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FEDERAL ENERGY REGULATORY COMMISSION

1026th Commission Meeting

Thursday, April 21, 2016

Commission Hearing Room 2-C

888 First Street, Northeast

Washington, D.C. 20426

The Commission met in open session at 10:00 a.m. when were present:

NORMAN C. BAY, Chairman

TONY CLARK, Commissioner

CHERYL LaFLEUR, Commissioner

COLETTE HONORABLE, Commissioner

REPORTED BY: Gaynell Catherine

FERC STAFF:

KIMBERLY D. BOSE, Secretary

JOE McCLELLAND, OEIS

MIKE BARDEE, OER

JAMIE SIMLER, OEMR

ANN MILES, OEP

MAX MINZER, OGC

ARNOLD QUINN, OEPI

LARRY PARKINSON, OE

PRESENTERS:

A-4 Electric Storage Participation in Regions with Organized Wholesale Electric Markets (AD16-20-000)

Michael Herbert, Office of Energy Policy and Innovation

Accompanied by Leopoldo Soto, Office of Energy Market Regulation

Heidi Nielsen, Office of General Counsel

Anuj Kapadia, Office of Electric Reliability

A-3 - National Labs Panel on Grid Modernization (AD16-19-000)

Patricia A. Hoffman, DOE

Roland Risser, DOE

Bryan Hannegan, National Renewable Energy Lab

PRESENTERS:

Jeff Dagle, Pacific Northwest National Lab

Kev Adjemian, Idaho National Lab

Juan Torres, Sandia National Lab

Chuck Goldman, Lawrence Berkeley National Lab

P R O C E E D I N G S

(10:00 a.m.)

SECRETARY BOSE: Good morning. The purpose of the Federal Energy Regulatory Commission's open meeting is for the Commission to consider the matters that have been duly posted in accordance with the Government and the Sunshine Act. Members of the public are invited to observe which includes attending, listening and taking notes but does not include participating in the meeting or addressing the Commission.

Actions that purposely interfere or attempt to interfere with the commencement or the conducting of the meeting or inhibit the audience's ability to observe or listen to the meeting including attempts by the audience members to address the Commission while the meeting is in progress are not permitted.

Any persons engaging in such behavior will be asked to leave the building. Anyone who refuses to leave voluntarily will be escorted from the building. Additionally documents presented to the Chairman, Commissioners or staff during the meeting will not become part of the official record of any Commission proceeding nor will they require further action by the Commission.

If you wish to comment on an ongoing proceeding before the Commission please visit our website for more information. Thank you for your cooperation.

CHAIRMAN BAY: Good morning everybody. This is the time and place that has been noticed for the open meeting of the Federal Energy Regulatory Commission to consider the matters that have been duly posted in accordance with the Government and the Sunshine Act. Please join me in the Pledge of Allegiance.

(Pledge of Allegiance)

Since our last meeting on March 17th the Commission has had a very busy month. We have issued 98 notational orders since that meeting. Our colleagues do you have any opening statements or announcements? Cheryl?

COMMISSIONER LAFLEUR: Thank you Mr. Chairman. With your lead I wanted to just take the opportunity to welcome a new member of the FERC team who is David Ortiz our new Deputy Director in the Office of Electric Reliability sitting over in the staff seats on the side. David was formerly Deputy Assistant Secretary in the Department of Energy with responsibility for -- we worked together on a lot of important projects related to grid security and geomagnetic disturbances and other forms of grid resilience and he has been a regular participant who we have gotten to know at NERC board meetings.

As if that wasn't enough for me to like him because he works on GMD he also went to Princeton and it has the same name as one of my favorite Red Sox players but I say all of this with some trepidation because his former boss and colleagues are in the room but I think he will be a great addition to FERC and I commend you Mr. Chairman and Mike Bardee for hiring him.

CHAIRMAN BAY: Thank you Cheryl and welcome aboard David it is great to have you here at FERC, Tony?

COMMISSIONER CLARK: Thank you. Welcome David and welcome to all of you to our meeting. I would be remiss if I didn't note since our last meeting the University of North Dakota won the NCAA Ice Hockey Championship, their 8th title which places them at second most all-time so congratulations to UND and also congratulations to my favorite player at Quinnipiac who they beat, Sam Annis who is from the DC region so congratulations to Sam as well but congrats to the University of North Dakota.

Just noting for the record I will be releasing a statement later today on E-5 which is something for the end part so you can look for that. I will push it out on all the usual social media, thank you.

CHAIRMAN BAY: Thank you Tony and I should mention that Sam's mother Demi Annis works here at the Commission. She is a lawyer in the Office of Enforcement.

COMMISSIONER CLARK: I didn't want to celebrate too much when UND won so I have been a little bit conspicuous about that but congratulations.

CHAIRMAN BAY: Thank you Tony, Collette?

COMMISSIONER HONORABLE: Thank you Mr. Chairman. I too would like to welcome Dave to our family here at FERC and I thank DOE for allowing us to have him and I am also -- I was in attendance at the American Association of Flax and Energy Conference on yesterday and there are a number of incredibly dynamic speakers and topics of interest that I know would be of interest to all of us in particular the ruling from the Supreme Court in Hughes vs. Talon.

And I tweeted about this that I would look forward to our continued work with regard to forming solutions ensuring that demand response can participate in wholesale energy markets and I will look forward to working with all of you on the trail and certainly with Commissioner Clark mentioning his favorite team. Many of you didn't hear of the Little Rock Trojans until they burst your bracket for the NCAA Tournament.

So they were one of the Cinderella teams that broke through but didn't get to the elite 8 but I was very proud to be a Trojan on that day, thank you Mr. Chairman.

CHAIRMAN BAY: Thank you Colette. Madame Secretary I think we are ready to proceed to the consent agenda.

SECRETARY BOSE: Thank you. Good morning Mr.

Chairman, good morning Commissioners. Since the issuance of the Sunshine Act notice on April 14th, 2016 no items have been struck from this morning's agenda. Your consent agenda is as follows: Electric items, E-1, E-2, E-3, E-4, E-5, E-6, E-7, E-8, E-9, E-12, E-13

(AUDIENCE INTERRUPTION)

SECRETARY BOSE: Mr. Chairman I will resume the vote call at E-14 for the record, E-14, E-15, E-16, E-17, E-18, E-19, E-21, E-22, E-23, E-25, E-26, E-28, E-30, E-31, E-32, E-33 and E-34.

Gas items G-1, G-2, G-3, G-4, G-5, G-6 and G-7.

Hydro items H-1, H-2, H-3, H-4 and H-5.

Certificate items C-1.

As required by law Commissioner Honorable is not participating in consent items E-18 and E-19. As to E-5 Commissioner Clark is dissenting in part with a separate statement -- we will now take a vote on this morning's consent agenda. The vote begins with Commissioner Honorable.

COMMISSIONER HONORABLE: Thank you Madame Secretary. Noting my reprisals in items E-18 and E-19 I vote Aye.

SECRETARY BOSE: Commissioner Clark?

COMMISSIONER CLARK: Thank you Madame Secretary. Noting my dissent in part of the separate statement on E-5 I concur and vote Aye.

SECRETARY BOSE: Commissioner Lafleur?

COMMISSIONER LAFLEUR: Thank you Madame Secretary, I vote Aye.

SECRETARY BOSE: And Chairman Bay?

CHAIRMAN BAY: I vote Aye.

SECRETARY BOSE: The first time for discussion and presentation this morning is item A-4 concerning comments received in Docket No. AD16-20-000 regarding electric storage participation in regions with organized wholesale electric markets. There will be a presentation by Michael Herbert from the Office of Energy Policy and Innovation. He is accompanied by Leopoldo Soto from the Office of Energy Markets Regulation, Heidi Nielsen from the Office of the General Counsel and Anuj Kapadia from the Office of Electric Reliability.

MR. HERBERT: Thank you, good morning Chairman Bay, Commissioners, staff would like to take this opportunity to highlight the Data Requests and the Request for Comments that was issued last Monday, April 11, 2016 in a new informational docket, Docket No. AD16-20-000 regarding participation of electric storage resources in the organized wholesale electric markets, that is, the regional transmission organizations or RTOs and the independent system operators or ISOs.

Staff began its examination of electric storage resources providing wholesale services with a Request for Comments in 2010. Since that time, the electric storage industry has grown significantly and concerns about operational challenges and the need for faster and more flexible resources to account for the growing integration of variable renewable resources have made electric storage resources increasingly important for Commission consideration.

The commission has taken several actions to ensure that the Commission's regulations and the RTO's and ISO's market rules are technology neutral and also allow emerging technologies to complete alongside traditional resources as long as they are technically capable of doing so.

While these reforms have helped alleviate some of the barriers identified for electric storage, it is important for us to continue to ensure these resources have fair access to the markets which they benefit.

At the November 2015 Commission meeting, the Commission hosted an energy storage panel to discuss developments in the electric storage industry and the participation of electric storage resources in the RTO and ISO markets. The panelists discussed, among other things, the state of electric storage technologies and cost trends, initiatives to help incorporate electric storage assets into the RTO and ISO markets, the procurement of electric storage resources to meet California's energy storage mandate, and the benefits and services that electric storage assets can provide.

Additionally, the panelists explored the challenges and open questions for the continued integration of electric storage resources into the U.S. energy markets.

In recent years we have witnessed numerous electric storage assets come online in PJM, several initiatives in California related to the State's energy storage mandate, significant developments in the technology and cost-effectiveness of electric storage resources, an increase in the number of docketed proceedings at the Commission that either directly affect energy storage resources or have implications for them and in increasing exploration of the value electric storage resources may provide to the grid when acting both as generation and load and providing transmission services.

In light of these developments, the staff is interested in examining whether barriers exist to the participation of electric storage resources in the capacity, energy, and ancillary service markets potentially leading to unjust and unreasonable wholesale rates.

Staff also expects to examine if potential barriers exist, whether any tariff changes are warranted. Staff plans to explore these issues by obtaining information through the Data Requests and Request for Comments issued last week in Docket No. AD16-20-000.

In the Data Requests, staff is seeking information from each of the six RTOs and ISOs about the rules in their markets that affect the participation of electric storage resources. The information requested includes but is not limited to, the eligibility of electric storage resources to participate in the RTO and ISO markets, the technical qualifications and performance requirements for market participation, bid parameters for different resource types, and the treatment of electric storage resources when they are receiving electricity from the grid for later injection. Responses from each of the six RTOs and ISOs are expected on or before Monday, May 2, 2016.

Staff also issued a request for comments to the public seeking information on market rules that affect the participation of electric storage participation in the RTO and ISO markets. Similar to the Data Requests, staff is seeking comments on the eligibility of electric storage resources to participate in the RTO and ISO markets, technical qualification and performance requirements for market participation, bid parameters for different types of resources, and the treatment of electric storage resources when they are receiving electricity for later injection to the grid.

Comments are due on or before Monday, May 23, 2016, three weeks after the responses to the Data Requests are due. Comments are due after the RTOs' and ISOs' responses to the Data Requests to give commenters an opportunity to review those responses and to assist them in providing specific examples of rules that may facilitate or present barriers to electric storage participation in the RTO and ISO markets.

Staff will review the information submitted in this docket to examine whether additional action is necessary to address potential barriers to electric storage participation in the RTO and ISO markets. Thank you and we are happy to answer any questions you may have.

CHAIRMAN BAY: Thank you Michael, Leopoldo, Heidi and Anuj. I'm pleased with issuance of these Data Requests and the Request for Stakeholder Comments. I hope that both staff and the Commission gain better understanding of how storage resources participate in the organized markets. I believe a critical responsibility for this Commission in ensuring just and reasonable rates is identifying and moving barriers to participation in the wholesale markets.

The generation nexus changed considerably since the formation of the RTOs and ISOs. It's important for the

Commission's regulations and the rules of the markets we regulate to keep pace with these changes so that the operational benefits of new energy technologies can be captured.

So I have one question for the team today. I understand that a technical conference will be held on May 13th that will include a discussion on interconnection issues related to energy storage resources and could you tell me what storage related issues that you have identified for discussion at this May 13th tech conference?

MR. HERBERT: Yes absolutely. So the storage issues I guess I should emphasize that they are potential issues for discussion still at this point in time. We have been or we issued a Supplemental Notice last week for the technical conference and teed up a number of issues for potential discussion and so the issues that we included in that notice were the applicability of the standard generator interconnectional agreements and standard generator inter-connection procedures to use electric storage resources and potential changes to those per forma documents.

The appropriate level of interconnection service for combined generation and storage facilities, the triggers that require new interconnection requests when electric storage resources are added to existing facilities and the interconnection of distribution level and aggregated energy storage resources when they want to participate in the RTO and ISO markets and lastly the modeling of energy storage resources for the interconnection study processes.

And so these are issues for potential discussion. We have also been doing some outreach in the industry to help us sort of prioritize these issues and allow them to add additional issues for our consideration which may be important to them and also ripe for our consideration.

CHAIRMAN BAY: Thank you Michael, thank you team, Cheryl?

COMMISSIONER LAFLEUR: I'd also like to thank the team for your work on this and thank you Mr. Chairman for making it a priority. Energy storage and electric storage has the potential to be transformative in serving customers reliably, shaving peaks to keep electricity affordable and accommodating other technologies that are being deployed to meet environmental goals.

I think it's important that we understand how storage can best participate in the markets and I think the outreach that you have outlined and undertaken is an important next step to do that. I want to note that I am particularly interested that in our exploration on storage we monitor the impact of what we have already done in this area and make sure we get the maximum benefit of the steps we have already taken, particularly Order 755 on compensation for frequency regulation which plays a critical role in balancing markets.

I'm concerned under the assessment that there has been such an uneven deployment of storage for frequency regulation in the different markets and I would like to understand why and if there is more that we should do as well as of course thinking about additional things we might do, thank you very much.

CHAIRMAN BAY: Thank you Cheryl, Tony?

COMMISSIONER CLARK: Thank you Mr. Chairman and thanks to you for taking this up as an important issue. Thanks to the team for the work you have done so far and what you are going to be doing over the next few weeks and months. This is very -- I don't have any questions but this is a very important topic area. I have said for some time that energy storage is one of the big potential game changers in the energy industry for sure. All of the issues and concerns that I think we all share with regard to the tightness of the grid especially in an era where you have a number of base load resources retiring, a number of intermittent resources coming online, a lot of those problems and concerns can be fixed if we can bring energy, utility scale energy storage into the grid both for energy and ancillary services and things like that.

So this line of inquiry that we are opening and the responses that we are going to get back I think are going to be tremendously important so I am proud to support the effort up to this point.

CHAIRMAN BAY: Thank you Tony, Colette?

COMMISSIONER HONORABLE: Thank you Mr. Chairman and thank you to the team for your work and for the presentation. I agree I think this is the next big game changer and the year that storage had in 2015 was quite remarkable. I am excited about what the future holds for storage and more importantly the impact it will have on great efficiency and operations and our ability to harness and integrate additional evolving technologies and resources.

Certainly, pardon me, I think that and I will certainly look to the comments that are filed in this docket to pay particular attention to a couple of areas one -- whether there is a need for us to continue to examine existing rates and terms of service to ensure that there is fair treatment for all resources, that there is no undue discrimination or preferential treatment.

This is important to the preservation of markets and also to grid operation generally and I will also pay particular importance, pardon me, to our ability for particularly regions the RTOs and ISOs, my understanding of the work that is evolving with regions is similar to what you have mentioned and I am pleased to see my information tracking with yours. I applaud those regions that have really taken huge steps and worked diligently with stakeholders to transform and to improve the tariffs to reflect this important resource and to reflect all of the attributes that storage possesses.

And I also encourage those regions that haven't gotten there yet to really make it a priority because we have a very unique opportunity here and so I look forward to ensuring me, pardon me, as storage is integrated more frequently in regions that we see new and more evolving technologies and more importantly to the point that the chairman referenced that our work and the region's work enables storage integration, storage usage and ultimately cleaner and more efficient energy integration as well. So thank you for your work and I look forward to the work that lies ahead.

CHAIRMAN BAY: Thank you Colette, Madame Secretary?

SECRETARY BOSE: Mr. Chairman the last item for discussion and presentation this morning is A-3 concerning grid modernization. The presenters for this item are as follows: Patricia A. Hoffman, Assistant Secretary Office of Electricity Delivery and Energy Reliability in the

Department of Energy, Roland Risser, Acting Deputy Assistant Secretary for Renewable Power also from the Department of Energy, Bryan Hannegan from National Renewable Energy Lab, Jeff Dagle from Pacific Northwest National Lab, Kev Adjemian from the Office of Idaho National Lab, Juan Torres from Sandia National Lab and Chuck Goldman from Lawrence Berkeley National Lab.

The presentations will be given in that order and certain presentations do include power point slides.

MS. HOFFMAN: Thank you Mr. Chairman, Commissioners. I really appreciate the opportunity to be here today to talk about grid modernization. First of all I would like to mention that our national laboratories are a very important asset to the federal government and the Department of Energy. They provide research and support to the federal government in many issues ranging from national security issues to scientific advancements to energy and applied research.

And so it is a good opportunity and I am really pleased here to have the National Labs talk grid modernization, the research and development efforts being done at our national laboratories to support advancements in the electric grid. As you all are very familiar with the grid is a strong backbone of our nation, it supports our economy, but there are challenges moving forward.

We have to pay attention to security issues, cyber, physical security we have a changing supply mix that is currently current in the United States. We also have to recognize extreme weather events and new market opportunities. So what the national laboratories are doing is aiding in that conversation and developing advanced technologies and solutions supporting major research efforts including the development of efficient and clean generation technologies, advancement of energy efficiency, looking at the opportunities of what demand response and other consumer sided technologies can play in the markets.

Looking at grid modeling, advanced computing, sensing of materials are all areas which the national labs play an important role in the grid modernization discussion. The grid modernization initiative with the Department of Energy is an effort across the whole Department of Energy. Secretary Moniz did a bold effort in taking a hard look at the Department and saying, "We need to build upon the capabilities that we have with the Department of Energy." We recognize the teams that are cross-cutting our research efforts and our divisions within the Department so what we are looking at is bringing technology together with markets and policies.

We are really looking at how we can integrate our office efforts so that's why you have here with me, we have

Roland Risser who is the Acting Deputy Assistant Secretary for Renewable Power at the Department of Energy along with myself in the Office of Electricity Delivery and Energy Reliability.

We represent a significant advancement and integration that is required for modernization. The reason that we also have the national labs here together is we have asked the national labs to likewise coordinate across their research complex to be able to bring together projects that are stronger, more comprehensive and will go after making significant impacts to the community.

In January Secretary Moniz released the multi-year program plan for grid modernization. We announced an award for 220 million dollars with 80 projects focusing on grid modernization.

I think everybody here is familiar with the vision of where we are trying to go with grid modernization. That the grid is going to be a platform for the future, it is going to support economic development and it is going to support all forms of generation including central and distributed.

It is also going to be very supportive and responsive to customer needs. What is represented here is 14 labs that participate in the grid modernization. We pulled from labs across the country we have 5 labs here presenting their research efforts and some of the activities that are going on today.

So in summary I expect to have significant advancement from these national labs and at the Department of Energy's activities. I expect that we will achieve significant advancements in the areas of buildings integration, vehicle integration, consumer participation, modeling, the integration of sensors, providing greater visibility to the electric system. So with that and that introduction I am going to put the weight on all of my co-workers here to tell you how it is going to be achieved, thank you very much.

MR. RISSER: This is Roland Risser and I want to thank the Chairman and the Commissioners for letting us be here today to talk with you and I just want to re-enforce Pat's messages. This is the message from DOE in total and I think it's really important to understand that we are working collaboratively and cooperatively to get this solution that we need. So I am not going to take any more time I am going to let the time go for the labs to present their information, thank you.

MR. HANNEGAN: Good morning Mr. Chairman, good morning Commissioners. Thank you for having us here to talk about the grid modernization initiative and the work in the nation's national labs in helping to modernize and transform the grid into a platform on what we can grow stronger as a nation in the coming century.

I'm Bryan Hannegan, I am the Associate Laboratory Director at the National Renewable Energy Lab. Together with my colleague Carl Imhoff from PNNL, the two of us serve as the co-leads of the grid modernization laboratory consortium which is really I think a unique effort, unprecedented in terms of its collaboration, its cooperation and its structure amongst the 14 national laboratories that do work in the grid space.

It is something that speaks of good government I think in the sense that we are really putting together All-Star teams with the best and the brightest minds in the lab system and then inviting those minds to work with the best and the brightest minds in the industry in the academia as part of the shared national effort to transform the grid going forward.

So it is a new governance model on how R&D is structured and I think it's one that bears watching and hopefully will prove its worth here subject to the admonitions of our colleagues here from the Department. As the Commission is well aware renewables integration is challenging the traditional means of planning, operating and governing the grid.

You see on the bulk power system a lot more variability on the supply from particularly wind and solar but also from a variety of other resources that are coming onto the grid. On the customer side you are seeing variability in the demand that is unprecedented from the onset of new devices, new services and goods that are being provided.

What that does is it puts strain on the flexibility of the delivery system grid in the middle which was really built in a paradigm for being a one-way delivery system. We are now seeing two-way power flows we are seeing unprecedented flexibility requirements on both ends of the spectrum. And so a key element of our grid modernization program is really to look at how do we empower this grid to have the flexibility that it needs for a clean energy future but also one that has the reliability or even better than what we have come to expect and it maintains the affordability that is so important for our society.

So I want to share with you a couple of items that are presently under way and this is much too small to be seen from across the room but there is a series of reports the labs put together inventorying all the ways which you can bring flexibility on the grids. Everything from how you change the nature of the system operations itself through market design, through managing loads to follow the supply instead of managing the supply to follow the loads to engaging more flexible sources of generation, both fossil and renewable to looking at how you operate the networks with one another.

And some of the most intriguing areas that I am interested in is how the electric network, the gas network, the transport network, the water and wastewater networks can interact with one another to provide each with the flexibility and the service that it needs.

So for example a wastewater pond can take a signal from a market or from a control point and respond to the needs of the grid either to run to absorb the extra supply or to hold off in order to preserve the need for grid reliability going forward.

And then the final area as the Commission is well aware and already spoken of this morning is energy storage and my colleague Kev Adjemian from Idaho will hit that in a moment.

In the area of providing flexibility I want to point out a couple of recent things that the laboratory has been doing in this regard. These are three examples of just a few of the wide diversity of activities underway. The first is an effort focused on the eastern interconnect and using the high performance computing capabilities of the laboratory we have now been able to model the operations of that eastern interconnect at a very high resolution, a five minute resolution to better understand how the existence of the renewable resources, both now and in the future will challenge and actually empower the grid operation of this eastern interconnect in the future.

And as you can see on the right-hand side there the yellow at the top is production from solar PV, the blue comes from wind and you can see the variability of those resources and how it affects the black resources, the coal, the red is nuclear, you can see how the loads are changing over time and this gives you some insight into where and when and how you need to provide this flexibility to the grid to maintain reliable operations going forward.

This work is being conducted with a 30 member Technical Review Committee that includes many of the utilities, the RTOs, the NERC, the EPA as well as we are looking at the panoply of issues affecting the changing supply mix in the eastern interconnect.

And again the key to this is high performing computing capabilities deployed at a scale that is really unprecedented. The second area I will highlight is some work that is being done in Puerto Rico looking at how large scale PV power plants can actually provide grid services to help support the reliability of the grid on the bulk power side.

And here we were able to illustrate a 20 megawatt

PV power plant that can provide automated generator control, up and down regulation, within a very short period of time, within 500 microseconds. This is the first exhibit where a large scale commercial solar plant could actually partake in grid services to this extent and it is something that will be key to helping Puerto Rico meet its clean energy goals going forward while keeping the reliability of supply in place.

That's at the large scale. The third element that I will share with you with the smaller scale we are now looking on the customer side behind the meter working with Solar City and the Hawaii Electric Company to look at how the onset of rooftop solar PV can actually go from being a challenge to grid operations to actually being the strength.

That if you deploy power electronics with these new PV installations you can actually buffer the variability and control it coming from these PV systems in a way that allows for a much higher penetration of renewables at the distribution edge than ever before. In fact as a result of this project there is 15 new megawatts of solar PV on the Oahu distribution system that wouldn't have been there otherwise had the utility relied on old models governing how much PV it could penetrate and still keep the grid reliable.

So these are three great examples of recent work going on in the labs system. As I mentioned there are many more and under the grid modernization initiative we are carrying this forward looking at characterizing devices so the PV systems, the power electronics, the energy storage, the electric vehicle, to understand what they need from the grid and how they provide services to the grid that are of value and doing so in a systematic way.

We are then looking at how to develop inter-operability and interconnection standards so that any device from any manufacturer can talk with any of the others that are on the system so that we can have the maximum plug and play so to speak. And then using the National Laboratory capabilities how do we interact with industry and the private sector to deploy those capabilities in a way that allows for innovation in those sectors to quickly pass through the valley of death so to speak and get into the marketplace in a way where the labs are helping foster acceptance of emerging technologies.

No one wants to test out something for the first time on an existing grid with real customers so maybe we can provide them with an intermediate between the bench top and the real world so that we can all gain confidence in the emerging technology of the new market design and then we can take the risk far less than it would have been otherwise in the real world, that's to me the value of the laboratory system in helping accelerate things through the pipeline of innovation.

And working together with my colleagues here we are looking forward to coming back to you in a very short period of time with some of our new success stories from this effort. Thank you very much and I look forward to your questions.

CHAIRMAN BAY: Thank you Dr. Hannegan.

MR. DAGLE: Good morning my name is Jeff Dagle, I am an electrical engineer at the Pacific Northwest National Laboratory where I have been for 27 years and it is a real pleasure to be here today to address you on some of the work that we are doing in the area of system operations and control. I guess I don't have slides. Oh here we go, I guess we are out of sequence.

So the system operations and control slides are available. So I am going to get started while those slides are coming up. As Pat, Roland and Bryan mentioned we are very excited to have our grid modernization initiative at the Department of Energy and in the area that I am skirting in the system operations and control, we are really looking at ways that we can achieve this flexibility that Bryan talked about significantly.

So one of the things that we are doing is we are building our past success. And one of the things that I am really proud of is over the past decade or so the Department of Energy has been working very closely with not only NERC and EPRI and other industry stakeholders to promote the deployment of wider and measurement systems or synchro-phasors.

And through activities like the North American Synchro-Phasor Initiative we are enabling wide area measurements for improved situational awareness that's a critical foundational building block for wide area controls. And so that's one thing that we are definitely leveraging on.

We are also leveraging on modeling and simulation activities. So recently the Department of Energy with the leadership of David Ortiz developed a contingency analysis tool for looking at the ability of better understanding the prospects for cascading failures of the power system and we recently did a prototype of that capability working very closely with ERCOT to extend the state of the art of today's modeling simulation tools.

These are foundational activities that we are leveraging to move forward as we develop the goals and objectives that are laid out in Grid Modernization Initiative. The key trends and beams that we are reinforcing is that an evolution towards more distributed control. As we are evolving away from our traditional centralized control and towards more distributive control, we need new technologies and techniques to be able to enable that.

We are also going to be doing more innovative things so for example Bryan alluded to the fact that historically we've forecasted demand and dispatched supply. I think increasingly in the future we will be forecasting supply and dispatching demand so it's a whole new way of thinking about dispatching and operating our power system.

So this innovation will enable us to have what I would consider a future proof grid. It doesn't necessarily matter if you invest in controls, it doesn't necessarily matter if you have a future that is full of one resource or another, the future grid needs to be able to adapt and accommodate whatever future resource fix that the nation has for its energy supply and the delivery infrastructure needs to be able to accommodate that.

So that's the exciting prospect that we have in front of us is to develop the foundation for enabling that future vision of our energy delivery infrastructure. We have worked very closely over the past -- over a year on developing a multi-year program plan this slide shows some examples in the system operations and control area, of specific program areas that we are undertaking and this was developed working very closely across the DOE offices and laboratory consortium that was pulled together for this effort and we are currently vetting that through a series of regional workshops.

We have had two regional workshops already and four more to come to work with industry and other stakeholders in the region to get feedback on this plan and so that's underway as we speak. In the architecture area we are building on prior successes. We have had over the past decade plus of DOE support we have had things like that Grid Wise Architecture Council, the Smart Grid Operability Panel and the EPS Office at DOE has been supporting some architecture activities as well. So we are going to leverage that moving forward with focused activity on looking at future grid architecture and how the different regional implementations of that architecture can fit together in a way that we have some unifying principals that allows regional specific implementation.

In the control theory area this is an area that a lot of research that I believe is necessary as we evolve towards this highly distributed future we are going to want to have opportunities to be able to have evolved from thousands to millions or even tens or hundreds of millions of individual control points so they are working together collectively to manage the infrastructure, not only in normal conditions but in abnormal and off normal conditions.

So an example responding to off normal or emergency situations so the theory to provide that distributed robust control needs to be developed.

And then finally my last slide is this is going to require an integration between the transmission and distribution and the buildings and end use area and we are building on technologies that DOE has already spear-headed in this area but with some focused research we will be able to move the ball forward on this area as well.

So I am really excited that we have got some technologies that will through innovation allow the infrastructure to continue to be robust and resilient but it will improve the flexibility with these advanced controls, thank you.

MR. ADJEMIAN: Good morning Mr. Chairman and Commissioners. Thank you for the honor to speak to you this morning. My name is Kev Adjemian. I am the Division Director of Clean Energy and Transportation at Idaho National Lab and I will be discussing the energy storage slides.

So being a car guy I typically come from a car angle so I apologize for that. So I will first talk about some of the energy storage development that has been occurring thus far under the DOE umbrella with regards to lithium ion batteries and again this is an eye test, so I certainly apologize.

The Department of Energy Vehicle Technology Office has been working on advanced battery development for quite some time. They were actually one of the original funders of the LG Chem battery which can now be found in the Chevy Volt at local dealerships.

And so the Vehicle Technology Office has a three-prong approach to energy storage development with the ultimate goal of achieving useable cost targets, batteries that have the performance and durability at a cost that consumers can accept. And the three-prong approach is looking at advanced battery material research and the box on the lower left shows kind of the details where there is a variety of national labs and universities that participate in that program.

There is applied battery research which as you would expect now starts to integrate some of the battery companies and material developers such as the 3M and the DuPont. And then finally there is the advanced battery development which is looking at cell integration and packed development and of course major companies are involved such as LG Chem, General Motors, the big three, Ford as well and that's the portion of the triad that INL leads in terms of testing and validation of said batteries to really understand are these batteries providing the performance and the durability that the customer needs and wants when they purchase their vehicle.

So on the next slide it kind of demonstrates some of the capabilities that we have at Idaho National Lab in regards to energy storage for testing and validation. So while we don't necessarily do the material development that occurs out of Berkeley or in Oregon which they are going to develop the next great cathode or anode, what we do is the testing validation at various scales.

So anything as small as a coin that you can find in your watch to a full vehicle pack and beyond now with the micro grid environment. So in this graphic we do testing on the coin level, the cell, the pack, the vehicle, micro grid and what we are able to do is gain greater insight in how these battery technologies scale up and what are possible opportunities or negatives that we have to compensate for when we design vehicles and large battery packs.

And what we are able to do is really provide the U.S. taxpayer, an independent testing and validation of said technology to ensure that it does meet their end goal needs. If you look on this particular graph, this is one that I find of particular interest when we are looking at battery validation testing and analysis at scale. And this is when we start looking at how vehicles are really beginning to interact with the grid.

As we are plugging in vehicles they are no longer completely separate right, their electrons are now flowing to the vehicles and possibly down the road the electrodes will be flowing from the vehicles back into the grid. And so what we did in this particular study is we looked at various charge rates.

There is level 1 which is 110 volt, level 2 -- 240 and level 3 -- 480 volts that charges the vehicle and the consumers and the car companies really are trying to invoke more and more DC fast charge -- 480 volt as that enables a more transparent charging experience that people have when they use their typical internal combustion engine.

But the question we had was does this effect the battery lifetime? Is it going to really negatively affect the durability of the vehicle and are consumers going to say, "Hey this isn't going to work?" So what we did at Idaho National Lab is we bought two Nissan Packs and we tested them in our lab. We also had 8 vehicles on the road in Arizona where we have professional drivers driving them on the street and testing them on one -- driving on the road and level two verses driving on the road and then doing level three.

We have the pack testing in our lab and now we are apparently breaking it down to the next level and looking at the cell. To really understand what are the pros and cons and there has been some really interesting insights in that area. Number one is that the road data correlated with the lab data, which is obviously very important otherwise all of our national labs are null and void so that's a really great point.

Number two and probably the most important for the industry is that we didn't see any great detrimental increase in degradation when doing level three versus level two. What's really causing the bigger issue with batteries, in particular lithium ion batteries is temperature. And so trying to main their temperature at a lower level is really critical to length and longevity of said batteries.

And so these as you can see the degradation was quite severe. We had 25% degradation within 50,000 miles which is quite a lot and you have to remember that this is done under very aggressive conditions, number one and it was done in the state of Arizona which is incredibly hot and so this is certainly an accelerated test.

If I go to the next slide talking about something non-automotive -- we are looking now at hydropower as a possible way of energy storage for the grid. Here we are leveraging real time digital simulators which is those two boxes shown on the right where we are able to do a simulation and emulation of the electromagnetic and hydrodynamic relationship of trying to convert water going from an upper reservoir to a lower reservoir to electric motors to satisfy the grid.

And as my colleague Bryan mentioned what we are trying to do is do simulations and emulations of this at our lab at the micro scale so that we don't make a mistake when we apply it to the full grid and so this is really a great learning experience that we can do to understand how water and electrons interact with one another.

And then finally this is a cartoon of kind of a holistic approach that we are looking at when we look at integrating advanced, excuse me, advanced transportation technology such as electric vehicles with next generation power and energy.

So to echo the sentiments of Mr. Clark what we have here in the middle is energy storage and there is a variety of technologies that you could use. And as a car guy I look at lithium ion batteries but there is also flow cells, electrolyzers, hydro, I mean the list is really endless.

And what we are doing at Idaho National Lab with our colleagues at NRL via the R2DS is looking at how we can integrate existing thermal, nuclear solid baseline generation with renewables that is more intermittent, leverage the energy storage devices in the middle so that we can provide the consumer whether it is at their home, business or for the charging of their electric vehicle the electrons that they need to meet their day to day lives.

So with that thank you very much for this opportunity again.

MR. TORRES: Good morning and thank you Chairman Bay, Commissioners for giving me the opportunity this morning to tell you a little bit about the work that the labs are doing in security and resilience for the grid. My name is Juan Torres, I'm with Sandia National Laboratories, I have worked there for 26 years and I work in the energy security space in particular since 1988.

I would like to also thank my colleagues, our partner labs for all of their contributions as well to this particular effort. So securing the grid and energy resiliency is a very difficult challenge for several reasons. One being that the grid is very diverse and heterogeneous. We have a system that is comprised of legacy components with legacy systems that have been around for decades in fact along with some very, very modern technologies and how do we maintain some consistent level of security resilience across the board? That is one of the big challenges.

The other thing is security tends to be an afterthought in most complex systems, that is usually bolted on after the fact as opposed to incorporating it from the very beginning and so we are living with some of those concepts that were incorporated in the design of the grid early on as well, so that makes this a very, very difficult challenge.

The approach we are trying to take is being able to look across the entire lifecycle of the system. Things that exist but as new things are added can we start to incorporate these new concepts? Including things like looking at the supply chain, where are components coming from? Do we know where they were manufactured? Could there be things that could have been incorporated at that point?

So the general approach that we have proposed is we are calling an all hazards approach. So looking at the biggest cause of disruptions to the grid and most expensive are storms -- those continue to be most expensive but we also need to understand and address the emerging threats around cyber because we are starting to incorporate more computer technology into our infrastructure and that could potentially add additional threats or additional attack rectors that can be exported by the various threats.

And of course the physical threat has not gone away either. And there are other things like geomagnetic disturbances that can also be threats to the grid. So we proposed a framework for addressing these challenges in all hazards approach loosely based on the NIST cybersecurity framework. It includes identifying the threats, early trying to get an understanding of where the threats are going, what kinds of exploits that they are thinking about across the different areas and how climate is changing and could potentially affect various parts of the country and the grid itself.

Then understanding how can we better protect against these threats, what kinds of technologies can we incorporate, what kinds of policies, what kinds of procedures should be in place to minimize disruption to the grid? And during an event can we detect what that attack might be and can we differentiate because it is possible that we could have a multi-prong type of attack maybe during the heat of the summer when the system is being stressed and somebody decides to maybe launch a cyber combined physical attack. How do you differentiate and understand really what is going on within the grid, are we really prepared to handle that?

And if something does happen how do we respond? How do we respond? What is the best way to do that to minimize the impact? Can we build in response -- automate that into the system as well as include some heating in the loop types of response. And of course how do we improve -- reduce the recovery time and reduce the overall impact to the system so that we can minimize the cost and get the system back online as soon as possible.

I am going to talk a little bit about some examples of several activities that the labs have been involved in over the past couple of years. Back in 2012 super storm Sandy caused extensive damage in the New York/New Jersey area. And area particularly that was hit was infrastructure -- was the transportation infrastructure. Most people in that area use mass transit to move and when the power was down that system was reliant on the power so we could not move people out of those areas safely.

It was also a significant impact to the economy of course. What we have done is we designed a team from Sandia, New Jersey Transit and other partners have joined a micro grid concept to maintain power in the event of such type of destruction from the storm and that includes looking at placement of generators, looking at modifications in how the power lines are routed so they would be less vulnerable to those systems -- to those types of disruptions.

We have done an initial conceptual design and are moving toward detail design. There is 410 million dollars granted by the Federal Transportation Administration to implement and carry out the micro grid. It is going to include natural gas power plant as well as a variety of sources from distributed generation, solar, combined heat and power, electric vehicles, demand responses and energy storage technologies.

That particular design built on concepts were developed at Sandia and applied with the military under the Spider's Program. Another example here some success DOE has taken a leadership role in working with the electricity sub-sector specifically around improving the maturity of cyber security.

And over this past year it provided some guidance that links specifically to the NIST framework, cyber security framework but is aligned specifically with the needs of the energy sector. How they use information technology is a little difference than maybe how it is used in other sectors. There is a real time implications that we see in the power grid and so this guidance looks at things like configuration management, program management, supply chain and external dependencies, identity and access management, event and incident response, information sharing and communications, risk management, situational awareness, threat and vulnerability management and workforce management so it takes a very holistic approach to understanding where the organization is and be able to align with its target level of risk acceptance.

So some promising technology in the cyber area -- there is a team comprised of Sandia, Livermore and several partners from the industry to look at how we can maybe make it more difficult for an adversary to exploit, disrupt a control system within an infrastructure.

And what we are trying to do is basically look at things differently. Typically once a network is established it is fairly fixed and that somewhat makes it vulnerable even if you have security mechanisms in place. So how could we actually make the system appear like it is changing randomly to an adversary, it would make it much more difficult for them to figure out how do we attack this, how do we exploit it?

And make the system smart enough to understand as it sees patterns in attacks then it can anticipate what things we might try as well in the future. So this is looking at making random network settings as well as randomizing how some of the software applications when you are looking at things like malicious code. Malicious code also makes some assumptions that a system operates a certain way, it uses certain addresses that are located in locations and so we would do things that might modify those randomly.

So this is some very promising technology. This particular project called Artificial Diversity and Defense Security being sponsored by the Department of Energy is moving very well.

So as far as future we have a couple of projects that are funded -- that are just taking off this particular year. One is we are looking at micro grid applications for an industrial type of campus, working with UPS in Louisville, Kentucky. Our partners there are Oakridge and Sandia National Labs. We have also got a project looking at adding resiliency to the city of New Orleans, looking at a whole variety of concepts, not necessarily the micro grids, but different types of technologies, approaches and architectures.

And the third project is focused around threat detection response data analytics which is looking at an all hazards approach to understanding real time how we analyze data from sensors to better differentiate what is really going on within the system, understanding that there are a variety of hazards that could potentially cause the same kind of impact. Thank you.

MR. GOLDMAN: Good morning my name is Chuck Goldman. I am a Division Director at Lawrence Berkeley National Lab. I have been there for 34 years and as a policy guy it is really a pleasure for me to walk with the Chairman and the Commissioners some of whom I have worked with before in various state regulatory processes.

So in the area of institutional support the overall objective in this area is to enable regulators and grid operators and utilities to make more informed decisions and reduce risks on key issues that influence the future of the grid and the power sector. We are going to focus on high priority grid modernization challenges and needs that have been identified by electric power industry stakeholders, academic institutions and the private sector.

And as you can see from the chart on the right one of our real goals in this area is to try to improve coordination and linkage between the four technical R&D areas and the institutional policy and market issues that we all confront. DOE has been supporting tactical systems in the institutional area for the last ten years or so. We hope to provide it at a more enhanced level and also the better coordination with the R&D side of the House so that we can ultimately try to bring some of the -- help to facilitate the adoptions of some of the R&D results into the grid modernization space.

In this chart I also show you the four areas in the multi-year program plan and the first two technical areas focus on expanding efforts to provide objective, high-quality technical assistance primarily targeted to state energy agencies, public utility commissions, energy offices and regional planning organizations.

The third technical area focuses on activities that analyze the potential impacts and barriers faced by emerging technologies on grid operations and markets and to develop analytic methods and tools to value distributed energy resources.

The fourth technical area focuses on the future of electric utility regulation which is critical for a grid modernization initiative. The success may depend on adapting the existing regulatory system to give low serving entities the opportunity to create sustainable business models while incorporating emerging technologies.

The next couple of slides I am going to talk about some of the projects we have done over the last several years in the area of regional planning and future utility regulation given the time constraints, I have given what I hope is FERC's interest and focus.

So several labs in the west have a long-standing relationship with utility regulators since the energy agencies in the west have participated in regional electric system planning processes as working with WECC as part of the Western Interstate Energy Board. With DOE funding in particular, LBL has provided tactical assistance to enhance current methods and approaches for incorporating demand-side resources into WECC's regional transmission planning process.

And in this chart here I show you some examples in the bullets of what we have been working on so we have been -- as part of WECC's transmission planning process we have helped developed high efficiency load forecasts, high potential forecasts, we have tried to figure out how much efficiency is in the base case of the planning authorities, we have produced results by state in the west.

We have developed high B architectural studies, building up some of the work that FERC did three or four years ago and updating that work. We have developed DR dispatch algorithms and DGPV scenario tools for the west.

And all of this work is open and transparent in the public domain and a lot of states end up picking up this work and they use it in their regulatory processes as part of the regional planning process.

In the east a really important project that was funded by the DOE Office of Electricity was initially designed to support the regional planning process and the eastern interconnect it involved a team from Argon, Oakridge and NREL and involves the development of an energy zones mapping tool.

The tools is a web based decision support system that allows users to locate areas with high suitability for clean power generation in the U.S. portion of the eastern interconnection that is being extended nationally now. The mapping tool includes 9 clean energy resource categories, 29 types of clean energy technologies, GIS kind of framework it's publically available at a website with a pretty large user pool of folks that have accessed that information.

And again the objective of this project was to help stakeholders identify areas with a high concentration of clean energy resources that could provide significant power generation and importantly to promote open and transparent collaboration among state level, energy planning and regulatories in the east which has been a challenging area.

But it is one in which these kinds of tools have really helped facilitate progress. Turning to the area of future utility regulation at LBNL we have developed utility revenue requirements and financial model that is a forward looking model that includes that works over a 10 to 20 year time horizon, includes existing and proposed generation T&D assets as part of an asset base and revenue requirements.

We project future fuel and O&M costs, future earnings, impacts on customer bills and rates and we use that tool and it had been used in the context of assessing state policy goals for efficiency for distributed resources, for demand response and for PV.

And in this process we have worked with commissions in 5 to 7 states and utilities in several others. It is used in stakeholder and regulatory processes to assess the financial impacts of either efficiency or PV on utility earnings, customer bills and rates, impacts on participants and non-participants and we found that -- and we also in this tool explore various regulatory and rate-making options, whether it be decoupling, shareholder incentives, utility ownership of assets, changes in the rate design, fixed cost, variable cost, different kinds of things that allow stakeholders to get a sense quantitatively of what the impacts of different levels of PV penetration or efficiency are.

And on this chart I show you a study that we have done from the southwest where we explore different levels of PV penetration from zero to 10%, what impact that has on the utilities earnings, several percent -- what impacts it has on reduction of revenue requirements and costs and this was a project that was used in the southwest for the stakeholders.

I also wanted to feature another project. LBL is managing a project that we call Future of Utility Regulations again funded by the Office of Electricity. It is designed in form, ongoing discussions and decisions by utility regulators, policy makers in the industry.

One of the unique features of the project is we are taking this point, counter-point approach. We have a technical advisory group of about 20 folks for regulatory commissioners, 4 or 5 utilities, a bunch of technical experts, a number of stakeholders and we are trying to get authors with diverse viewpoints on the questions of the future of the industry and you can see that we have produced the first six papers that have been produced.

We do webinars, we do that and we hope that we can contribute to the dialogue and discussion about distributed energy, resources, industry structure, what role for distribution systems in the future, what about performance based regulation, what are the options, what are the issues?

Thinking about distribution system pricing going forward -- the advisory group suggests the topics and the priorities, LBL finds the authors, we peer review the work and we try to publicize it. Going forward this chart lists 6 projects that will be conducted over the next several years in the institutional support area. We have foundational projects in terms of developing metrics for the work in terms of affordability, reliability, resiliency, flexibility.

There's a project on evaluation frameworks of technologies, there's another project in the area of distribution system planning support tools. We think that state regulators need some additional education and training about how distribution planning is changing as trying to accommodate more distributed resources.

We are going to continue the project on future utility regulation. There are several regional projects in New York and California that are supporting those regulatory commissions who are considering pretty far reaching changes to their distribution system business model going forward.

To highlight the California project -- in California the current utility distribution resource planning process is based on methods that focus on the grid's ability and readiness to cope with new distributed new sources without necessarily analyzing optimal locations from the customer's perspective.

The current process in California says what is the grid need in terms of hosting capacity? And we hope to try to help that dialogue along by developing a tool that will try to integrate integrated distribution transmission planning tools with distributed energy resource tools that take the perspective of what customers think about in terms of economics and different PV, micro grid, CHP, on site generation technologies, locational issues, valuation issues, and try to fold that in to the planning process.

We are working with the PUC in California who requested the project it builds on some tools of the national labs developed in this space. It is definitely sort of R&D oriented, it is pretty future looking, it will take a couple of years to get results but we hope that it will sort of contribute to the discussion about how the grid should evolve from both the utilities' perspective and customer's perspectives going forward, so with that I look forward to the questions and comments, thank you.

CHAIRMAN BAY: I would like to thank the Department of Energy and the national labs for coming here today and telling us about this work that you are doing. It's exciting. Your research has the potential to be transformative in modernizing the grid with economic reliability and environmental benefits. So thank you very much for the work that you are doing.

One question I have is whether there is anything that FERC could be doing that would be helpful to you as you launch into this project?

MS. HOFFMAN: So thank you I will take a stab at it and ask my colleagues if they have any other comments they would add. I think as FERC identifies challenges and problems and some of the actions they are looking at, having collaboration with the Department of Energy where we can support with additional analytical work.

Also as Bryan Hannegan mentioned as we move forward with the modernization I think we can at the Department of Energy help the risk and bring out conversations and debates that should be occurring earlier in some of the discussions with respect to some of the challenges that the grid is seeing.

So from that perspective I think having the understanding of some of the challenges that you are facing and some of the analytical work that the Department can help in support of that.

MR. HANNEGAN: And Mr. Chairman I think the other aspect in addition to kind of sharing with us what are the challenges that you are seeing and helping us deploy our resources to support those is we anticipate the work of the research program being translated into practice through a variety of regional partnerships that involve stakeholders from a variety of sectors.

And while that is not immediate in the sort of first year activity there are some sort of pioneer regional projects that you have heard mentioned in the various discussions. In future years we expect those projects to be much more ambitious in terms of the scope and the scale of the deployment of these technologies and I think when that happens you as a Commission may see those and may want to look at them perhaps through a different set of lenses than you normally do with a garden variety investment that is being proposed. I think that's a longer term issue but just as a heads up some of these ideally will come your way and the notion is that we want to transform and modernize the grid first in small chunks and then learn from that and then progressively larger chunks and that over time we reach a pace in the scale that matters for things like the Climate Action Plan, 21 Agreement, et cetera.

It is a pretty ambitious goal and it is no doubt going to involve you and your staff very shortly.

MR. GOLDMAN: I would just add to consider having some of your senior staff participate in some of the advisory committees that we set up for some of these projects in the area of future utility regulations, some of the regional planning areas and the valuation. I think we could really benefit from your participation in the dialogue.

Also I think in the regional planning space I think that as balancing authorities in the west file sub-regional plans I think FERC really needs to be active and so it is supporting the historic work that has happened in the western interconnection that is now devolving down to that next level. I think it is an area where we really have to build on the successes that the west has done as we move down to that next level.

MR. RISSER: I was just going to add one thought which is as we have been demonstrating some of these solutions across the U.S. the big issue that comes up is how scalable is that? The issue that we continue to face is how do we create an interlock-ability solution that allows this to scale at lower cost across the country?

So if you keep an eye on that I think you will see some solutions that come out of this when those solutions are amplified through your voice with the utilities and it will help keep the costs down for those solutions to proliferate.

CHAIRMAN BAY: Well we certainly look forward to further collaboration with the Department of Energy and with the National Labs. I have one more question, let's say a utility were interested in learning more about someone, is there exciting research that you are doing or perhaps even wanted to work with you in some fashion, what should they do if they have this interest, who do they contact you know do they contact the National Lab, do they contact the Department of Energy, what should they do?

MS. HOFFMAN: So they should contact any one of us. We tend to work as a team as you can tell we closely collaborate in meetings within the Department, with each other with projects that are being worked on across the labs and if somebody wants to approach any one of the laboratories or even different entities at the Department, NRGP, the Office of Energy Efficiency or my office we will find the right network and partnership that is for that project or that activity to grow.

MR. HANNEGAN: And as I mentioned Chairman the notion of the labs working together in a consortium is to provide exactly that one stop shop for anybody who is interested in accessing any of the lab system capabilities or competencies so myself, Carl Imhoff is the other co-chair, contact either one of us and we will be able to route them accordingly.

I also want to point out that here at the table plus in the audience we have all six of the technical area leads including Tom King from Oak Ridge National Laboratory who leads our work on sensing and measurement to the grid. And john Grasch who is here from Lawrence Livermore who leads our work on design and planning, those are the two areas that we didn't contact -- spend a whole lot of time in the discussion here with the guides but equally important to good modernization.

CHAIRMAN BAY: Thank you Cheryl?

COMMISSIONER LAFLEUR: Thank you very much Norman. It is an honor to have all of you here. Pat has been a wonderful partner, one of the first people I met when I came to town and she's forgotten more about electricity than I will ever know so we are very lucky to have her doing that job.

And I was impressed by the fascinating research you are doing and the level of collaboration between the different labs. Just to tell a couple more stories, Pat and I spent a couple fascinating days in June at Idaho National Labs and I have still not recovered from the fact that the Idaho National Lab is as big as the state of Rhode Island.

I find that quite daunting.

But they have an actual full-scale grid so not only just kind of modeling on the tabletop, you can actually introduce an electro-magnetic pulse or something actually on a grid so it is just extraordinary and I have been to NREL as well, what you guys are doing.

I want to sort of pick up on Norman's question. One of the things that we try to do is to be alert to trends out there and see what we might need to do to allow technologies to be deployed, you know to have the technology push or the policy pull work together.

And I am interested in any of you in your work either on the storage or renewables situation, security, where particular technologies or things that you don't think are getting the pickup where the advancements are ahead of the deployment in a significant way where we should maybe look in and say okay why is that happening, is there something we can do either with a financial regulation or something else to address that, a little bit overarching.

MR. HANNEGAN: So Commissioner I will take a stab at that one coming at it from sort of the energy efficiency and renewable site that befits NREL. I think one of the challenges is that we are seeing a lot of technological development, particularly behind the meter at the end of the grid on the customer side where the technology development is being premised on a business model or a value proposition that isn't yet realizable given the structure of the markets.

So when I think about a consumer managing their home energy systems, what's the incentive for the consumer to do that if they are paying a relatively flat rate, it's based on a volume metric charge. This is where some of the work that my colleague Chuck Goldman described around business models and valuation DER really comes into play and how does that valuation of the distributed energy resources on the distribution side, how is that driven by and actually drives up into how we value services and technologies on the bulk power system where it is right square in your wheelhouse.

I think what we are starting to see is a real blurring of a line between transmission and distribution and that brings in some very interesting jurisdictional questions and coordination questions and those are things that unless we address them they are real opportunity states for things like trans-active control can't be realized and it is not obvious how we get there but at least starting that dialogue now is something that will be critical to the success of some of the technologies that we are developing.

MR. ADJEMIAN: If I may also answer the question. Again coming from a car perspective consumers often speak with their dollars right. I mean there is some sort of desire to do "the right thing" but for example when someone walks into a dealership and they see that an electric vehicle is $20,000 more than a 40 miles per gallon vehicle even though they have the intention of buying that electric vehicle, they have a tendency of migrating toward that 40 mpg.

And so I use the state of Georgia and the city of Atlanta particularly I had very positive tax credits and incentives for purchasing electric vehicles and at one point it was actually the city that had the second highest rate of electric vehicle adoption because of that. And so there are some very beneficial effects I believe with the right sort of tax credits or incentives so to speak to accept sort of the said technology. Otherwise consumers with all of their best intentions typically speak more with their wallet than they do with their spirit.

MR. TORRES: I'll build on something Bryan mentioned and the fact that the grid is moving very much toward a distributed or distribution based backbone. That's where most of the growth is in generation, technologies, the demand response technologies, electric vehicles the internet of things. Just about everything now I mean you can control your thermostat at home now. I do that at home electronically or from my phone.

The challenges as we get more and more of these technologies emerging they don't necessarily have the full understanding of the potential vulnerability they could be adding to the system they are connecting to. And it goes back to something I said earlier which is the fact that security is typically an afterthought.

A lot of it has to do with the way we were trained. Right look across the board any of the engineers here in the room typically are not trained about security unless you specialize in that area so a typical mechanical engineer, electrical engineer just doesn't get that training because they are designing the next generation fuel cell or battery, they don't look at it from the perspective of whatever I am building or designing at some point may be added to the grid.

It can be an entry point to do something that elsewhere in the grid let alone it be attacked. It is usually afterwards we bolt on the security and what I think would be helpful to incorporate some of those requirements earlier on in the process and that understanding.

Just a very quick story here -- years ago when I was working in this space in the late 90's we had discussions with the utilities about security and we asked them, "Why aren't you putting more security as you are upgrading your control systems and why aren't you incorporating more?" And they said, "Well the products we are buying you know from the vendors are including it." So we went to the vendors and we asked them, "Why aren't you including more security in your technologies?" And they said, "Well the utilities aren't asking for it."

So we went back to the utilities again and we asked them the same question again, "Why aren't you asking for it?" And they said, "We don't know how." And so as we are getting new players that are developing technologies for the grid including things like wind and solar they don't necessarily look at things from a security perspective okay so how do we then educate the new players that are going into the space.

MR. RISSER: I would like to add on to what Juan said a little bit because one thing that we are trying to do is figure out how to educate the utilities and the manufacturers and the consumers to know what to ask for. The challenge you have today with security is if you get some supplier offering you some security solution, cyber sphere solution, you don't know what you are training against, there is no framework to know what level of security are you getting, how much are you paying for what.

So the sellers don't know how to describe that, the buyers don't know how to describe that. So what we are doing is we have got a project across several labs to actually put that framework in place so that in the future if someone wants to say, "Okay I want to make sure my smart you name it vehicle or refrigerator or HVAC system or PV inverter, how do I know how much security I need to build into it."

Someone can come in and say, "Well here's the framework that we are offering this as a standard offering. If you want more security here's another offering and you can compare across vendors."

MR. GOLDMAN: Commissioner LaFleur you asked how FERC could help. I have two suggestions. One is the projects that I have described in the regional planning area were funded primarily at a Recovery Act dollars. When DOE had more money to support it and encourage regional planning activities in the west and the east and in Texas.

And I would urge FERC to consider supporting public participation in regional planning processes. You have these state bodies that have developed but they don't really have financial resources so when you get tariff requests, things like that it is something to consider.

And the second thing is and I'm not aware where this is, is to think about public goods R&D. You know ISOs now span three-quarters of our country in terms of markets and historically state regulators have had a pretty important role to think about what kind of R&D is appropriate for the utilities section to do.

And I think FERC has a similar kind of approach that you could take to think about the kinds of R&D that might be appropriate for ISOs that's in the public interest that could deal with good modernization issues that they are looking at.

COMMISSIONER LAFLEUR: Well thank you very much that's very helpful. Besides the specific suggestions that I think were excellent I heard a couple of messages about coordination at the wholesale level at FERC with the states. We all know there is so much going on in the state capitals right now and the business model of the future but there is a wholesale element in there as well.

And coordination between the policy-driven initiatives and the reliability and security efforts and then vendors and equipment which I think is the key to the whole future is how we build the grid of the future and what you spec in and all so I will -- in particular I just want to say I am particularly interested you do such important work in the deployment of it and making sure people see it so we will leverage what you are doing and I think we can be -- if we can be a part of that that's something I think maybe industry is not using -- having in it. Not using some of what the government does as much as could be and am eager to help, thank you.

CHAIRMAN BAY: Thank you Cheryl, Tony?

COMMISSIONER CLARK: Thank you and thanks for the presentation. It seems like a good deal of the questions that we had and the ones that I had coming into this and I think in both of my colleagues questions have been at the heart of what seems like to me one of the more intriguing issues is how we define the feedback loop between the researchers and the engineers who are doing the front line work and those of us that are on the policy and the regulatory side.

And I know Chuck a lot of your presentation was around just that. I think the Chairman and Commissioner LaFleurs' questions were similar to this. I'm wondering if anyone else wants to take a stab at defining the -- well let me ask it this way. Did there need to be more concrete ways in which there's a formal feedback loop between FERC and the researchers in research labs as opposed to just getting together periodically and talking about some of these things.

It's interesting these ideas, I'm wondering if there needs to be something a little more formalized than that or not.

MS. HOFFMAN: So Commissioner I would agree with you in some ways if we could take some very challenging topics that the industry is facing and set up a structure where we can take the modeling and analytics work that the Department is doing, some of the technology solution sets and dive into what does that mean for future policy or regulatory opportunities looking at inner operability issues.

Whether there is a pleather of issues around numerous challenging topics that both of us are facing whether it is on the scientific side of what is you know, what is some of the protection means from an A&P point or view or from a market point of view of what this bowl of energy storage plan markets.

And so some of those topics that I think we could gain a lot of value together by bringing together the scientific community, the technical advancements, the modeling work, the analytical work in concert with some of the directions and opportunities and things that you are considering under your portfolio.

MR. HANNEGAN: I'll just add to that. I think this opportunity is a great example of what I think we need more of. Just the ability to have this open dialogue, find out what is on your mind and find out what is on our mind, what we are doing. I think more of this works and that can take the form of having more FERC staff participations in some of our regional workshops as we are scoping through the multi-year program plan or presenting results in an interim area that is of interest to the Commission.

Having your staff participate would be useful. Inviting us as laboratories to participate in your technical workshops and there is nothing more that a good engineer loves than a big challenge. So give us your challenges and you know turn us loose on that. You know the national labs are really a national resource and we are here to help you with solving those things and to the extent that you can bring us those challenges I think you will find this team and our extended teams are more than happy to roll up our sleeves and get into it.

COMMISSIONER CLARK: Thanks. One final question which is this -- just as researchers always have set priorities in terms of what projects they want to take on, FERC also has to set some of those priorities. I am wondering if you were giving advice to us in terms of here are some cutting edge areas that seem like the proverbial low-hanging fruit and defining low-hanging fruit is some combination of big bang for the buck in terms of advances to the grid combined with it seems like it's fairly achievable in the near term future, some combination of that.

Are there certain projects that you are working on that seem like they are sort of ready-made for that kind of prioritization by FERC on the regulatory side, does anything stand out? I know it is all interesting, but --

MR. DAGLE: I think in my opinion to that question some of the work that we are doing in fast acting demander spots just stabilize and then use that control capability to improve the flexibility and integration of the different types of technologies albeit distributed energy resources or star driller types of technologies. I think that's an area that we have gained quite a bit of confidence with some of the demonstration projects that have come out of the recent Recovery Act projects and is placed to really make a difference if we just sort of put the pieces together, so that's one example I can offer.

MR. HANNEGAN: So I'll confess I started my career as a meteorologist so everything to me is a forecast problem. And everything that's a forecast starts with good data and I think we didn't talk about that much here but Tom's area, something in measurement is a really nice opportunity. We have got phaser measurement units, we have got smart meters, we have got condition monitoring and equipment. We are beginning to get critical mass data where we can do data analytics both from a security and resilient standpoint but I actually think we can start forecasting the state of the grid at some point in the future.

With a certain amount of skill that allows us to know what grid services are going to be required later this afternoon when the clouds roll over the small community.

And when you know that with enough lead time in advance then you can fashion markets that clear that are open and transparent. You can start transacting in those services.

And these new technologies now have a market to play into with their value proposition that didn't exist before and you now remove some of the financial barriers that Kev referred to between the customer buying the conventional vehicle and the electric vehicle. Now that EV can be involved in energy markets in a more robust way and that's an additional source of revenue that offsets the additional cost.

So it all to me comes back down to if we understand what the devices need from the grid and we understand what the condition of the grid is, then we can run the system leaner than we used to but still keep the reliability. We can design and plan for more uncertain future, we can begin to detect and protect against emerging threats and if we get the institutions built around that then we can create a lot of new opportunity for innovation which is a part of what we are trying to bring about.

CHAIRMAN BAY: Very good thanks to all of you.

MR. DAGLE: Well Brian's comment triggered something in the data area. There is a recent National Academy in Florida and analytic foundations for the next generation grid that came out last month and it has some recommendations in it specifically around data sharing and I should have thought of it earlier but there are some specific recommendations for FERC in there in terms of the making some of the data formats public, you know for the Form 715 and things like that.

So if you are not familiar with that National Academy of engineering report, I think there are some interesting things in there it just came out last month.

CHAIRMAN BAY: Thank you Tony, Colette?

COMMISSIONER HONORABLE: Thank you. I want to thank each of you not only for being here but more importantly for the work that you do. I'm going to start with Pat our colleague and friend we have worked together for years now. And I want to applaud again your work -- I've said to Pat privately I don't know how you do what you do.

And then to have this really I think unprecedented opportunity to thank you all here together for the ways in which and I think Dr. Hannegan said you want to be a national resource. I can attest that you are. And unequivocally you are seen as the pre-eminent authorities and experts in this area and you have demonstrated that here today.

Pat it is always good to be with you and I want to thank each of you for the ways in which you have worked to support not only all the efforts and test cases throughout the industry over the years but the ways in which you have supported regulators and others in industry as they are grappling with connecting innovation and technology with policy, with regulation and making it work.

And I can attest certainly coming from Arkansas you all -- NREL for instance years ago came to aid us when we were hearing, "Oh we don't have as much wind as other states" NREL said "Oh contraire, we brought mapping tools to really demonstrate and get us all on the same page so that we were unified then with the knowledge to be able to move forward."

The ways in which you have supported our efforts in Arkansas with regard to EM and V development with regard to the deployment of our energy efficiency programs, the development of safe energy plans, I could go on and on. And to have you here making these presentations, seeing what you are working on now, but more importantly what the future holds, it is really invigorating.

So I want to thank you for your work because I believe it was the necessary and proper foundation to be able to harness technology and innovation in a way that will allow us to ensure that our grid is flexible and able to integrate renewable and other distributed resources.

I also wanted to reference and I know I am last and I know you are hungry but we are all energy nerds and this is what we come to do. I was very pleased to hear about the grid integration studies. Dr. Hannegan you mentioned those in the test cases and we hear about those from our colleagues and we are very hopeful about the promise that those test cases bring.

You mentioned the luxury you have to be able to take the risk for a widely deployed. I am also really interested in we are hearing so much more about the deeper and more frequent interaction between both power systems and distributed resources at the state level. You all reference the New York and California efforts in particular. Many, many people are watching those efforts and we are realizing that we are having to think in new ways and different ways about that interaction and how to see it as more of an opportunity than a challenge, but your work with regard to R&D will help us get to that next place.

Kev I'm delighted to hear your work on EVs so there are some car men and women up here I imagine and pardon me, it really gives me comfort to know that you all are on the case with regard to yes we want more electric vehicles on the road but how is that putting out, are we prepared for that and are we integrating proper technological tools and thinking about innovative ways that EVs can be used and batteries in the future.

And with regard to security and resilience, the micro grid test case and I have to tell you I think it was Juan or maybe it was Dr. Torres forgive me, that spoke of the DOE and cyber security guidance. I have to tell you that is highly tauted. We had a technical conference here it was a few months ago and a number of individuals I think unanimously indicated that they looked to that guidance. Thank you for that work.

And your reference to the artificial diversity and defense security effort I think it gets fascinating. Honestly I couldn't begin to comprehend the ability to randomly change the way the grid looks, the way that our operations look to become more resilient and secure.

Last but not least for Chuck, thank you, thank you, thank you -- for years you have been holding the hands of states and regulators and providing this important institutional support so that industry can make that important business case. We can't get to the point of integrating this if industry can't do that so thank you for that.

I think it seemed like it took forever but we are finally there and now we have the energy zone enacting tools and quite frankly your work there brought together a number of diverse stakeholders who are connecting now in ways that we have never been before in the eastern interconnect, thank you.

I look forward to learning more about the finder model, I had not heard of that. That is finally that is the proper place speaking about the consumer because they are what this is all about so thank each of you for what you do and we look forward to working with you.

CHAIRMAN BAY: Thank you Colette and let me again thank our panelists for coming here today and for this wonderful presentation and with that this meeting is adjourned.

(Whereupon the meeting was adjourned at 11:43 a.m.)