steel sector losing these jobs, there are other pressures that are creating challenges when it comes to spending money on R&D and efficiency and other areas that are really, really crucial. So I don't know that it's a difference of opinion. I think it's just the nature of the circumstances, the economic circumstances at this moment for industry.

KAREN LEFKOWITZ: And I just want to add, for utilities like ours that operate in areas where there is retail void we are often prohibited from entering into generation and there are very interesting regulatory decisions that are happening. Some regulators look at battery storage as generation. And when you start thinking about that, that's a little crazy. From a technical perspective it doesn't make a lot of sense, but it also means that as a utility you're prohibited from acquiring or building generation, then you are very limited in what you can

offer to low income customers. You're very limited in what you can offer to use new technology like batteries from defraying the cost of additional infrastructure upgrades if that is viewed as generation as well. So there are some barriers that are easily removed. I think that a lot of utilities would welcome the opportunity to find innovative ways of serving with renewable energy those customers that can't afford to do it on their own. I think there's a great opportunity for us there if we can find a way to do it with the regulatory environment.

MICAH REMLEY: And customers want both, right? So we saw alone explosive growth in both solar installations, residential and commercial and industrial. We focus on commercial and industrial so I will focus there a little bit, but cost is first. No doubt, cost is first. Environmental benefits are next. And when you have a coalescence of them, then everyone wins. Last year alone we saw a 300% increase in the number of companies buying renewable energy power. Why was that? Because the price of all grid power across the entire United States that's year averaged at the wholesale level \$35 a megawatt hour. The price for wind power through typically virtual PPA or direct off take was \$29 a megawatt hour. So in our corporate customers we saw a huge shift in buying wind because it makes economic sense for them and by the way, it works in their sustainability ports and everything else, but first it makes economic sense for them and obviously we have seen the same thing happen with solar with the incentives layered in there too, so it's both. I don't think it's necessarily a disagreement, but you do have to think about both things.

CHRIS KELLEY: Thank you. Did you have a comment?

ED WHITE: I just couldn't agree more and oftentimes we talk about it and it's - to highlight that point it's the "and". It's cost and the investments that need to be made. So it is the "and" and not the "or". So very much what we're finding as we're engaging more on the residential side than the commercial side, customers just don't understand and so you're lucky to have just an educated customer base, but I think as we look at our customers, yes, there's a desire for technology, there's a desire for investment in solar because it's cooler and it's exciting but when it comes to really understanding energy, I don't know that they actually do understand it nor do they really care as long as you can make it simple for them. Like the levelized building and the predictability, so using data and analytics to predict what the bills are going to be, whether you're a commercial customer or residential customer, predictability is what they're looking for.

KAREN LEFKOWITZ: My customers are smart but they don't understand deregulation. So they just -- they just don't. And not only that, but there was a time not too long ago where commercial customers didn't understand deregulation and didn't understand that the money they paid to us as an SOS supplier was a pass through to somebody else that we were buying generation from. So they understand what they want to understand.

CHRIS KELLEY: Okay. Other comments? Let's turn to the subject of security. So we talked about data and information being available and we talked a lot of new technologies being used to operate the grid and that -- coming with that all of the associated copious amounts of data. We talked about customers having more access to data and making choices based on that data but by nature of collecting all of this data there is an inherent risk associated with

cybersecurity, the potential for interruptions in operations and breach of customer data. Can you spend a little bit time talking about how important that is to you, maybe from an industry perspective or how important and what you're doing to address this with your customers?

ED WHITE: We take the security of our system, the security of our customers' information important to us in all aspects. I think sometimes it gets very blurry as to what security we're talking about. Is it physical security or is it customer's personal information, their usage information? And we have learned a lot within the industry and the company with regard to what customers actually do care about. And it's evolved and if you think about it, ten years ago, people were not checking in everywhere they go. Now people know you're checking in because you're using apps and giving away a lot of that personal security where you're at. So I think we continue to evolve as to really what is important and what needs to be protected. But the physical security, we have had incidents recently that were well publicized. The physical security of the infrastructure is absolutely paramount and there is a lot of work that we are doing, and this is where we benefit from being part of a large international company where we can work with experts across the globe to understand the latest and the greatest when it comes to security of the systems.

KAREN LEFKOWITZ: Certainly I'm not going to talk about grid security in a public forum and what we do and how we do it. It's enough to say that there's an opportunity for all of us to spend a lot of time and energy really considering how we are protecting our infrastructure and I think the industry has moved quite a long way over the last five or six years. When it comes to PII data, I just have to say, Mike was talking about social media. It is astonishing to me that people worry that somebody is going to know how much electricity they consume. I just don't know what the big deal is. Now, having said that, we think it's very important that we maintain security and privacy of customer data and we go to great lengths to do it, but I would point out that people who develop apps, public service commissions do not hold them up in front to testify about what the cyber security controls they have on that data is and they due to regulated utility. This is an example where utility is held to a standard where I suspect very few other players in that particular space are being held to, and I'm not ever sure that the customers really care. Certainly customers care that we're protecting their bank information from our billing system and certainly customers don't want to advertise when the power is out at their house so that people know to come and rob them and things like that. But I think we make a lot of fuss about consumption data, to an end that I don't understand. So we're spending the time and the resources and the energy doing what we have to do because it's the right thing to do and I'm not sure at the end of the day it's a good use of our energy.

DENA DELUCCA: I would just add that from a consumer perspective, we had policies in place long before this was on horizon about member information and it's all member information from our perspective, that we protect it. We don't give it to anybody else without the members' permission. That said, when we did our project with the new infrastructure for the meeting system, there was significant concern for the membership about people knowing their energy usage, to Karen's point, why are they concerned? They just don't think anyone has any business knowing how they use power or when they use it, which they believe leads to knowing when they are home or not home. And here is what we said, which is the absolute truth today, too. We know what your usage is. We have always known your usage from the

whole house perspective. We don't know if you're using a hair dryer or something else. We just know the whole house usage and that's still the only data we're collecting today. We're not getting anything new. But we're protecting that just as we did before when we had to go out with physical people to read the meter. So for security reasons, I won't tell you how we do all of that, but it was a significant part of our project to protect their usage data as well as their personal information.

KAREN LEFKOWITZ: And I think -- I just think one of the things that is interesting is load desegregation. It's just part of your business model and it's the thing that customers are scared that I'm going to do. So how do we reconcile these two things so people give away enormous amounts of information about their life and for some reason there are people that think load desegregation is a good thing. I want to know when my heat pump is running amuck, it's broken and consuming a crazy amount of energy and I ought to be calling a repair person, but I don't want anyone to take a look at what my consumption is.

MICAH REMLEY: It's a benefit piece. It's a benefit. People are on social media and I'm happy to share my data on WAZE where I am, because I'm getting a benefit from it. And that is what people haven't seen yet. As an industry we have not done a good job. They're just scared. They're doing it, they are taking my energy data to help build cheaper or not have to send someone to my house anymore, but I don't see the benefit from it, so people are happy to give information and you gave lots of great examples of where they are happy to give information, as long as they are driving a personal benefit from it and I think that as an industry we haven't done as good a job convincing them of the personal benefit they can get from sharing that information. So that's part. So people just have fear rather than, oh wait, I'm getting something out of this. And I will say, talking about the evolution in security, what we have seen is, always utilities were really -- security is very important for them. But for our direct business customers, it wasn't really on their radar for the past three or four years, and now they care very deeply about it and it comes down to what type of encryption -- how you are encrypting the data, how you are transmitting it. All of that information is really important for them to know. We are seeing corporate IT departments getting very involved in it. So we are seeing customers starting to care, because data security is becoming much more important to them. I think that is good for us as an industry to push security and making sure that we're keeping information, and they're willing to share it when they see they're going to benefit from it but if they're not getting a benefit from it, that is where it's going to be a bigger issue.

DENA DELUCCA: The key is them sharing it.

MICAH REMLEY: Yes, right.

DENA DELUCCA: There's had a big sentiment of distrust for the Federal Government and people suggesting to us that we were going to have Big Brother watching and share information with the government. They can choose to share it but we wouldn't.

MICAH REMLEY: You used that not home example and that's one of the obvious things that you can do with real time energy data, but at the same time they are posting photos of their vacation on Facebook so they're doing that. That's exactly right.

NED BARTLETT: You touched on important elements. I agree this is largely cybersecurity conversation. I think of data security, not physical - I think we all think physical as critically important, a lot of attention to it and a lot of effort and a lot of coordinated effort I think through the layers of companies private and public. But I think that element of exactly who chooses to share the data and who is in control of when it comes out and your point about benefit and it just comes to trust and integrity issue and we see this in government ownership of data all the time. Many legislators throughout the state level are passing bills about use of private information, containing private information and folks pushing on energy agencies even around the electric vehicle incentives, people wanting to us tap in DOR databases rather than fill out a form at a dealership. We already have that information on a person. Can you imagine suggesting they get a rebate in Massachusetts for purchasing an electric vehicle that I'm going to have a dealership talking to Mass DOR, Department of Revenue, to get into their income value? It's an absurd suggestion that you're going to start looking at people's taxes, social security numbers, their income, what they do for business, that would be part of a vehicle rebate. You couldn't design a program that way. You would have no trust, no integrity in government for that kind of crossing utilization in our world and resisted calls to design programs for that effect. You know there is absolutely a trust in the integrity issue in how you handle data, and broken is extraordinarily hard to repair.

CHRIS KELLEY: Thank you. Any other comments on security? Okay. So let's -- I'd like to swing back a little bit and maybe even steal a question that Ed asked in his talks. You said, perhaps we will talk about how you tell these value operating plan for DER. So I think it is important that we touch on energy efficiency, renewal energy and specifically renewable in the space of distributed energy resources. So my question to you is, do you have the resources that you need to actually address and attack that problem, what kind of impact do see that having on operations and reliability and all of the things that we said were important, and what are you doing about it?

ED WHITE: So I asked the question.

CHRIS KELLEY: Yes. You're first.

KAREN LEFKOWITZ: I will jump in. We are investing pretty heavily in developing algorithms in technology to allow us to get much smarter about how to improve our ability to integrate renewable energy, particularly in places where we see high penetration. We track every installation. We manage and look at all of the data associated with working with a couple of very forward-looking vendors to develop those solutions so that's all in the planning side. And we are also now changed our base assumption for the planning criteria to assume certain level of integration renewables moving forward on any new feeders as well as any renovations that we're doing on the existing feeders. It couples into decisions about how to improve our substations. I mentioned looking at using battery storage to offset new construction and things like that. So that is all on the planning side. And on the operating

side, it's a whole different story. We don't have the visibility into the output. We theoretically could get it through our AMI aggregating AMI data at the transformer and that would require modifying the way we expected that system to work. We looked at that system as gathering hourly data. That is certainly not a period that makes sense for operations. And so one of the things that people suggested to me that, if you get a 15% penetration of DER, then you have to know what it is, and where it is and measure it. I said, is that a rule somewhere? Did somebody do a study? The answer is, no, we think that is probably the right number. Well maybe it's 5%, maybe it's 25%, maybe 80%? I don't know. That's a problem. If we don't know when we need granular data, then we don't know how to make those decisions. We don't have the rights to that data and that is an enormous change. So ten years ago any operator in the country knew what the generation output entering into their territory was, and they were managing their grid around that information. Now they don't know and that ought to worry you if you want to have a reliably operated electric system.

DENA DELUCCA: We actually incentivized PV installations, we solar water, as well as wind and general solar. So we are planning for that. We had in New Hampshire, there's a cap of 3.16-megawatts for PV installs at the retail rate is how they're getting it back. At that point, because New Hampshire is -- our co-op is self-regulated, we determined that we would go beyond the cap and let more people put solar in, but we would change the rate so that it was more fair across the membership in terms of not getting the full retail rate for what they were putting back in the system. So we're managing and monitoring that and incentivizing it because if people want to do it, we think it makes sense to do it and there's a small segment that they could get or a rebate for that. So that metering, we also - our power supply mix has a lot of renewable in it because again, we're trying to balance the original question about how do you meet the needs of some consumers who don't think climate change is an actual issue and happening, and those that do, so we're trying to balance that in our portfolio mix of power supply is another way that we do that. So we have wind in there and some solar in there and a lot of gas, so it's a mixture that we're trying to balance the needs of the consumers and also provide the lowest possible cost that we can, given the circumstances.

CHRIS KELLEY: Further comments?

ROXANNE BROWN: Just from manufacturing perspective, obviously coming from this differently but you know, these facilities are pretty energy intensive, so in terms of base load energy, wind and solar can be a challenge. But there are some manufacturing facilities who are the investing these technologies and will slap, you know, two wind turbines on the grounds of a steel mill, but that's not really providing the energy that is needed to run these facilities. And so that's where we talk so much about combining power because for energy intensive industries when you're talking about efficiency and you're talking about generating, you know, a reliable base load source of energy on site, it really is CHP and that is helping these companies. And you know by in large, in the United States, the largest user of co-generation as a pulp and paper industry, but other industries are really trying to invest here and I mentioned earlier that cost is a barrier, access to technical expertise is also a barrier, so it's great that your company is helping to connect the dots for some industrials, the Department of Energy is also helping to connect the dots. You know they have a lot of CHP centers around the country that are engaging with industrials to figure out ways that they can

reduce their emission but also reduce their costs and become more efficient. But it is a challenge. The most significant example that we used when we talk about, you know, efficiency at these sites is a steel facility in the Midwest who you know, during the Recovery Act got a grant from the administration for \$30 million to install a huge massive CHP installation on site. The government put up \$30 million. They put up \$30 million. They didn't know about this program. It just somehow -- the energy guy came across his desk, he saw it, they applied and have saved a tremendous amount of money and I mentioned earlier that the steel sector is in crisis right now and that is one facility that is still operating and the investment, they are able to make in efficiencies helped them a bit to still operate. But we want to see more of that happen in the United States. But there are just a lot of challenges.

MICAH REMLEY: This is where we see an opportunity to engage with the customer and it's been our business to -- the leading demand/response provider across the world and this where we see customers often have the ability to reduce their load to be able to help even at the load whether it be through ancillary services and economic demand and response but the price signals in so many places just aren't right. They are not there. I think this is including the folks on the panel here are doing really interesting things, trying out new things to get load more involved and when we had think about integration, distributed energy resources, it's going to be in all of the above type solution, getting people involved, better system planning, better real-time integration of the data and the control system. This is going to be a thing where it will be a big change for the system but I think this is where we have lots of different tools at our disposal right now, that we can bring together to help address the challenge, but it's certainly one that is looming on the horizon.

CHRIS KELLEY: Any more comments?

ROXANNE BROWN: Can I just add -- just for utilities; I would urge you to think about how you can aid your industrial users in helping to deploy efficiency technologies on your sites because of the cost barriers. There are innovative ways that utilities can come up with programs to help fund some of the technologies and so I just urge you to think about that. We have had some discussions with folks, but you know, as you're doing your work it's really key to think about that.

KAREN LEFKOWITZ: So I should mention that a couple of years ago, we established two specific teams of people and one was to give advice to residential customers on energy efficiency, and one to give advice to small to mid-sized commercial customers. The really large industrial customers generally have a staff that is looking at those things. But the smaller organizations don't, so we saw that as an opportunity to provide some value to those commercial customers.

NED BARTLETT: Not from a utility perspective obviously, but government perspective that programming in that area has been very successful here and the partners in state including grid who are both energy efficient and then really trying to get into that small to mid-size CNI, it's critically important, a lot of ground to be gained. But it is door to door. It is -- you

can get some pattern and CN1 is extraordinarily industry specific and you really spend a lot of time very, very directly with those entities to make a change.

ED WHITE: Right. I guess not to answer my own question that I started this with, but - as I have been listening, it does go back to an education, education, education, from all different areas. It's still fascinates me. So National Grid, we have been operating efficiency programs in the Northeast for 20 years, 20 plus years. We're in the top five of all three of our states and it still fascinates me that I meet customers, big customers, that don't understand that there are energy efficiency programs, EnerNOC walks in and has the same conversation and we're just blown away with the fact they don't know. So I think education at all levels, hearing it from multiple places really is going to be important. When it comes back to the discussion around how we value distributed generation, I do want to commend New York doing for the REV proceeding. As much as REV has been positive and negative and challenging and all sorts of different ways to describe it, the concept is not wrong. So the concept is and you mentioned it in your discussion, as operators, we know at a transmission level what all the generators are doing, which allows the ISO to do their thing and allows the transmission operators to do their thing. At the distribution level we're kind of flying blind. When it was just policy objectives and the few - the interconnection process wasn't bad. I'm thrilled I haven't heard interconnection once, but I have heard integration ten times. We have evolved into the integration phase and I think now we need to evolve even further into the value phase. I think the enlightening piece that is going to be troubling to deal with is, everybody thinks their DER is extremely valuable. So how you price that and how you break it to a customer that your DER in the middle of nowhere, where I actually have to spend money to get to you, is not as valuable as near a load center and I think one of the things that New York is trying to do is how do we make that information more available, so that the development community can start focusing in on the right areas versus spreading it across the state like peanut butter. So a lot of good work to be done but a lot of exciting opportunities and challenges to really under take.

KAREN LEFKOWITZ: And I think that one of the things that customers don't understand is -- and don't want to understand and really honestly, shouldn't have to understand is the physics of the grid. They don't want to have to -- they don't want to know that for them to export from their house, I may have to increase the capacity on the line and I may have to increase the capacity on the transformer and I may have to put in -- they don't care about that. So that is a real challenge. Because fundamentally, people just want to flip a switch and have the magic happen. They don't want to think about it. And then somebody comes to them and says, rightfully so, if you put solar panels on your rooftop you can reduce your cost to pay back over "X" number of years and there are federal credits available and maybe state and local credits available, so it becomes an economic question. Nowhere in that conversation does the person say, but your local utility may have to invest another 20 grand in labor and resources to have the transformer down the street. Right? And they don't care. So having -- so who should have to understand this? The end customer doesn't want to understand it and isn't going to understand it. The person that is selling the solar system is a profit motive, why should they talk about it? Our regulators are the only place and our legislators where we can expect them to understand. We should demand that they understand how the electric system operates and understand what all of those moving parts are. I have been thinking about some

of the comments I made and may be coming off that I am not in favor of renewable energy. But I am. I want a sustainable future, I want a future where most of the energy that we are consuming is coming from renewable sources, but I want a reliable electric system and I understand the challenges getting from here to there. Why aren't the legislators and regulators held to the standard of understanding all of this so they have the burden to help to educate all of these stakeholders?

CHRIS KELLEY: So Karen you answered a bit of my next question, but I will give you a chance to talk more if you like. We only have a few more minutes but I did want to get a regulatory question in and also give Ned a chance to talk a little bit more potentially. But it's just a broad question. You know, given the dynamic and changing nature of our business, all of these changes that are happening that you all have talked about, we're trying to get or are at the forefront of addressing this, on the regulatory side, do you feel that the environment is structured well to support the changes that are being asked for by the customers in industry? And if not, what suggestions might you make? You can take the lead.

NED BARTLETT: Yeah, I think there's a good discussion of restructured environment here in Massachusetts earlier and New England is the same so I think that is a complexity right off the top. How those six states operate through their legislators, differs how their markets are structured, differs in, I think, give us credit to ISO New England, when they have representation here. They have to manage all of that. They have an issue of public policy differences, market differences, and then run the grid throughout the six state region. Not an easy job. So broadening your question is just regulator and public policy, I think that is an evolving and that's how this evolved and we have seen that evolution of some places splitting the generation and transmission and distribution and we have different profiles of companies here on this panel and what their roles and responsibilities are and I think that's a constant evolution and I think probably the one thing I would say about certainly the New England energy market is that has been evolved. Our state has evolved and in restructuring it has evolved. It's not just a one stage activity that occurred. There has been course adjustments throughout that and the challenges and opportunities of renewables and bringing different resources online is going to continue to challenge how we look at our markets, how best to operate them and how to keep them competitive. I can say that is critically important at a competitive marketplace and the benefit of a competitive marketplace is critical to those concerns that you see from citizens and businesses on cost, reliability, as well as policy goals. I like to keep at that. It is a dialogue, it is a collaboration and it is a constant evolution. A more general response. I may reserve a response depending on what I hear from these guys.

ED WHITE: And I want to commend Ned and his predecessors, and I think Massachusetts has done a nice job in regulating the outcome, not the steps. If you regulate the outcome, not the steps, you can open yourself up for a lot more innovation and so we talked about energy efficiency. We have pretty aggressive energy efficiency goals. We have budgets. But we also have the ability based on our service territories to come up with different programs meet our customers' needs and it loops back to the customers. So I guess my one bit of advice would be regulating the outcome you want, not the steps.

CHRIS KELLEY: Thank you. Other comments?

KAREN LEFKOWITZ: I will just say we have -- we operate in several regulator jurisdictions and I often feel sorry for our regulators because they are just sitting in front of this rapidly changing industry that they're trying to regulate and think about, they need to know a lot about the energy sector and they may be the people who are regulating taxi cabs. They have to understand cybersecurity. They don't have the budgets and the expertise and staff to meet the kind of knowledge challenges that they have in front of them. And one of the biggest challenges that they have got is the average tenure of a regulator in this country is less than three years, so they aren't necessarily coming from the industries that they're regulating and we have had a short time to come up to speed. They have a lot of big technical challenges that they're trying to wade through, and then they're gone. So that is -- that doesn't feel like a recipe for success to me. And the era of having long-standing commissioners that last for a long time and learn things, seems to have gone by the wayside. So it's a challenging environment and I expect that states are going to start to take a hard look at how they do that. Notwithstanding, a number of our regulators have taken that brave step of starting proceedings like the REV, to take a look at how to address these future challenges.

CHRIS KELLEY: Thank you. Any other comments? Okay. Well we will go right to the last question then. And just like the last panel I'm going to ask you, you have the QER task force before you. Any final comments or thoughts, or any summary points that you would like to make to make sure that they hear it loud and clear? We have time for one minute per person, we will start right here the end with Ed.

ED WHITE: The focus on education on the front end but then also when it comes to innovative regulation or innovations even with regards to technology, it's not focusing on each individual step of what is the outcome we are trying to achieve. I think those would be the two areas of focus that I would submit.

CHRIS KELLEY: Thank you, Karen?

KAREN LEFKOWITZ: I just want to remind everybody that we have been long - had a social contract to provide a reliable energy future for all of our customers and we continue to think that is an important role for the utilities to serve. That we are uniquely situated to be the integrator. I know you don't like that word. All of these new entrants that are coming into the marketplace. And we have to strike the right balance between regulatory and economics to make it all work.

CHRIS KELLEY: Thank you, Dena?

DENA DELUCCA: A couple of key points. I think we should remember that all utilities are not the same. All three of us here are vastly different. We provided similar service, but we are not the same. And it comes down to affordability for the consumers whether you're a business or residential consumer and the value they are going to see in that is going to be balanced with the policies and programs that we put in place.

ROXANNE BROWN: I would just say that I really appreciate this process. Gil, earlier, talked about this being a collaborative process and as labor, we just really appreciate being at the table and I would urge the Task Force to continue to reach out to labor because we are extremely invested in reliable energy future. Not just unions like mine but Karen is here from PEPCO, the International Brotherhood of Electrical Workers is the union that predominantly represents workers from PEPCO. They have their own ways of talking about our energy future and so, make sure the labor voice remains at the table as this QER process moves forward.

CHRIS KELLEY: Thank you, Roxanne. Micah?

MICAH REMLEY: I would say, focus on the customer. Think about how every other part of their lives is changing so rapidly and then think about how much it changed from the electricity distribution system in the past 120 years. And every other part of life is changing so quickly. We need a regulatory structure and a program to help address the fact that technology and the life is changing very dramatically. So rather than thinking about how are things in the past, how things look like in the future and how to usher in that era from the way we have done things in the past to the way it looks in the future.

CHRIS KELLEY: Ned?

NED BARTLETT: I think consistent with the rest of the panel, it is often about starting with the end in mind, so the opportunity to have that dialogue focus on what that end is and looking to what the end of the day, this is all service based. Whether a government or utility perspective, private profit perspective, you have a consumer, a citizen. This is a need to be met that is again, affordability and reliability and ultimately policy goals whether it's environmental or otherwise. If you have that squarely in front of you, squarely in view, then I think that is how we succeed.

CHRIS KELLEY: Thank you very much. Please join me in thanking our esteemed panel here.

[Applause]

So we'll just take a moment or two to set up for the third and final panel. As we are transitioning, we'll get you set up for the third panel. Please come up and join us. If you wish to provide public comment, please do so. For those that are on the Internet watching this at home, please feel free to provide your comments at www.energy.gov/QER. We will get started in a moment.

[transition]

Panel 3

Ensuring Resource Adequacy

CHRIS KELLEY: So we are going to get started with our third and final panel. Just a few housekeeping notes before we do. Wanted to remind everybody that at 2:49 we will be taking a break for a moment of silence and reflection. If for some reason we end up going a little bit long, I hope you don't mind if I just jump right in and do that. We'll do our best to try to stick to time here. Again, I want to remind everybody that the views expressed by the panelists joining me up here are their own views not the views of the administration including the U.S. Department of Energy.

We are about to started our final panel today on the topic of ensuring resource adequacy and this panel will likely touch on some of the earlier comments that we heard from the first two panels but we'll also be diving a little bit deeper into this one into issues surrounding design and operation of the three eastern wholesale electricity markets including their effectiveness in providing economic and reliable electricity capacity. So, each speaker will be given five to seven minutes to provide their comments and we will go right down the road here and start with Craig. When we get to the end, it will come back to me and I'll have a chance to ask you a few questions, maybe expand on some of the topics that we heard. So that is the game plan. Everybody ready? Let's go ahead and get started with Craig.

CRAIG GLAZER: For those who are left, Monte Python used to say, now for something completely different. So I'm going to do something completely different. Especially given the hour and the time that we have got. I'm going to boil this whole subject down to an analogy. I came up here and have to pass the ship yards in new London. That's what made me think about this. Imagine yourself, you're a ship captain in the Navy, and you suddenly have been given this important critical mission. You have got to move troops from point A to point B, an incredibly important mission, so you have gotten the ship all ready to do that. You have trained the crew. You have got the ship designed. You have got it fully stocked and ready to go and carry out mission critical. You get ready to launch on an important mission and suddenly this junior officer comes running down the dock and says, wait, you can't leave yet. What do you mean I can't leave yet? Well, I know this ship is fully provisioned. I know it is ready to go but I think we need to add 25 tons of baggage to this ship, because we got to load additional baggage on to this ship. The Captain says, you know, officer, I can do that. It's going to make it a lot more expensive. It's going to take longer to get the results. It will be a lot less efficient but if you want me to do that, I can do it. Load on the baggage. And the ship gets a little heavier, but it is still able to leave the docks. The Captain dealt with that and we are ready to go. And now another comes running down the dock and says, Captain, you still have that order. You still got the orders for mission critical, but you know what? We got another mission you need to do. Because while you're on the way to delivering those troops to the foreign land, we need you to stop at these island nations and talk about promoting renewable energy. Okay. That's part of the mission. The Captain says, wait a minute. I had another mission then you added the baggage and now adding another mission and here come about ten other junior officers coming down with other missions. You can imagine at some

point the Captain's head is spinning. Very soon the mission itself gets very muddy. The orders are confused. All of the efficiencies that you built into this well-designed ship and highly-trained crew suddenly are getting lost.

And the reason I came up with this analogy is, that is the plea I'm making today to the Department of Energy that does the QER to focus on the mission. To ensure that as the mission in this case is ensuring reliability at just and reasonable rates and please don't cloud that mission with all these other competing things that you want to add on to that ship. There is a way to deal with them but there is a way not to deal with them.

So, let's bring this ship analogy back home to what we are familiar with. This is in fact the ship that I work for. It is PJM. We operate one of the largest regional grids in the country. I won't take a lot of time on that except to say that this is the mission. The mission is in fact, ensuring reliability and efficient markets to produce results for customers, reliability, delivery of electric service at just and reasonable rates. That is the mission. That is the task that we are assigned to do. That is the ship we want to sail. Now, just because you have a core mission doesn't mean that you can't find creative ways to effectuate that mission. It doesn't mean you are stuck in only one way to pilot that ship. We have many different types of markets. Each of which we use to harness to meet that mission. Also, the fact that you have a mission critical task doesn't mean you don't have to adapt to changing conditions. This is the PJM fuel mix as it was in 2007 and as it is in 2017, and you can see a really significant difference in terms of reduction in coal, increase in natural gas and some but not as much increase in renewables in our footprint. So you still have the core mission but have to adapt to that core mission and I'm not saying we don't have to do that. It also doesn't mean because you have a core mission that you don't use innovation in effectuating that mission. We have to be nimble. We have harness demand response as a capacity resource to help keep the lights on. I'm very pleased the Supreme Court cleared that issue up because to me, that is a continuing tool that will be available to us. And just because you have this mission and you're fixated on the mission, doesn't mean there aren't ancillary benefits. In fact, we have seen significant reduction in emissions in PJN region alone and I'm sure people have seen that in other regions. But what is my key point? The key take away? Think about what the markets can do and most importantly, also, make sure you're not loading that baggage on from things at the market that really you were not designed to do. Markets are tools. They can help you drive the most efficient dispatch. They can take the policy choices and put them into the mix and come up with the best mix of generation, the least cost mix of generation that incorporates those policy choices, but that they do well. What they don't do as well is drive the policy decision. What they don't do as well is choose different kinds of resources. And I would say they never were designed to do that. So please don't load the ship up and ask it to do that or frankly, write it to the QER, frustration that the markets are not doing it, that is not what they are designed to do. I'll close -- so that is one of my core message. Focus on the mission. Use the markets as a tool. Don't criticize them because they are not effectuating policy the policymakers haven't themselves adopted. But as an added problem the captain of the ship has. It's bad enough you're getting all these mission, it's bad enough you are getting all this baggage, there is an added problem. It's not each clear who you take orders from. Because there is a lot of players in this act. You just think about it. You got state, you got state energy offices. State PUCs, governors, legislators, CFTC is now in this act, Congress, even the U.S.

Supreme Court is in it. It is not even clear for that poor captain on the dock when people run down and hand him orders, who he is to listen to. So, me plead to DOE in summary is view the RTOs as a tool. Make them accountable for what they do, but don't load more on to the ship than it ever was designed, otherwise it will never get out of the harbor. Thank you very much.

CHRIS KELLEY: Thank you, Craig. So with that, let's turn to David.

DAVID CAVANAUGH: Thank you, Chris. Thank you all for lasting this late on a Friday afternoon. It's tough to be the closing panel. And thank you for the Department of Energy for the opportunity to participate on behalf of NRG. It is very important discussion on issues surrounding design operation at the wholesale electric markets, and their effectiveness of providing economic and reliable capacity. These markets are very important to NRG, it's important that they are run fairly. NRG is a leading integrating power company in the U.S., a Fortune 200 company where we serve approximately three million residential and commercial customers. We have a complex portfolio across the United States composed of oil, gas and nuclear, wind and solar. Approximately 48,000 megawatts. Nearly 25,000 megawatts of that is in these three eastern RTO markets.

Turning to the markets in the topic of this panel, I want to share with you our perspectives on how these markets are functioning. To date, we think the markets are functioning well. They are meeting their liability requirements. They meet those resource requirements through competitive market structures that provide price signals necessary to draw new investment and maintain the investments on existing resources. They also help for the efficient exit of uneconomic resources. The regional capacity market structures are bringing a broad mix of resources for solar, demand response and conventional, thermal to offshore and onshore winds. In New England over the last three capacity markets, over 10,000 megawatts of new capacities has come in. Over 3,000 of that is dual fuel gas fired resources. Looking to PJM, their reliability pricing model since the beginning of RPM has brought in excess of 39,000 megawatts. Over 29,000 megawatts of that being gas fired and dual-fuel fired CTGT and combined cycles. The markets are functioning. They are working. They are drawing investments and providing the backbone for deeper penetration of global resources. Looking at some of the strengths of these markets and focusing on them, you look at the ISO markets and they utilize slope demand curves to reflect the value of capacity at various levels of resource adequacy while protecting consumers from the exercise of market power. Further, you look at PJM and New England ISO, those markets use a forward view of capacity commitments to permit efficient entry and exit in the marketplace. These capacity markets with their advanced procurement, when tied to transparent retirement rules and retirement information, help to provide important market signals to developers. Additionally, the ISO and capacity market design that has a price lot, which allows a new capacity resource to receive the instant capacity auction current price for up to seven years, provides revenues to resource developers allowing them to secure competitive financing options and provide a hedge against regulatory uncertainty overlocking period. We know the rules change rapidly. So a seven-year lock provides that additional hedge against rule changing. Additionally, when you look across these markets, the strong mitigation of both buyer's side and supplier side activity further permits confidence in these markets. These safeguards against market

relations support appropriate price formation and further confidence in the marketplace. It's worth noting that we are seeing increased need for appropriate buyer side mitigation rules to ensure efficient outcomes in lieu of efforts that might otherwise harm the markets.

Turning to some issues of concern: now looking forward, capacity markets and market operators need to ensure both resources participating directly in the market and those that are accounted for through load adjustments to load forecast, they must have clear and comparable resource performance requirements. Forecast expectations of auto market resources not subject to performance incentives, may place undue risks on regions reaching their resource adequacy goals, create additional scarcity pricing risks on market resources to consumers and can undermine market fundamentals.

As we previously mentioned, ISO New England and PJM have forward markets with strong performance incentives. On the other hand, a New York market uses a prop capacity market and relies on its energy markets for performance incentives. With low energy prices, and low load growth, energy concerns the ISO market might have ability attracting new entry and retaining existing resources within the existing market construct. When you look at the market in general, and you look at capacity resources, we have to make sure we consider the fact that market resources enter and exit based on expectations of needed capacity ancillary and energy service revenues. A capacity market's ability to economically procure resources and meet its resource adequacy needs, once tied the linkage of service revenues to capacity market. As New England and the rest of the U.S. are facing record low energy prices, we can expect due to commodity prices and increased penetration of renewables, we can expect to see significant pressure placed on nuclear, coal, oil and older gas units. At the end of the day, when energy and ancillary service prices fall, capacity revenues must increase to balance the old requirements of capacity resources.

Finally looking ahead, decarbonizing the production of energy is an important step in the future of our society. As the power industry continues to dramatically reduce carbon emissions, it is critically important other sectors like transportation and buildings, start to do more. Focusing on the evolution of the resource that will power our homes, devices and businesses, we need to make sure that the transition from today to the future state is under the deliberate and thoughtful manner. A rush to implement heavy reliance on interment resources could end up with unintended consequences. Long-term and long-life assets such as those entering the market now could be forced to retire early or worse yet be put under contract. So as we move to that new future, we must be careful how we get there and be thoughtful in our deliberations. That's it. Thank you.

CHRIS KELLEY: Thank you. And if I could just interject really quickly, I was remiss and I don't think I introduced you all when you joined me on stage. So let me just, for the sake of the audience, just let you know who we have up here. So I'm joined by Craig Glazer, the Vice President of Federal Government Policy for PJM. Also with David Cavanaugh, Director of Regulatory and Market Affairs for ISO New England and NRG Energy. Edward Tatum, Vice President Transmission American Municipal Power, and William Berg, Vice President of

Wholesale Market Development at Exelon Corporation. Now I have taken care of that, let me head down the table.

WILLIAM BERG: Thank you very much. My name is Bill Berg and it's a pleasure to be here today. I am the Vice President of Wholesale Market Development and that means that I have responsibility for all of the RTOs which Exelon operates, which I believe is all of them at this point. And in dealing with the market rules and trying to promote competition and fair outcomes using the power of markets to provide benefits to customers. I have been involved in this for about probably a decade now. I have seen a lot of changes. I think that the rules and regulations in market design have evolved and they have gotten smarter in some cases. I think the three Eastern RTOs up here are probably the most advanced PJM New York and New England in terms of dealing with market -- competitive market design. Most of those states have moved to retail choice so having a functional competitive wholesale market, nicely compliments retail choice. And the result, and I know others have talked about it, both on this panel and today, the results are to date impressive. We have seen a lot of new generations coming into the market when and where it is needed. We have seen a lot of growth in new technologies, such as demand response and energy efficiency and equally important we seen a lot of inefficient generation leaving the market and most of that generation has left the market without the need for market disruptive reliability contracts. All of that is success. As you look forward, and as you think about where this industry going to be in the next five years, ten years, there has been a lot of discussion on that. The future is that, particularly for competitive markets, not as fierce to me. We have a low gas environment which is a low price gas environment which is good for consumers and healthy for the industry but it puts pressure -- it further amplifies gaps that we have in the industry. There are a lot of gaps in the industry. A lot of situations where we are not using the power of markets to accomplish our objectives. I was here this morning and I saw the slides like you all did. With solar has grown 1000%. We now have 2000 megawatts of it, energy efficiency has grown X amount. Wind X amount. Most all of that is done outside of the wholesale market. Those resources were built. There was a policy decision to build those resources and they were paid for by the policymakers. And then they are brought into the competitive wholesale market. And they are not part of the market. The policymakers aren't necessarily fully harnessing the full power of the markets by defining what constitutes success, what objectives do we want to achieve? How can we use markets, regional markets to accomplish our objectives? It's not happening right now and the result is the physical realities of this industry are, it is very interconnected. And the interconnection, price impact and load impact. All of that ripples through and it's blind to state jurisdiction and Federal jurisdiction and state lines and it's all interconnected. So we set up these regional power pools with this notion that why can get all the load counted for and get all the resources accounted for and we can serve customer needs at the lowest possible cost. I believe that to be a true statement. The challenge we have is that all the resources and all the loads aren't optimized together. We have a disconnect. And that disconnect will ultimately show its head and inform prices at the competitive wholesome market and there will be unintended consequences. I have heard ISO New England put a paper out about supporting capacity markets and talking about how they are going to grow in importance as more and more of these zero-cost energy resources enter the market. So what they are saying is capacity markets are not only important, and becoming more important, they will become more important as we move forward in time. This is true.

But the issue that we are beginning to discover, is that there are -- this is indirectly impacting the fuel mix of the industry. The industry has always had a combination of base load, intermediate and peaking resources. That was the mix that best meets the needs for consumers and I think that will continue. I think the proportions will change and I think that basic logic will continue. And connecting the dots here, so you have got where energy markets fall, capacity prices rise. That is the general relationship and vice versa. Here you have got a situation where energy markets are falling, not only because of low commodity prices but because of policy objectives. Yes, capacity prices will rise, but they will not rise high enough to support base load resources, so that is an unintended consequence we need to think through here. We at Exelon, we have certainly some very challenged nuclear units. And they are predominantly in areas where there is an abundance of renewable proliferation. I don't think anyone thought that would be the consequence, but that is where we are at today. So, as we talk about this term "resource adequacy", we talk about powering -- using power of markets to benefit of customers, I think it is important to expand the conversation to bring in some of these policy desires which, I don't think take issue with, of the various states and try to find a way to incorporate them into the wholesale market so that the prices meet the needs and there is not -- you minimize unintended consequences. Thank you very much. I look forward to the rest of the day.

EDWARD TATUM: Thanks, Ed Tatum, American Municipal Power. Craig, I liked your analogy and I was going through it and trying to figure out, I guess you're the captain? I'm trying to figure out in the PGM stakeholder process what boat I was on. I guess the only thing I can say at this point, is call me Ishmael.

American Municipal Power, we are the non-profit wholesale power supplier in the service provider for 132-member municipal electric systems over nine states, over two RTOs and 640,000 meters and approximately 1900 megawatts of owned generation with a system peak of about 3400 megawatts. So we are transmission dependent utility. We are a member of the American Public Power Association and our geographic scope and our resource mix provides AMP with important insights and perspectives on what we call the organized markets. From an energy perspective, public power supports wholesale energy markets when they work well and are competitive. This generally occurs when there is little or no transmission congestion and fuel pricings are not volatile. Energy markets are intended to improve the efficiency and lower the cost of dispatch, but they do not work well to determine or incent the resources that need to be built, retired or retained. Our focus should be to improve the functioning of these markets, reduce reliance on resource adequacy constructs, or capacity markets, and shift to a different construct for the resource adequacy and planning. And as always, we need to balance the consumer perspectives with the market perspectives.

Administrative resource adequacy constructs is what I call capacity markets. They were originally developed to address the missing money, from my perspective, they never worked well. And I think this is evidence. I have ten years' worth of history now to show that we had continual changes to these constructs since 2010 there has been at least 24 filings. There is probably more. And the volatile results of the past auction. So I have in my slides and presentation results of the 2018-19 base residual auction and I was trying to think of what to call this curve, because in California, I guess you have a duck curve. Best I can come up is

the snake eating the monkey curve, in that the prices of various base residual auctions over time and it starts out kind of close together, but then separates wildly, like the poor monkey is sitting in there and then starting to converge as we get further out. It shows that the prices have been extremely volatile over the entire history of the construct. PJM's most recent manifestation, capacity performance, inappropriately incorporates performance attributes that would be better address in the energy and ancillary service markets. We are seeing these constructs as needlessly complex. They take us further away from competitive markets and what was once intended to be a backstop residual temporary construct, has morphed into a primary revenue source for supply. And I think as we think about what is going on in the energy markets and we heard from other speakers, the capacity revenues are important to keep some of these existing units that are important like the nukes online.

Additionally, the constructs focus on revenue enhancing strategies rather than optimal resource mix at the lowest cost to consumers. Results in high cost to consumers and were of the opinion they not had the benefits suggested by those costs. So 88 billion dollars has been so far either spent or is to be spent through 2018. An additional 7.3 billion dollars was added on when we did capacity performance. And of all the units that have so far been built, 4.8% of them are from units that are not - don't have long term contracts for actual merchant generators. The key to workably competitive markets lies in its efforts surrounding price formation, specifically a need for better models that actually captured all the known constraints and more rigorous development of the inputs for the cost. And it goes without saying that any energy market improvements should seek to provide the lowest overall cost to consumers and protect them from those who seek to exercise market power. We would hope the DOE would vigorously pursue the recommendation from DOE's multi-year assessment for improved models and price formation initiatives. Additionally, we are asking FERQ to resist any additional changes to capacity constructs and we think there are simpler and easier ways to achieve the same result. Gentleman from Navigant has offered a bi-cap approach and I will refer folks for material in slides for additional detail on that.

Regarding market power and buyer side market power, I just need to say that it is exceptionally important if you have a true market that there is a place for self-supply. You can't -- it seems that there is a real problem if you can't have lots of different business models interacting in a market and so, that might be an indication to us that the capacity constructs that have hopefully competitive market results because of the mitigation and the rules, maybe there is some different adjustments that need to be made. It's analogous to requiring me to no longer be able to grow my own tomatoes but have to buy them all from the local supermarket. So I leave with you that. Thank you. I look forward to discussion.

CHRIS KELLEY: Thank you, Ed. With that, let's turn to the questions. So, Bill, I believe you touched on this, the subject of fuel diversity. My first question what role, if any, should fuel diversity play in considering effectiveness of markets? So should market rules be structured to encourage this fuel diversity? Take it if you like or anybody.

WILLIAM BERG: Hopefully what I was hinting at, is the design we set up originally, if you ignore the policy issues which are very real and growing today, would have -- and I think has promoted fuel diversity. When capacity prices were fairly low, energy prices were high, I

know Exelon and PJM effectively built a new nuclear plant through a series of upgrades. That was in response to the energy crisis. I know we have seen a lot of gas combustion turbines and combined cycles we built over the last few years and that is the right choice. And so the question is, will it evolve over time in such that you maintain fuel diversity and you let the market forces determine the fuel diversity or not. I think in theory; the answer is yes. However, the issues I was also hitting on earlier is that there are a lot of policy objectives going on right now in the various states within -- all different within the different RTOs and they seem to be -- and they will - seem to be not going after fuel diversity. They seem to be going after carbon. And that is a good thing. Exelon supports that. However, it will, if we don't take account for it in the current wholesale market constructs, it will skew fuel diversity. You will if you play it out to it's extreme, you will have all the renewables the state bought and some quick start peakers, so that's why I think it is important to use the power of markets and regional grids and come together on a state basis and define what you are looking for. What is it, what constitutes success? What policies does a state need to meet the needs of their customers? And let's articulate it and find a way to incorporate into the market. Absent that, I think fuel diversity will become a greater challenge going forward.

CHRIS KELLEY: Thank you. Anyone else care to address that?

EDWARD TATUM: I would echo Bill's sentiments. And agree with the theory that we first started after Judge Brenner locked us in FERC -- you have been doing this more than a decade I want to say. But, I guess my message is, let's recognize that and if really we as a nation are concerned that we only have one source of fuel, then we need to think about some other things other than layering on to try, as Craig said to try to make his boat carry the fuel diversity baggage that goes with it.

DAVID CAVANAUGH: I think the markets and design of the markets will drive some of the behavior to have a trench of market procurement just on fuel sources is tough and I think it will just undermine the market constructs. Given the right design and then the right incentives, resources will respond to signals out there. They will build. We are seeing that across the markets. We are seeing greater penetration of solar, wind and so offshore wind as well. So, as the markets have their expectations about what they need for resource adequacy, and those markets are constructed correctly and price formation, you're seeing the resources respond. And the fact that you have also performance incentives also is tilting how resources respond. You're seeing more dual fuel and so I think the design of the markets will drive the behavior. It's like anything else. It's an evolutionary cycle that we will evolve through.

CRAIG GLAZER: Ed picked up on my analogy, which I appreciate, because it is to me, just somebody else is running down the dock with another piece of baggage. This is my plea to the drafters of the QER. If you think fuel diversity is important, which I do think it is important, then argue in the QER for a policy that promotes fuel diversity. It's not quite what we have today. We have got a policy that promotes a whole lot of renewables, but not sure all of these other generation resources. If you think it is important, argue for a policy. What I might plea is, don't criticize that the market is not delivering the policy that the policymakers

haven't even adopted. That's my plea to -- I'm mindful of what the venue is here and that's my plea to the drafters of the QER.

WILLIAM BERG: Thank you. And just --one more point on that. When we move to competitive markets, it was we wanted to take a step away from integrative resource plan. That's why we did this. And there was enough comfort that properly designed market would yield the optimal mix over time. And I think we have seen evidence of that. Picking up on what Craig said a little bit here. We use the term markets and hopefully you picked up from my message, there are an enormous number of market distortions going on right now. The market has a difficult time dealing with.

CHRIS KELLEY: Thank you. So my next question involves -- I would like to turn to -- a potentially evolving term, base load. I'm curious how you define base load. Is it defined in economics, like base load units that generate cheapest electricity like we are seeing now with evolution to natural gas or based on the design? Is the unit that was designed to run most efficiently? Or based on fuel type like nuclear or coal? And how do you see or do you see markets as affecting this definition of base load? I see you nodding, David?

DAVID CAVANAUGH: Yes, I would agree. Much like the market, the term is evolving. When I was in plan operations 30 years ago, base load was a unit that was low cost, online all the time. But I think you're right that perhaps evolving to reflect the change of resource mix in the fuel source as well where you might see more combined cycle efficient resources running more often that becomes to be somewhat your new base load resources. What does that look like ten years from now? What is base load in the middle of the day in California? Solar. So you have a duck curve. It is an evolving definition. And I think it is going to be interesting to see it evolve as we go forward

CHRIS KELLEY: Thank you, anyone else?

EDWARD TATUM: I will jump on that, the original question, my answer was just yes. They are design characteristics of units that are historically from base load, coal units and the nukes are designed to come on and stay on. And that is the most efficient operation and actually at least for the nukes, that is still a pretty good source of low cost energy. Coal has been under a lot of pressure and back and forth. But, you think of solar as base load. What if it's a cloudy day? It's not there. Thinking of wind, if we get a lot of penetration. I mean, it has -- when we think of base load, from a public power standpoint, I think of it as load. It's like what -- there is a curve. And 80% of the time, the amount of load in a certain area is below that curve. So that is the base load. That's what we need to serve. That's why it is load. So you have different resources, but if we get further and further away from the design and efficacy of some of these engineering designs, I don't think that is going to particularly serve the country well.

CHRIS KELLEY: Thank you.

WILLIAM BERG: I think it starts with design. There is a choice made when you build a unit and you want to invest a lot of capital at the front end to receive a large proportion of energy

margins, energy benefits all the time. And that is the tradeoff. Or do I want to spend a little bit of capital and build a peaker and I'll run on gas? I think from there, I think that is the way I typically view it and that is a choice that we need to be cognizant of going forward. Whether it is gas today or coal tomorrow, I think that is really an input, a result of commodity prices. Rather than upfront investment that results in the ability to run for two years straight wide open. That is kind of the difference.

CRAIG GLAZER: Just a story about the term, base load. The energy bill that actually has now or is now pending on the Senate floor and it looks like it may pass at this point, it started out with a group of proponents arguing for legislation that would direct the RTOs to promote and dispatch base load generation. Those were the words. I got called into this discussion and as we got into the discussion, since no one could define what base load meant, the proponents were who were arguing for coal in this case, rapidly came to the realization that they actually were promoting solar under the definitions. They said we don't want to do that. So quickly the term itself fell out of the legislation. So hopefully it's not in there still. But, it's an example of writing terms we think they know what they mean and then end up in law and then suddenly they don't mean what people think they mean.

EDWARD TATUM: Let me circle back on that. I appreciate you sharing that. That's funny. Kind of. From my perspective, and I said earlier, I want to reiterate. Base load is load. And so, the question is, what is base load generation? And perhaps base load generation should be the generation that over the long term, can most effectively to serve that base load. I just throw that out.

CHRIS KELLEY: Thank you. So perhaps we related to this, we heard about market efficiencies affecting retirement of nuclear generators as one example that I heard in the discussion today and many new natural gas generators coming online. But, to what extent do markets plan for uncertainty of the commodity costs of the price of natural gas? So to what extent do the markets plan for the future? And so if we are building all these new natural gas plants, are we prepared to address resource adequacy in the event of market price changes?

WILLIAM BERG: So there is a two-part question. First off, I think one of the lessons learned with capacity markets over time, you need a clear definition of what you're procuring. What are we procuring? What are the expectations associated with that and what are the consequences for not meeting the expectations? I think that is the first part. To the extent, commodity prices change over time and you have a capacity commitment. It is what it is in terms of commodity price. You have a clear commitment and obligation to the RTO to perform and if you don't it is what it is. I think most generators, most developers, they look at the forward prices to the greatest extent they can and right now everything is saying natural gas. That will change over time and the market will see it and the market will adjust.

CHRIS KELLEY: Any other thoughts on that?

CRAIG GLAZER: I go back to my analogy. The ship's mission for capacity market was ensuring reliability. That is the mission. The mission doesn't change in that sense based on well, there is a riskiness in the price of the commodity. That is an issue that is a concern but

again, it's not something that you layer on to the capacity market. The capacity market is procuring a product to keep the lights on and the dispatcher when he needs the product, really doesn't give a hoot if it is gas fired or nuclear fired or whatever if it is there when he or she needs it. So again, Bill is right. What is the mission of each of these markets that are discrete? When you start to mudding them is when the ship has trouble getting out of the dock.

EDWARD TATUM: But here is the thing and if it were a market I might feel better about it. It is a resource adequacy construct and with all due respect, Craig, it is with the most recent capacity performance thing, we are putting operational parameters into the capacity market and we almost completed the trip to Oz where the man behind the curtain really is determining the prices and how things are working. In an early discussion, if we lose our fuel diversity and let's say gas prices go up, then all we are going to have based on this resource adequacy construct is a bunch of gas plants with a really high-energy price. That's going to be the outcome of our current construct.

CHRIS KELLEY: Any other comments? So I'll turn to a regulatory question and the last panel we discussed the dynamic changing nature of the business. And whether the regulatory environment is structured to support these changes. So, now from a resource adequacy perspective. And a market perspective, do you feel that we are moving in the right regulatory direction?

CRAIG GLAZER: I think what is happening is, and this is an issue of concern, I think a number of states in New England, New York, and our region are sort of doing their own thing. Outside of the markets. So we have got and playing out in real time in New York and PJM in the New England, you have got the Federal regulators with this market model that they kind of hold on to this market model and the states either totally going around the market model or injecting their own resources in, in some cases subsidized and some cases mandated, whatever, into that model. That -- we spend a lot of time. We are our own harshest critics at PJM many times, and we struggle with how did we get in this situation? Are we failing because the states are doing some of this stuff? Has the market failed? And that, how do we get this back? How do we satisfy some of those state needs or is this just a nation of 50 states, stuff happens? It's going to happen. Live with it. That's a huge internal discussion that we are having. So, it's not one I'm very comfortable with. One where I think we are all going to have to struggle with and one argument is live with it, wall off the rest of the market and let those states do what they want to do, but it is an integrative grid and what one state does doesn't stay at the borders. It affects the other states. So do you step in and try to fix it for everyone? With all those politics? I don't have an answer. It is a real internal struggle we are having ourselves and FERQ is having and the states are having.

DAVID CAVANAUGH: Fundamentally, it's a multi-faceted question. You have state policy initiatives that there is a national intention between what they want to achieve in the markets and how do you do that without breaking the market structure and undermining the market? And then you have generally a market builds that might want to be done. Again, another issue of national tension, undermining the market fundamentals by allowing it to take place. It goes back to having strong and making sure they are administered so the market fundamentals stay in place. How state policies relative to other initiatives get in, that is

something that should be looked at and I mean, effectively it would be great to find a way of achieving state policies which need to be done through market structures. I think we have a ways to go on that but undermining the markets through just states state sponsored builds, it takes the MOPR and how we can have strong market fundamentals.

WILLIAM BERG: There was an article, I think it was in yesterday's plats from Commissioner Clark from FERC and he described - the title of the article was, will CO₂ policies undo competitive markets? The pointed he was making, is that it is kind of a theme we have been talking about. We talk about regional markets but I think what Commissioner Clark did and what we have tried to articulate today is, there is a lot of things happening outside of the markets, which are impacting the market decisions and we need to get our arms around it. And it is most pronounced in the restructured markets. The states that have not restructured, they are responsible for the entire resource mix. They can make conscious decisions to what resources they want and they don't want. It's all integrated and there is a decision made. Having been part of more than one discussion on a MOPR, I can tell you that it is necessary. It is suboptimal. it is not fun. I think I'd rather argue for a capacity market than debate a MOPR. It is not fun for anyone. And I think a better path forward for all of us in our consumers and industry really is to come together as we did when we first set up these regional markets and come up with a shared vision of where we want to go and how can we use a regional market to achieve our objectives? I think that is superior to MOPRs but we can't always get there.

EDWARD TATUM: Since we are going to talk about MOPR, when it was first explained to me back in 2005 or 2006, I said really? Let me get this straight. My little organization is going to exercise buyer side market power? Are you kidding me? I still hold that position. Think about it for a second. We are going to have a market, but only certain people can come in under certain circumstances under certain rules and certain prices that have been predetermined by other people hiding behind the curtain. That's not a market in any sense of the world. There are impacts and it's a holistic integrative world. I get that. But, I think it is more indicative of the fact that we might just need to take a step back and as Bill said, think about what we are doing. Your question was about regulatory hope. I think we have got some regulatory hope. I'm particularly pleased with FERC's efforts on price formation and I think that's really where we will have an opportunity to make changes there. I sure hope they don't do any additional tweaks to our resource adequacy construct. I don't think I can survive another one. But the other thing I think that FERC has done a great job on, and I hope they are getting ready to return their focus to, is on transmission planning and what is happening with 1000 and how are we are doing implementing it. And AMP has been very active in the PJM stakeholder process and getting ready to get more active in MISO to make sure the transparency is there and that we are actually going to need a transmission build. Because if you go back to basic principles, at the end of the day, we want lots of buyers with lots of sellers. We want low or no barriers to entry and the way you do that is to be a regulated transmission that makes sense under uncertain futures so that our use for scenario analysis.

CHRIS KELLEY: So we have time for one minute a piece for your final comments. You have the QER Task Force in front of you. Just want to leave them with any last comments or

ship-related analogies. You're welcome to do that. Why don't we start with Ed and work our way back to Craig?

EDWARD TATUM: I appreciated being here this morning because it gave me time to really contemplate this. Energy markets have their place. We need to be patient. We need to let them continue to evolve. By my fingers and toes, we are about 19 years into this process. We have 100 years of momentum going the other direction. We need to work on our models. Models are hard and we need to work on price formation and stop relying on resource adequacy constructs. There are certain simple alternatives that would easily address any of the missing money issues which I get. And we need to somehow explore a Federal and State partnership for resource adequacy that does somehow address fuel diversity and resource diversity.

WILLIAM BERG: Really quick, I think the term, market, when we use the term, market, we hopefully have broadened that term and we created an awareness that we can't look at a market as we traditionally think about it. IERTO in isolation without considering all the other things that are happening around it. I think this industry will continue to evolve and has no choice and that is -- we need to be adaptable quickly. And moving in the right direction and I do think customers, the industry, the regulators, we are all better off when we define or establish a shared vision as to where we want to go and then we can debate how best to get there from the benefit of all and that is what is missing today.

DAVID CAVANAUGH: Looking at today and looking forward. The industry sat still for decades and is now moving quickly and as we look at carbon policy and state initiatives, we need to find a balance to make those things happen while managing a marketplace and managing investment in those marketplaces. It's going to be a path to get there. It's going to take a lot of work, but I think is there a way of implanting all these policies while still instilling and managing investments through that framework.

CRAIG GLAZER: I guess I get the last word. I will say that markets are a tool. Use them as a tool but they are not a substitute for good public policy. As a result of that, going back to the ship analogy again, I'm in love with the ship analogy. Give it the mission. Tell it what its mission is or adopt a policy that makes sense and then let the market and let the ship go do what it is designed to do. I'll leave with that. Thank you.

CHRIS KELLEY: Thank you. Please join me in thanking our panel.

[Applause]

Public Comment Period

So we'll be turning to the open public comments if you did sign up outside. I'll be calling you in the order in which you signed up. Before we do that, we are going to take a break here at 2:49, which is coming up in a couple of minutes for a moment of silence.

So we would like you to join us here in a minute and we'll take just some time, a moment of silence and reflection in memory of those who were affected by the attacks three years ago and in honor of One Boston Day. We'll do that now.

[moment of silence]

Thank you. So I'm going to turn the mic over to Dr. Karen Wayland who will get us started with the public comment period.

KAREN WAYLAND: Thank you very much. This is actually our favorite part of the meetings because we never know exactly what is going to happen here. And it's I think, the most important part of the day because we get to hear sort of feedback from the panel discussions that you had. We have several different ways that we are collecting stakeholder comments through this period. Our public comment period ends July 1. We have these stakeholder meetings around the country. We have a website where you can upload comments. It's different from the way we did it last year where we had an e-mail address. We have a web form at energy.gov/QER to send us comments or upload reports and documents and we encourage you to use that website throughout the period. It was really important for us to be able to provide a way that people could upload reports and data and reactions to this process all the way through our stakeholder engagement process because the e-mail did not actually allow people to really have that kind of interactive work with us. All of our comments that we receive and we receive thousands of pages of comments last time, as well as the 14 public stakeholder meetings that we did, all of that this time around as well as last time will be available on our web in a searchable database. We treat the public statements that we get, the written comments that we get and the text for all of these panel discussions the same way. They are all tagged and read by multiple people and they are summarized and they are provided to the analysts and then provided again for the public. So the public is aware of who has been influencing us. So I want to assure you that the public statements that we hear are as important as the panel discussions and the written documentation that we get.

So, to that end, I am going to turn the discussions over to running the discussions back to Chris. We have a list of about 11 people, 10 people, I think, who signed up to speak. And I have to say that is the most we ever gotten in any one of these meetings. So it's exciting that people are seeing this open mic as a place to provide feedback for us. Usually it had been in the past e-mails or the stakeholder comments. I would like to, if Nick Clemons is still here, ask Nick to come forward first. Nick is with Congressman Joe Kennedy and the congressman could not be here today so I'd like him to kick it off and then Chris will run through the list.

CHRIS KELLEY: Before you get started, Nick. We have a time limit for each comment. So, you'll see in front of you here the lights just like we used for the panelists and once that turns red, your time will be up and I'll need to cut you off. So you have five minutes for your comment and this will be true for all the public commenters.

NICK CLEMONS: Thank you and thank you to Secretary Moniz and Dr. Holdren taking the time to be here today. I'd like to read a statement from Representative Joseph P. Kennedy III. "Secretary Moniz and Dr. Holdren, your leadership, council and efforts to address the energy

issues we face here in Massachusetts, in New England, across the country, and around the world are second to none. Almost exactly one year ago the first installment of the QER laid important groundwork in our understanding of the nation's energy infrastructure. I'm pleased the second installment, which is under discussion today, will focus on the electrical system. During my time as a member of Congress and for the last year and a half, as a member of the House Energy and Commerce Committee, I focus squarely on ensuring our electrical system provides not only reliable service, but also as the Federal Power Act requires, at just and reasonable rates. Today, New England pays the highest average electric rates in the Continental United States. On top of that, in just the last three years, the portion of our electric bills known as capacity rates, has skyrocketed and these charges won't hit until next year. In the last several years, our region experienced dramatic reduction in base load generation with closures of over 4000 megawatts, disappearing from already antiquated already over taxed grid. This speaks to the larger balance this region must strike. How do we move towards renewable energy future in the way consumers, businesses and communities can actually afford? From policy and political and practical perspectives, there is no single answer. We need a balanced solution that includes investment in renewable resources so the clean energy becomes scalable, cost competitive. We also need a collaborative regional assessment of countless proposals to bring more supply to our grid for natural gas to hydropower with carefully scrutiny of projects of that magnitude require and with impacted communities at the table as any decisions are made. I'm hopeful the process on display today and with informed debate with input from public officials, energy policy experts and private individuals will lead us in the right direction. I look forward to continuing this critical conversation and reading the resulting QER Task Force report in the coming year. Thank you for your time and consideration.”

CHRIS KELLEY: Thank you. So our next commenter is Asa Hopkins. Asa has left. So we'll move to Nancy Israel. And Nancy, while you make your way to the microphone, I'd like to just introduce the folks that we have up here on stage. You already heard from Karen Wayland. And we have Matt McGovern and John Richards and Larry Mansueti. Nancy, the floor is yours.

NANCY ISRAEL: Nancy Israel, a business attorney. I'm also a New England Chapter Director of Environmental Entrepreneurs, E2. Speaking here personally, I'd like to address two matters, big picture. The first is achieving our Global Warming Solution Act goals in carbon reduction and the second is developing a scalable, cost effective, local energy resource offshore wind. Excuse me. I can take this down. In the context of post-Paris agreement, the U.S. was one of 18 countries to sign a ministerial declaration calling for market solutions. REGI is a market base slides to carbon reduction. It's extremely successful. It does what markets are intended to do. It trades. Through REGI, we reduced carbon emissions 35% regionally, 24% of that due to REGI, according to a new study. We also have become number one in energy efficiency in Massachusetts and most of the region is in the top five or six, through money developed funded by REGI. We have capped and reduced our electro power generation. REGI can do a lot more and we hope that it will. We hope that it will be extended to 2030 with annual cap reductions equivalent to at least two and a half percent of 2014 emissions and that we will model 5% reductions to see if we can do even more. Again to put this in the post-Paris context, 90 countries submitted NDCs saying that

they are either considering or committed to market-based solutions. We have other Regional -
- China is implementing a nationwide emission trading system besides its pilot projects. The
EU emission trading system has been extended to 2030. Switzerland will be joining once it
ratifies here in the U.S. We have Canada, Quebec, and Ontario is about to join, Washington
state and Oregon also considering. So these market-based solutions are making a lot of sense.
They are working regionally and collaboratively to reduce carbon and generate other benefits.
And they meet the President's -- I think the President's call to lead internationally on carbon
reduction.

Turning to the offshore wind industry, we heard a lot of talk about developing to scale local
resources. We have a huge opportunity here off the Massachusetts coast to develop a clean
energy local resource to scale cost competitive rates. And to do that, we need the kind of
public-private partnership that we heard mention today. The public aspect being public
policies that to support the development of the industry to scale, meaning at least 2000
megawatts over 15 years, so that regulatory certainty that the industry has time to develop.
There is a recent University of Delaware study that shows if developed to scale, the cost will
rapidly become competitive with the first system coming on in 2020 at 16.2 cents a kilowatt
hour after ten years declining to 10.8 cents a kilowatt hour and with continued technological
developments anticipated, continued cost declines after that. Based on the European
experience, which we in Massachusetts and New England region can learn from. We lag
Europe and we have no offshore wind industry here. Rhode Island and kudos to our neighbor,
first to have an offshore wind pilot project with steel in the water. That is terrific but we won't
achieve scale on a project by project basis. We have to have that regulatory certainty.

CHRIS KELLEY: Nancy you're just about out of time

NANCY ISRAEL: Thank you.

CHRIS KELLEY: Well done. Our next speaker for the open microphone is Berl Hartman.

BERL HARTMAN: Good morning. I mean good afternoon. My name is Berl Hartman and I
am a founding Director of Environmental Entrepreneurs knew as E2. We are a group of
business and professional leaders who advocate for good environmental policy based on its
economic merits. Thank you for the opportunity to speak at this important issue. So, we in
New England, as you heard from many speakers, at a pivotal turning point. Many of our
dirtiest and oldest plants are retiring and we have the opportunity to replace them with either
old fossil fuel 20th century technology, or with 21st century technology that will be cleaner
and cheaper. And in that vein, I'm a little disappointed in that among all the panelists who
were all very knowledgeable and very interesting, there were none who took the position that
new natural gas pipelines brought into this region would in fact result in less fuel diversity,
higher prices, and are actually unnecessary. So therefore that is the point I'm going to try to
make. And these gas pipelines are unnecessary because first of all, we already have adequate
capacity. It's been shown in several recent studies most notably one done by the
Massachusetts Attorney General, that showed that the resources are adequate except on a
very few hours on a very few days between now and 2030 and those peak period issues could
be better solved more effectively and cost effectively than building 8 billion dollars' worth of

new pipelines. Secondly, this project subjects rate payers to unprecedented financial risk. 8 billion dollars for two pipelines. Bringing in approximately 78% of the capacity we already have. So many people have spoken about the virtues of fuel diversity, we already get over 50% of our electricity based on gas and more of our heat based on gas. So, how does bringing in more natural gas make us better off in terms of resiliency and fuel diversity and security? That assumes that the price of natural gas is going to stay perpetually low. Good luck on that. How has it been over the last 20 years? Take a look at that. As the capacity grows, it's of many experts noted that natural gas will become a global commodity, much as oil is, which means that the price will be set by what is going to in Europe and Japan where the price is three and four times as high. These are giant megaprojects. They are like the Big Dig. Eight billion dollars. That's what the price of the Big Dig was originally supposed to be two billion and ended up over 20 billion. Guess what? Ernst & Young did a study of major pipeline issues and found a lot of similarities. Over 60% of them come in late. They have budget overruns that on average are 40% larger than the original cost estimate. And worst of all, the way these pipelines are being supposedly financed is not through the normal market, which we heard so much about. But to ask rate payers to shell out the money in advance and take all the risks. And that is just plain crazy. That's a tariff on electric rate payers to pay for gas pipelines. That never happened before. Finally, two things. There are more cost effective solutions, everything from new L&G brought in this year, new market reforms, CHP, offshore wind, there are solutions on both the demand and the supply side to meet those few days when we might have a peak overload.

The environmental costs and risks are extremely high. In fact, if we just stick with the natural gas we have now, we can't possibly meet our 2050 climate goal, so imagine bringing in 78% more gas in pipelines that are designed to last for decades. And finally, we have a very thriving clean energy sector here in Massachusetts that employs over 100,000 employees in energy efficiency and solar and all sorts of things. It's 2.5% of the state's gross state product. It's a 10-billion-dollar industry. If we bring in these gas pipelines, that sends a signal to the market. We are not really serious about clean energy. We are going to do it our way. We are going to do it the old way. We can be more resourceful and make better use of our time and resources. Thank you.

CHRIS KELLEY: Thank you. Our next speaker is Stephen Dodge.

STEPHEN DODGE: Thank you, Chris and Dr. Wayland and members of the panel. For the record, my name is Stephen Dodge, I'm Executive Director of the New England Petroleum Council, we are the local Office of the American Petroleum Institute. API is a national trade organization that represents about 650 companies engaged in all aspects of the oil and natural gas business. I'd like to thank the Department for holding this important meeting here in New England and much of the northeast, electricity, cost, reliability and infrastructure needed to deliver both fuel and power has been the subject of significant discussion and debate. We are encouraged by the Department's attention to these issues and would like to offer a few points for consideration for the record.

First, natural gas is providing clean, reliable and affordable power to residential, commercial and industrial customers throughout the Northeast. Here in New England, nearly 50% of the

region's power generation comes from natural gas. This represents a tremendous shift from only a decade ago when gas made up less than 20% of the electricity production. The shift also has provided considerable environmental benefits, Steve Rourke from ISO mentioned this earlier. I think it merits mentioning one more time. From 2005 to 2014, this is directly from ISO, total system emissions have decreased overall, NO_x by 65%, SO_x by 92% and CO₂ by 35%. The decline in emissions during this period reflect shifts in the regional fuel mix with increasing natural gas generation, offsetting decreases in coal and oil fire generation. That is what they report. Greater natural gas utilization also is helping to support expanded use of renewable power sources. While renewable sources can help lower demand, as we heard from earlier panelists, we know the sun doesn't shine and the wind doesn't blow 24/7. Natural gas generation provides a backstop of consistent always on power. This region is working on long term strategies to meet power needs, however presenting alternatives sources and natural gas as mutually exclusive is really creating a false choice. Hydropower, solar, and offshore and on shore wind all have roles to play in the energy mix, but these options are no immediate substitute for natural gas. Regarding affordability, the tremendous supply of natural gas in the U.S. has driven prices down across the country. Last year annual prices at the well head less than 3 dollars and lower than that averaging between \$1.25 and \$1.50 per million BTU in the prime producing areas of the Marcellus and Utica formations. In the northeast and in particular in New England, low summertime prices for gas and electricity have given way to huge price spikes in the winter when gas has been utilized for home heating as well as power generation. In 2015, New England residents paid up to 53% more for their electricity than the national average in large part due to inadequate capacity to deliver natural gas to generators during these periods of peak demand.

This brings me to my second point. The shift towards natural gas requires the region to support the development of more natural gas delivery capacity and the form of new pipelines. Only a year ago, the Department projected in its 2015 study on the impacts of growing electricity demand that more than 3.2BCF per day of additional natural gas pipeline capacity will be needed to serve the projected demand in the Northeast between now and 2030. Multiple projects are in development to help fill this need, however opposition to development has led some public officials to attempt to delay the approval and construction of this critical infrastructure. Doing so could harm consumer, including manufacturers and industrial users that would benefit access to resources.

Thirdly and finally, energy markets must continue to evolve to ensure that fuel resources are meeting consumer needs and ensure reliability. We believe that well-functioning markets provide the most reliable and least cost solution to consumers for meeting energy needs and in conclusion, our country a natural gas abundance has been a boon for consumers and businesses, it has created jobs and lowered energy costs and reduced our country's reliance on foreign sources of energy. Unfortunately, these benefits are not reaching everyone. By supporting the development of pipeline infrastructure and rational market rules, our electric grid and pipeline system can ensure the delivery of reliable and affordable energy. Thank you.

CHRIS KELLEY: Thank you. Our next commenter is Richard Levitan. Richard? No? The next is Ari Peskoe.

ARI PESKOE: Good afternoon. My name is Ari Peskoe. My mistake on the handwriting. My name is Ari Peskoe. I'm the Senior Fellow in Electricity Law at the Harvard Environmental Policy Initiative. I want to thank the Department and the staff for organizing this event and for taking the time to take public comments. My comment goes to the briefing memo that is dated February 4th, which I found on the website and specifically Page 13, the section on distribution. And it says that quote, "a regulatory compact legally binds investor owned utilities and regulators into a partnership based on reciprocal obligations" and the memo goes on from there to talk about this so-called compact. My comment is to urge the Department and EPSA to avoid this framing of regulatory compact or regulatory contract as it is called, elsewhere. The framing is confusing. Historically inaccurate. Legally wrong. And I think the backwards looking approach is unhelpful as the Department is looking at a range of important critical issues for our nation's energy future. I intend to provide a written comment that goes into a bit more detail here but let me just say a few words on this point. First just a little bit of where the term came from. The 1970s were a time of upheaval for electric utilities. Costs were skyrocketing and consumer demand slowed and they made a lot of investments in nuclear plants they never completed and in other major assets and they were concerned about whether or not they were going to get paid back. So the regulatory compact idea comes out of that concern and how they were going to get their money back. It was again popular in the 1990s when there were issues about industry restructuring and there were talks about stranded costs and how the restructuring of the industry was going to affect the revenue generation model that had governed the industry for almost 100 years. It's now being brought back as we talk about distributed resources and how this is going to affect utility business models. So that is where it comes from. It doesn't come from where the industry started over 100 years ago. So that is why I say, it's legally wrong because the industry is based on state law. 1907 Wisconsin and New York passed the first laws establishing Public Utility Commissions that regulated electric utilities 20 years later nearly every state or most states have been in place. So that is the basis for rate regulation. It's not a contract. It's state law. And when you think about what a contract is, it starts having to be two parties to a contract. So you know, what are the two parties here? You can imagine utility one side and now who is on the other side? If you want to say rate payers through the Public Utility Commission through their legislature and then back through the voters again, you can try to make that argument, but then what are the terms of the contract? And how does that contract then affect the sort of changes that may be coming as we move perhaps to a more distributed system. It's not really clear. Even if you could argue there is a contract, it's unclear what the terms of that contract might be and how that might be a useful framing going forward. So I would argue that it is -- and one final point on legality of this is that while there are several Public Utility Commissions that use this regulatory compact as a sort of shorthand ideas to describe their relationship, it's never been endorsed by courts. A couple of state courts rejected this idea as grounds for either withholding competitive forces from coming into the market or in the stranded cost context in the 1990s that was rejected there too. When courts have used the term, they qualified it. It's a theoretical compact. It's a compact of sorts or just simply a theory. So it hasn't been endorsed in a legal sense. So as I said, I'll provide

some additional background in written comments and we just urge that this idea be stricken from future reported. Thank you.

CHRIS KELLEY: Thank you. Our next speaker is Ted Saunders. The floor is yours.

TED SAUNDERS: Thank you. Good afternoon. It was exciting to have Secretary Moniz and my distinguished friend, John Holdren and other important members of DOE here. I want to thank you for coming to Boston and Massachusetts to discuss our local and national needs and opportunities. It's an honor to be here and testify on behalf of countless business leaders in the area. My name is Ted Saunders of the Saunders Hotel Group. A fourth generation business based here in Boston, which is owned and operated 14 hotels along the Eastern Seaboard of the United States. I'm also a member of the American Hotel and Lodging Associations Engineering Committee, Alliance for Business Leadership, E2 New England and ELM's Corporate Council. I speak for countless companies who understand that sustainable business practices are no longer just a nicety but an essential part of thriving in today's marketplace.

I'm taking time away from work right now like you, I know how critical it is to get the near-term decisions right in order to maintain a prosperous and safe future for our businesses and as well as for our families. You will be happy to know; I came here my first time ever riding on a cutting-edge urban E electric scooter that our Lennox Hotel just purchased. Happy to show you afterwards. Extreme weather exacerbated by carbon pollution and other damaging greenhouse gasses is already impacted our company several times with severe consequences. Our New Haven, Connecticut property has been closed two different times by mega storms that left the hotel without power for six days, causing our guests major problems and hotel to suffer significant financial losses. We since sold the hotel. Since 1989, our Saunders Hotel Group properties have all been taken comprehensive and innovative actions to reduce carbon and environmental footprints and we actively serve as a model and willing serve as a model to hotels around the U.S. and abroad about what is both possible and financially sound. That said, we need you and your continued bold leadership on a national level to not only help Boston and Massachusetts, but this great nation to maintain a stable environment for the sake of our families and economic prosperity. We must all work together to do everything possible locally to avoid a wasteful, 8-billion-dollar taxpayer expenditure on new pipelines in the Commonwealth, which will become stranded assets long before they have created a return on investment. Instead we must focus on further strengthening our booming renewable energy and energy efficiency programs. These renewables and efficiency efforts which have created 98,000 good paying local jobs and kept millions of energy dollars right here in Massachusetts where they belong. As you may know, our Attorney General recently commissioned a third party expert study to look at the most cost-effective solution to ensure reliable energy in Massachusetts and meet our mandated statewide environmental goals and concluded definitively that additional renewables and efficiency measures were the best way to reach our necessary objectives. Since we are at the end of the proverbial pipeline, we must of course import some energy so we are also supporting bringing in smaller scale hydro and wind from outside of Massachusetts. On another front, together we must also find ways to financially incentivize utilities to repair the huge amount of methane leaks which are undermining so many of our other climate stabilization efforts. Massive leaks which currently

cost utilities nothing since they charge customers for the gas sent versus what we actually receive. I'm also one of many businesses who now support a revenue neutral carbon fee and dividend because we know that without it, we cannot send the right signals to the marketplace and provide the necessary predictability to investors and clean tech companies. We'll also enable the fossil fuel industries to pay for carbon pollution they currently spew in the air we breathe, the water we drink and the food we eat. We must even the playing field finally and end subsidizing the most profitable companies in the history of the world. On behalf of countless businesses, I implore to you push forward boldly, ahead with these innovative measures as our collective future as a nation rest squarely in your capable hands. Thank you very much.

CHRIS KELLEY: Thank you. Our next speaker is Chris Woodward.

CHRIS WOODWARD: I would like to thank the DOE and everybody who is still here who came out today. I recognize a lot of utilities. I work at a firm focused on bond investing in the corporate markets and in the public markets and in this market too. A couple of things I want to add to that is that we are focused on sustainability too. So when we look on the utility annuals, we are very much focused on the long term. We look beyond the ratings agencies and Moody's and S&P and some of the things that they look at that serve what I call the issue or pay model, which is something utilities you might have heard from today, who are focused on markets to a level that really serves them that may not be serving all stakeholders. Two subjects to comment on in the five minutes I have. One is more on the quadrennial, but primarily on where we sit in natural gas and the prospect of what is going to happen. I'd like to add a couple of data points to what we are seeing with natural gas and the parity relationship it has with the rest of the planet. Most of us who are looking at this policy issue see the geopolitical issue of 8-14 dollar rates. Globally we see \$1.98, I checked before I came down here and the [unintelligible] we are getting in 2016 are the ones that will suggest just how rapidly we will witness convergence in that price. We have L&G shipments, this country is about 70 BCF a day in its consumption from electric sectors and others. We have ships that carry three a day. Or three per shipment. Those amounts impact our daily market and suggest, by their frequency, as it will grow over time, having had only several vessels make the crossing, the impact of how quickly we can go up to 8-14 dollars or approach that. What limits are getting there? The price of getting the gas to Japan. Getting the gas to Europe. The two quotes I have from the *Wall Street Journal* one on February 26, is from George Katman, who writes for them, who commented that the break-evens are \$3.60 in BTU to compete with gas, who in a market they were currently serving was \$4.60. I say 8-14 as peak prices during the winter. We are about to compete with gas at prices that low. The other quote I'm going to relate is from February 26 again in *Wall Street Journal*, the other one is from February 17th, from a gentleman named James Henderson writing the financial times quoting a price of \$4.30 as the break-even point for BTUs. I know from working and talking with other elected officials and appointed officials, that you have an expectation that this gap was much bigger and a lot of dependence and home heat pumps and so forth and use of electricity, how much we are going to harvest this natural gas is something that we are hopeful is going to be at a price that might not be too far from two or three or four dollars. But I would encourage you to be aware of where these empirics land, the volumes that we are increasingly able to get parity globally and what impact that is going to have as rate payers actually subsidize these

pipes that will go from their Northeast on up to three L&G export facilities between proposals in those active today.

The only other thing I would comment on about the quadrennial is we heard from a great amount - 21 states that were invited and mostly deregulated states. We heard a lot about preserving a market. Long term contracts have a market just like long term mortgages that aren't variable. You can succeed as a rate payer, as a stakeholder, you can succeed at achieving a low cost, especially for decarbonized capital intensive upfront high cost directions we want to go. You can achieve low costs by entering into long term contracts and it is not -- we heard Eversource, I think I would single out as having remarked the debt ratios will grow if they have to engage in long term contracts and some other resistance that are deregulated markets have to going that direction versus being able to charge a tariff in the transmission of a fuel. That's a tariff that they can't put on wind or solar. And I think if we would also bear that in mind and how other markets, with the nuclear plants in southeast or wind or solar or it's not even the type of generation, it's the way diversity can be built into a market that allows cost recovery rather than the moral fear of not having the cheapest source of energy which may not be for long. Thank you.

KAREN WAYLAND: Chris, could I ask you if you were reading something -- you dropped a lot of figures. Is there something you could leave with our consultants so they can double check the transcript against what you said?

CHRIS WOODWARD: I would love to. I can get it to you very easy.

KAREN WAYLAND: That would great. Thank you.

CHRIS WOODWARD: I'll do that later.

KAREN WAYLAND: So we do make transcripts of everything that gets said in all of these meetings.

CHRIS KELLEY: Our next speaker is Amber Hewett. Probably a better way to say your name.

AMBER HEWETT: Thank you very much. Thank you for being here and thank you for the opportunity to chime in this afternoon. My name is Amber Hewett and I'm with the National Wildlife Federation. So, National Wildlife Federation is brought to this conversation, has been for a very long time, out of our concern, deeper rooted concern for climate change and impact on wildlife, their habitat and communities particularly here in the northeast region, communities on the coastline and those subject to extreme weather. So, for several years now National Wildlife Federation has in the Northeast, all along the Atlantic coast but specifically in the Northeast region lately, focused our advocacy efforts on our largest untapped clean energy solution which is offshore wind power. So we have really drilled down in Massachusetts lately following - New England is putting this clean energy solution on the map this year in Rhode Island and Massachusetts is poised to launch that to the next level. But we have seen and we continue to see in Massachusetts and New York this is an upward

battle. There are so many pieces that need to come together at the same time and it just shines such a bright light on the many levels at which this pivotal solution, huge opportunity for the nation needs to be all hands on deck moment. So much of this story is playing out in New England, it's really a national story. We have been saying for a long time in Rhode Island as they are putting five turbines in the water, it's a national victory. We are making history this year by finally pushing that project to the finish line. We need to ramp up quickly and get to the scale that studies continue to show will make offshore wind the cost competitive resource that we know it can be, that it is overseas and that we are missing out on here. So, we commend action to date on so many fronts that the Federal Government and many states have led. We come so far in the recent years in the Department of Energy has done so much in terms of investing and pilot projects and in helping investing in collaborative efforts in regions.

We do have a few requests and recommendations of specifically of the Department of Energy and Federal Government for the pieces they can lay out to help facilitate the action that will make easier what needs to happen in the states and regions. One of those being we really need to quantify the rated payer benefits of offshore wind. There is still not a clear story that is easily told to regulators in states as to how offshore wind power will impact rate payers in states and regions and across country. We need strong and credible research and analysis to inform state regulators on impacts of offshore wind and also on the auxiliary benefits that aren't -- a piece of the story not told often or well enough. Notably the price affect. The fact that offshore wind power is unique in how it really matches our demand curve here in our coastal energy markets. We know that winter cold snaps, summer heat waves and summer afternoons are the moments we need to serve offshore wind power. I'm a sailor. Those are the times I like to be sailing, because the sea breeze is kicking up and that's when the wind could be flooding clean renewal local power into our grid. It's part of the story that I think isn't told enough when I do outreach on offshore wind, I always stop there and say please remember that and repeat it because it's so unique to offshore wind power. And then also of course the rate stability and hedge value of offshore wind which we heard a lot about today. This is offshore wind will be procured or purchased with long term fixed rates and help buffer rate payers from the volatility of the fossil fuel market in a way that we in Massachusetts really need to figure out how to deal with, as we are replacing retiring power generation. And then also I think a piece of the story that can help be told by the Federal level is are the many things wheel can do to help drive down the cost of offshore wind power, we see overseas, really so uncommon that the U.S. is getting into something that is going to feel new to us and it will be, but there is a 25-year-old booming industry that we also get to learn from. There is an incredibly rich set of lessons learned that we can draw from and many of those lessons being how we can drive down the cost by going at this in a really strategic way here in the U.S. and whether that is by regionalizing our efforts and making sure that states are working in concert with one another to make it a large enough investment and long term commitment to give the market visibility to supply chain manufacturers and developers to give them the confidence to really root as much of the world here, to put Massachusetts and New Englanders to work building these projects and making sure that we can build them as efficiently and cost effectively as possible.

The final two recommendations I'll go through quickly just that we need to really increase the understanding of offshore wind among decision-makers. This is particularly unique to Massachusetts, but it is true everywhere that the story of offshore wind isn't being told in a way that matches the state of the industry.

CHRIS KELLEY: That's five minutes.

AMBER HEWETT: Okay. Quickly then I'll just say we need to also invest in wildlife monitoring. But that is it for the record. Thank you very much.

CHRIS KELLEY: Thank you. Our next speaker is Christian Hoepener.

CHRISTIAN HOEPENER: My name is Christian Hoepener, I'm the Executive Director for Sustainable Energy Systems in Boston, Massachusetts. I want to thank The Department of Energy for putting on this event, but in particular the whole process of trying to look into the plan for the future for some of the biggest challenges humankind faces. I want to comment on something that was brought up during several discussions, the emergence of increasing amounts of distributed energy resources and this discussion was mostly framed in looking at them from a utility perspective and I want to encourage or talk about these resources from two different aspects. The first one is, I want to encourage us to look at emerging class of consumer energy devices. If you go and look at it from the perspective of a consumer device, you will see there is enormous potential for market dynamics to be developed, which was hinted at which we may all be underestimating. As an example, we see right now in many states an explosive growth of residential PV systems. These PV systems are very expensive and despite that we see this growth in other parts of the world, the same systems are installed for less than half, sometimes a third of the cost of what people pay here in the United States. Let's imagine, we could turn the switch and install the system for the same price as it is being done in other countries already. Let's say at \$1.30 per watt instead of \$3.00 to \$4.00 per watt as in the United States. Let's imagine what a dynamic that would unleash. And I think to prepare the technological framework on the utility side, distribution grid side and also regulatory framework to really deal with the potential for completely different goal scenarios and we sit here and think about them as something we ought to undertake.

My second point is related to these resources as well and that is the question, why is it so expensive to install them here in the United States? And that is a very -- I mentioned a number already in other countries residential PV rooftop is installed at less than \$1.30 per watt routinely and I also applaud The Department of Energy specifically has undertaken already a lot of efforts to try to cut through regulatory code standards and permitting and inspection and interconnection processes and so on. There is already a lot of work being done. We are our centered directly involved in some of them as part of a so-called pluck and play PV initiative and the perspective I have gained from that, is we have a massive problem to solve. This is a problem which goes from local jurisdictions over regional planning, state and the Federal level. It's very widely disputed and responsibilities. And I still think that the Federal Government can take a big role in trying to promote work which makes it much less expensive and much easier and safer and faster to install this whole emerging class of

devices. I'm not just talking about solar. I'm talking about storage devices. I'm talking about electric vehicles and a lot of infrastructure which will go behind the meter which we are very ill prepared to deploy in an efficient way. If our society has decided to go and allow people to install those devices and I would say, I don't think there will be other alternative. It will happen anyway. But then we should all to make it as easy and simple and safe as possible. And I think there is a big role to play for the Federal Government and the Department of Energy. Thank you.

CHRIS KELLEY: Thank you. Christian was our last speaker who registered.

KAREN WAYLAND: That is my handwriting as well. It's up along the side, I apologize for that. That's my -- when I was consolidating them.

CHRIS KELLEY: So our next speaker is Peter Papesch.

PETER PAPESCH: Good afternoon. Thank you for the public comment period and many ideas that are being proposed to the DOE. My name is Peter Papesch, an architect developer and a member of E2. I also co-chair the Boston Society of Architect Sustainability Education Committee and therefore we are very interested in the proceedings today. We are heartened by the effort of DOE and EPA to cooperate –

KAREN WAYLAND: Excuse me. If I could ask -- I'm having trouble hearing Peter. If I could ask that the conversation be taken outside. Thank you.

PETER PAPESCH: -- and EPA to cooperate and hope that as part of the cooperation, DOE will urge a substantial decrease in the use of fossil fuels including natural gas. We would like to inspire DOE with a following tripling of wind strategy. Architects play an important role along with developers, owners and engineers and client users in the building sector of the economy. This building sector consumes roughly 70% of all electricity produced. You heard major pitches about trying to go and diversify the energy sources that we rely on here in New England. We in the building sector may be able to reduce plug loads our buildings but electricity production will still require energy. The DOE's contribution to making the transfer from fossil fuels to renewable energy fuels will result in a triple win for DOE, the nation and the planet.

And these three are: First of all, the switch from basically expensive fossil fuels to basically free renewable fuels is one win. Second, the near total reduction in greenhouse gas emissions from fossil fuels to renewable energy is the second and very substantial win and third, during the applications for new energy projects, policy change by the DOE in favor of renewables rather than fossil fuel based options is a third win because it will accelerate the public's awareness of the relationship between an economy based on free sunshine as a source of all renewable energy and our home, a healthy, sustainable planet.

CHRIS KELLEY: Thank you. So I believe that is the end of the list. But, if anyone did not have a chance to sign up and they wish to provide comments, we can open up the microphone to others. Anyone else? Okay. With that, I'd like to thank you for your time and appreciate

you taking time out of your busy days to come and provide these comments to the DOE, to the Quadrennial Energy Review Team. The comments will be posted and available in the next two weeks and thank you again for your time. Any closing comments?

KAREN WAYLAND: No, thank you very much for coming and spending the day with us.

[Applause]