

US EPA ARCHIVE DOCUMENT

**U.S. EPA State Climate and Energy Technical Forum  
The Electric System and the Benefits of Clean Energy**

**April 28, 2011  
2:00-3:30pm**

Denise Mulholland: Hi everyone this is Denise Mulholland EPA State and Climate Energy Program and I realize it's about 2:00 now and we're just going to give folks about another one or two more minutes until we have more folks on the line so please hang on.

Hi everyone again my name is Denise Mulholland and I am with EPA's State and Climate Energy Program and I'd like to welcome you all to the (tech) forum this month entitled The Electric System and Clean Energy. This is a first in a three part series on discussing the multiple benefits of clean energy.

As you know, reducing energy demand and increasing energy generation can lead to many benefits including increased electric system reliability, better environmental quality and human health, as well as cost savings and job creation. What we found working with states and locals over the years, though, is that not everyone is aware of the types of benefits clean energy can achieve or how to estimate them. As a result, EPA has created a resource, [\*Assessing the Multiple Benefits of Clean Energy\*](#), which provides an overview of the energy, environment, and economic benefits of clean energy and the various methods available to estimate them. You can learn more about this resource in our background documents on line.

To build upon this resource and to further increase understanding of the benefits of clean energy, we've also created this Webinar series. Today's Webinar is intended to serve as a primer, provide an overview of the electric system and how it operates, as well as describe how energy efficiency,

demand response and/or renewable energy programs and policies can affect and be beneficial to the system.

Our speakers today include Miles Keogh from NARUC, who will provide an overview of how the electricity grid works and how energy efficiency and renewable energy policies can improve grid security, diversity and reliability. We also have with us Dr. Paul Sotkiewicz from PJM Interconnection who will provide an introduction on how PJM coordinates the movement of electricity to 13 states through their expertise in power assistance operation, planning, and economics. And finally we have Brian Turner from the California Air Resources Board who will describe California's clean energy and climate-related policies and their effect on the grid as an illustration of how a state's actions can shape the electricity systems infrastructure and development.

I'd like to start off and thank all three of you up front for taking the time to be with us today and for putting together your presentations. We're really looking forward to hearing from you.

We do have materials online for today's call. You can see the Web link ([www.epatechforum.org](http://www.epatechforum.org)) at the bottom of the agenda on your screen. On that site you'll find all the presentations from the Webinar today. There are also two background documents. One provides an overview of the electric system and the other provides an overview of how clean energy initiatives benefit the electric system and where to go for more information about how to estimate those electric system benefits. You can go online afterwards and download those if you haven't already.

The next Webinar in this series is expected to occur in early June and is going to cover the emissions benefit of clean energy initiatives and how to estimate those. We will wrap up the series with a third Webinar that will discuss the economics of clean energy and how to estimate those. We haven't set the dates for them yet but we will send out a save-the-date note as soon as we do.

So, as the operator noted when you first joined everyone is muted right now so you won't have background noise. But when we do get to the Q&A, we'll talk about – for the folks who just joined - how you can ask questions and how

we can interact later on. So with that I'm going to hand the call over to our facilitator, Catherine Morris from the Keystone Center, and she's going to start it. Thanks.

Catherine Morris: Thanks Denise. Before I introduce our first speaker in a little bit more detail, I will give you a quick tutorial on how you can interact with them and ask them questions. Since we've muted the lines, your options are really to use your control bar at the right hand side of our screen and you'll see that there is a place where you can enter questions. We would like to ask you to use that as the – and direct your questions to a specific speaker if there is one or to all of them – make that clear.

And then at the end of each speaker's 15 minute presentation we'll take some time to at least answer the clarifying questions that have come in while they were talking. And then hopefully we'll have a fair amount of time at the end of all three speakers so we can get to more general discussion questions that you've sent in. As always, we never get to all the questions but we do include and the speakers have been kind enough to allow us to share their contact information so that you can follow up with them directly after this Webinar if you have some additional information you'd like to discuss with them.

So as Denise said we do have the documents, the presentation materials, the background documents posted. The second bullet here the [www.epatechforum.org](http://www.epatechforum.org) is I think where they are right now and there may be a little lag in getting them up to the EPA Website. So you can go to that link. We always get multiple questions about how do I get the documents while we're going on and I'll try to remind you again for those that are joining late. We have one small technical glitch with this call which is you'll hear – you're hearing the beeps of people entering and leaving which – usually we are – we have already set the call up so that you can't hear that unfortunately we changed our call in number so we'll just have to talk through that and get it fixed the next time around.

Next slide, as you heard when you came in we're being recorded so the recording will be made available on the same website in a couple weeks and typically we also post a transcript but that takes a little bit longer.

So again here is where you can submit your questions, this is what you should be seeing. This screen shot shows you what you should be seeing on your screen. Type it in and hit send to the organizers and we will get to them – to as many of them as we can.

So let me go ahead and introduce Miles Keogh. I think Miles with this call you officially qualify as a very frequent speaker for these tech forums, you've been on a couple of these and the reason is because Miles really is able to help us when we're talking about issues of the electricity system, particularly the role of the public utility, the state public utility regulators. So he is the Director of Grants & Research at the National Association of Regulatory Utility Commissioners, fondly known as NARUC. He is there serving as liaison between state commissions and many of the federal agencies including the U.S. Department of Energy, EPA, Department of Homeland Security, as well as the (National) Labs and industry.

He's written a slew of papers on just about every possible topic on the electricity system and he also provides training and facilitation services for the commissioners and commission staff on various issues. So he's incredibly well qualified. The reason we keep coming back to him is because he's also a great speaker and tells good jokes, so, Miles you're on.

Miles Keogh: Oh no that's a high bar you've set. I think Catharine the term you were searching for there is repeat offender. Folks today, I don't know if you can see my presentation is going to be titled An Insanely Succinct Summary of the Electricity System. I say insanely succinct because what we've got is a system that's a wonderful, enormous dance that brings together generation, delivery, customer end use, power plant transmission lines, light bulbs, all kinds of unbelievably complex operations that are balancing in real time and defying all kinds of laws of physics that would normally predict that the whole thing should collapse.

In total the electricity system is capitalized at just shy of a trillion dollars right now. So in 25 minutes, in 20 slides I'm going to try and summarize what's going on with that which works out by my math to about \$40 billion a minute

or \$50 billion a slide. Sadly I did not negotiate to be paid either by the slide or by the minute but we'll see if we can get through this pretty quick and of course I look forward to you questions at the tail end of this whole thing.

Just by way of explanation NARUC members are the state public service commissions that regulate investor owned utilities and gas, water, electricity, telecom, little bits and pieces of other things, insurance, banking, transportation and other things. And my department those folks and tries to help them find answers to questions that are facing them. Most important about this slide is my weasely disclaimer that I rarely even agree with myself so if I say anything that any of my commissioners disagree with it's certainly none of their positions, it's none of the NARUC organizational opinion and with that I'm giving myself license to operate with some colorful hyperbole.

Today I'd like to not put my summary at the end but at the beginning, this is what I'm going to be talking about, so after this slide you can all out on your fuzzy eye masks and your gentle soothing music and sleep through the rest of my presentation, if you already know something about the electricity system.

In summary I'm going to talk about where our electricity comes from, I'm going to talk about how the map of the United States looks really different if you look at it from a regulatory perspective, a market perspective or the engineering power system flows perspective. I'm going to talk briefly about how we choose when we run what power plants when, and I'm going to talk about briefly how we choose to build power plants and how we go about selecting what kind of resources we use. I'm going to talk a bunch about state program leadership and say some spicy stuff that's sure to provoke angry follow on emails from folks who disagree with me and then finally I'm going to end with a perfect segue that will dazzle you all, that will lead perfectly into the other speakers.

So for starters why do we bother thinking about new resources and about generation and demand side resources? It's because incorrigibly the citizens of the United States, the rate payers, you and I, are all using more electricity. Around 2010 we were using 4.2 trillion kilowatt hours of electricity and that's predicted to grow about 30 percent between now and 2030. The recession is

having an impact on that but we don't know exactly what that impact is and over the long term we think that electricity use is going to continue to grow.

So one of the things we're going to be talking about is how do we accomplish growth in electricity without accomplishing growth in air pollution and greenhouse gas emissions that we're trying to avoid.

Here are the energy resources in the United States where we are right now circa 2007. EIA has a hard time keeping up with additions to the power sector. The big change that's happened in this pie chart since 2007 is that little dark blue part that says 'other renewable 2.5 percent.' Back in 2007 we were looking at about 8500 megawatts of wind capacity installed, that's increased to about 40 gigawatts of wind capacity so it's more than quadrupled. So that other renewable piece of the pie has grown a little bit.

Everything else has stayed roughly the same and of course the pie continues to grow overall. We're a country that uses a lot of coal and going forward additions to the system, because of the way the coal operates which we'll get into in a sec(ond), coal will remain a resource that's really important to the electricity mix.

This slide shows how we've added resources. I'm going to use my little pointer so that you can see what I'm talking about here. These green guys here are coal units that we've added since 1950 and you can see that that's tapered off in the early 1990s. Nuclear units were added in the '70s and '80s that's also tapered off. Hydro units were especially added in the earlier part century. Oops pardon me we've gone a little further than I wanted to. The red units there are gas units. My experience at a commission was in Massachusetts citing gas power plants right in this area over here. And then these little black tips at the top over here are wind energy and as I said the wind energy installation has more than quadrupled since the last bar on this. So if you were to have bars that were added onto the end of this you'd see that wind energy installations have really picked up since 2007 and remain the – a large part of the transmission connection queues that we have now.



This is a great map which I stole from interestingly enough the NPR Website. Almost all slides are stolen the old (song) about originality just being the art of concealing your source, is definitely true for me, so I'm giving these guys credit now, this is from NPR.

This is a map that shows the power plants in the United States, the bigger the circle the bigger the power plant. You'll see down here in Arizona, the Palo Verde 4400 megawatt nuclear power plant. You see some big dams up here on the Columbia River, there's a mighty big power plant here in New Jersey, East Salem. There's plenty of big plants here along the Ohio River Valley and in the southern company large coal fire nuclear plants. A couple of decent sized nuclear and coal fire power plants here in Texas.

So what this map is intended to show is not only where the power plants are but equally importantly it shows pretty clearly where the load is. Load is people using electricity, about 80 percent of the load is in the eastern interconnection and the eastern half of the United States and generally speaking that's where a lot of the power plant capacity is as well.

So you can see that the transmission system here – that's the map that's up now - demonstrates that we don't always put power plants right on top of load but that the transmission system moves electricity from where it's generated to where it's used. The blue lines there are super ginormous, 765 (kilovolt) kv lines. Those are something that we don't use a ton of. More common are the yellow guys there in the TVA footprint and the green guys here that are 345 kv systems that are still connecting power plants that are distant from urban centers where load is to that load, Missouri over to Chicago and power lines running into greater Minneapolis, St Paul and the like. And the biggest ones there, the blue lines that are 765 kv lines and HVDC which are direct – direct current rather than AC alternating current lines that are used to move bulk power from places like Quebec down to New England and from the heartland around to load centres and the Mid-Atlantic and greater Chicago land.

Here are where our resources are in the United States, a lot of what you use to make electricity depends on what you've got and that's also a fairly big factor in what the price of electricity is for you. As you can see the United States



remains about 50 percent coal and here in the center and in the south east we have very large coal dominant systems, gas is used especially up in New England, the Upper Mid-Atlantic, New York, California and then places where there is a lot of gas, states like Texas, Louisiana and Oklahoma use a lot of gas as well.

Nuclear is a function of a build out that happened in the '80s and there about. Illinois remains a big nuclear user. Vermont for the time being remains a big nuclear user there, folks down in the south that use a decent amount of nuclear power and some of the proposals for new nuclear units that are coming forward seem to be moving forward best in the south and not moving forward as well in other parts of the country. There are a lot of reasons for that, some of which are obvious and some of which are difficult to explain but have mostly to do with cost, waste management issues and either perceptions or real questions about safety.

And then finally you'll see hydro on that map. The Pacific Northwest has a real healthy hydro mix. Hydropower is extremely cheap and so where they've got it they use it. There's also some decent hydro resources in New York and New England.

Those are not resources that tend to be picked up as new resources, the hydro resources nor the nuclear resources. The hydro because it's largely tapped out, the nuclear because it's very difficult and expensive to build a new nuclear plant. Coal is reaching increasingly difficult times as far as siting new sites are concerned and gas because of price volatility and other concerns isn't as appealing as you might hope it would be.

The next map is of where the renewable resources are in the United States. Like I said the wind resource is really growing purple on that map where we have wind, means good wind resource. So where you see a lot of purples is also where you've seen a lot of wind growth. Texas has the most wind, California has a decent amount, Minnesota, Iowa and the Dakotas are ramping up pretty quick and the New England states and New York are coming up pretty quick too largely driven by renewable portfolio standards which we'll just talk real quick about in a couple of slides.

Solar resources are in there - as you can see - where it looks like it's getting hotter and hotter, that's where it is getting hotter and hotter and there are good solar resources in the west. It's harder to find good solar resources especially for utility scale solar east of the Mississippi River. But that doesn't mean that states don't do it, states like New Jersey which has the second biggest installed capacity for solar move ahead even though they don't have world-class resources because they have good enough to get by and because it's a state policy preference.

Biomass and geothermal are also resources that the United States is blessed with and other countries around the world wish they had the resources that we do.

Let's talk a little bit about what the map of electricity looks like in terms of jurisdiction. There are two regular parties that regulate the electric sector in terms of its economics and in terms of its build out. So the feds - particularly the Federal Energy Regulatory Commission- and the states, particularly the State Public Utility Commissions but also the state energy offices, governors, state legislators. A lot of other folks have their hands in it too. But in terms of the build, out it's largely the Public Service Commissions.

Federal jurisdiction is largely over regional transmission organizations and interstate sales and sale for resale. State jurisdiction is over facility siting, facility choosing, long range planning, distribution of the electric system and on retail rates, which is the wellspring of almost all the money that comes up from rate payers to power plant builders and energy system operators. So the state role in this is pretty significant and if you look at the map here each of those states sets the rate terms and conditions of the distribution system and rates and in the states in white, they oversee utilities that remain vertically integrated. In other words the power companies own power plants, they own transmission lines and they own distribution systems in retail service to customers.

In the green states they've unbundled for the most part where they've either in part or in whole, broken up the electric utilities so that those - in those states

the power companies no longer own – the electric utilities no longer own their power plants, they buy it off of – they buy their power from market places for electricity. The power plants participate in those markets and the utilities purchase from those markets their power. So those are unbundled states and that happened in the late 1990s and early 2000s.

Where there are states in yellow on the map that are on the screen there this unbundling and restructuring was moving forward and then for a lot of reasons - largely having to do with a big smoking crater that happened with California's experiments with restructuring and unbundling - in those states it was either paused or actually rescinded.

So the map of jurisdiction over the United States kind of looks like a map of the United States, state lines and FERC has jurisdiction in most of it, except for not in Texas or Alaska or Hawaii.

Where things start to get a little messier is in terms of what the map looks like from a market place perspective. This is a map of regional transmission operators. These are multistate or in a couple of cases not multistate but they are transmission operator organizations that operate market places where power companies that have generators bid in to a market place to determine how to get the cheapest power. Utilities take their price of power from what's being served by those regional transmission organizations.

We're joined by a gentleman from the RTO that I'm actually physically located in, PJM, and he's going to speak next so I won't say anything bad about PJM because otherwise he'll give me a rolling blackout.

This is a brief intro to power dispatch and as I just said there's a guy who's coming on next who's actually going to talk more about how PJM operates its markets and how it operates its transmission system. So this is going to be sort of power dispatch for dummies and if you follow along – we're going to need my cursor to make this work. I had a heck of a time coming up with a power dispatch set of graphics that actually looks good but what we've got here is a curve that demonstrates what this regional transmission operator perceives as load on its system. If you see here at 2:00 AM load on my totally

hypothetical and invented demand curve here is at 2:00 AM about 3000 megawatts and then as it goes on though the night it goes up to about – by about 2:00 PM it peaks out at about 5600 megawatts and then as the day goes on it gets cooler and cooler and people are switching off their air conditioners and the like. By 10:00 PM it's down to about 4000 megawatts and then the next day we start all over again.

The way that this transmission operator who is in charge of dispatching power plants to provide power so that what is needed is actually available, what happens is it basically works like a Dutch auction on eBay. The transmission operator says OK, it's 6:00 AM and we need 3500 megawatts of power and so come all ye market participants, people with power plants, tell us what your price is to give us megawatts at this hour so that we can reach what we need here 3500 megawatts.

So if you see here on this side I have got what's called a bid stack at full capacity. These are all the power plants and how much it costs them to operate and participate in the market. So the first guys who come in a couple of wind farms they say because of the PTC and because we don't actually pay anybody for our fuel because its wind so its free, we can do it for a penny or two so they – they get into what's called the bid stack. They're going to end up being part of what makes up this 3500 megawatts worth of power here and so on and so forth. A big dam comes in and says 'I have my mortgages paid off - three cents', nuclear plant – '50 cents.' Coal unit one 'my fuel is pretty cheap, I've been around since the Eisenhower administration, two bucks.' Another coal unit, another unit et cetera until we get here to gas unit one at \$5 a megawatt hour is the cheapest unit that is bidding in to the market place and that would be sufficient for it to reach – for the RTO to reach it's requirement of 3500 megawatts.

So these guys here who are the most cost effective units to reach 3500 megawatts they get into something called the bid stack and the last guy who is the price setter this \$5 gas unit over here he's called the marginal unit. So that is a hugely oversimplified snapshot of an hourly market power dispatch and there are other markets, there's the hedge and spinning reserve markets and non-spinning reserve markets and all kinds of other things and there's nuances

between all these but I've over simplified it but that is the long and the short of how it works.

Let's see if I can get my next slide up here. Here is another picture of a bid stack. These guys are all coal and nuclear – I'm sorry these are all nuclear and hydro units that don't emit CO<sub>2</sub>. These are – in blue here are all coal units that do emit CO<sub>2</sub>. The red guys are natural gas, the yellow guys are oil and as you can see at \$100 a megawatt hour let's say that's what I need right now, these become the marginal units.

Adding renewable energy and renewable – other resources that bid in at zero, or adding efficiency, which shaves the peak but it shaves it from the bottom because it's cheaper than any bidding in resource, actually moves the dispatch price or moves which resource becomes the marginal unit in the bid stack. This is a complicated graph that it's going to take me like 100 hours to explain, so I'm not going to. But effectively what it does, I'm just going to summarize by saying this graph shows how adding a carbon price or adding environment compliance prices or adding zero cost to bid in to a resource market, resources shift what unit is the marginal unit and can thereby affect the emissions profile of the whole generating fleet.

So for my money all the other resources look pretty hard. Energy efficiency looks pretty good, it's expensive up front but you're saving money over the long run because you're not buying and paying for electricity or fuel or all those other things. It's very hard to stop in a siting proceeding because it's hard to say not in my back yard, it's hard to knock down with a hurricane, it's immune to international legal and other kinds of malfeasants. It doesn't hurt birds or bats or the environment, you don't have to store the waste in a long term repository and it's good looking and more popular every day.

So how do we get energy efficiency and renewable energy into the portfolio? For now the only programs that really matter on this are state programs. Renewable portfolio standards, energy efficiency resources standards, climate initiatives, incentives that promote these things, those basically all come from the states. The one exception being some of the tax incentives like the production tax credit that's helped motivate wind energy. But for the most

part the big programs that matter – that have really moved a lot energy efficiency and renewable energy into the market place have been these state programs. I've got maps here, who does decoupling, who does climate programs of which right now there's only one that's actively doing trading, RGGI (Regional Greenhouse Gas Initiative) in the North East, and states with system benefit funds.

Here are states that do renewable portfolio standards. I won't spend any time on this except for to say that if you really want renewable energy to be a part of your mix, one way you can do that is by passing a law that says renewable energy has to be a part of the mix. Right now there is only state leadership on this but boy I can't keep this map updated fast enough. Twenty nine states plus DC have an RPS and we may be at 30 any minute now so that keeps coming.

Another way you can do it is you can plan out your resources over a long period of time, a lot of states use something called integrated resource planning that builds scenarios of the future and then identifies resources that meet policy preferences at an affordable and a reliable way and the policy preference may be to have a renewable component to that. So a lot of states have been using resource planning as a tool to make sure that renewable resources are integrated. It's also a heck of a tool, one of the best out there, for integrating energy efficiency as a resource in your portfolio mix. And this map is actually wrong there's a couple of states that have added, including Connecticut, that have added IRP to their list of tools and even where IRP doesn't happen, portfolio management is a tool that is gaining ground to help integrate these tools, these resources, into the generating and energy resource mix in the United States.

So that was – I'm sorry about the forced march into through the electricity system. I basically left 99.9 percent of it out but hopefully that will give you a good introduction to power markets and to resource choices for our electricity system.

Catherine Morris: And I'm sure Paul will be happy to correct anything that – about the – interconnection in the system that he heard that he wanted to correct so we'll –

we have a couple of – we don't have any questions coming in right now I think you've stumped them with the amount of information you shared with them. So what I'd like to do is go ahead and move to Paul's presentation and introduce him and then maybe we'll come back to the questions as they come in.

So Dr. Paul Sotkiewicz is a chief economist in the market services division of PJM Interconnection and as was explained, PJM is an independent system operator over a pretty vast region and I note that Paul has a number of slides to explain what part of the country PJM covers and how their system works. He provides analysis and advice on PJMs market design and market performance including specifically demand response mechanism, scarcity pricing, intermittent and renewable resource integration, and also potential effects of climate change and other environmental policies. So, as Denise explained earlier, he's going to talk specifically about the role of demand response and demand side resources and their impact on the system dispatch and how that – and give you a little bit more of a tutorial on how that system works. So Paul we'll turn it over to you.

Paul Sotkiewicz: Thank you and good afternoon everybody. I appreciate the invitation to come and speak on the Webinar to you all today. I will try to make this not as complicated as it can get sometimes. I don't have anything to actually correct from Miles, I actually liked the presentation. It was a nice very crisp way of moving through the overview of the electricity sector. But if I go into – by the way I'm hoping that everybody can see my screen here without any problem, my apologies I can't get it to go to full screen I've got some bells and whistles on my monitors in my office here that don't allow me to actually do that.

Just to give folks an overview for those of you who are not familiar with PJM, we are the largest centrally dispatched power system in the world as well the largest electricity market in the world. Our territory covers all the parts of 13 states in the District of Columbia so essentially from the Mississippi River in Northern Illinois all the way to the Jersey Shore and to the Northern outer banks of North Carolina; quite a large part of the United States.



We've got over 600 companies an all time peak low of about 145,000 megawatts and 100 – almost 170,000 megawatts of generating capacity et cetera, a large system. But one of the things that we've encountered over the years is that – is this need for additional capacity resources and one of the way we've been able to do this is through demand resources or demand response and so primarily as we have began looking at demand response. Demand response has been an avenue by which we could help meet our resource adequacy requirements and help maintain reliability first and foremost.

So if we think about what demand response really is, think about it from the point of view as individual customer. It's a way of trying to manage your total electricity bill by either reducing consumption in certain high priced hours or shifting your consumption from high priced periods to low priced periods, depending on what kind of retail rate structure you're under.

I have a sub bullet here, I had another slide that I sent to the link but if you think about the price of gasoline today, I mean we're fast approaching \$4 plus again per gallon again like we did back in 2008 and people decided to drive less. Well demand response of electricity is very much the same way in the sense that if prices go up and you're actually seeing those prices in your bill you're probably going to consume less.

Conversely as you see prices for electricity fall, you might actually want to consume more. From a reliability perspective, however, demand response is committing to making reduction during system peaks so that we can maintain reliability. Generally speaking if you think about this on your retail bill, you're making that commitment to reduce consumption in exchange for some of payment or rebate on your electric bill.

While in PJM and the wholesale market it's very similar in that customers are receiving a payment for essentially providing capacity services to the entire wholesale power grid.

In some sense what we are doing is providing a substitute for infrastructure. So rather than actually building and putting new steel in the ground with coal

fired generator or a gas fired plant, you're just committing to reduce your consumption so we don't need to bill back next unit.

Now from an operational perspective ... from PJMs perspective at the wholesale level, we're seeing this as consumers changing their consumption in response to price. We see this in our dispatch operations, we try to account for it to some extent in our forecast methodologies getting close to real time, although there is still a lot of work that needs to be done in that area.

Of course, reducing that consumption at peak that's really the big reliability value and I've got some statistics on how that's evolved over time in recent years. However from a utility perspective getting down from PJM's wholesale perspective down to the utility level or load serving entity level, they are looking at this as a way of helping to hedge energy prices. So if you're a competitive load serving entity in a place like New Jersey for example, if you could set up a rate design to get customers to shift their consumption from high priced periods to low priced periods, that allows you to go out and purchase power in advance for your competitive retail customers and to do so at a much lower cost than would otherwise be the case.

Now if we think about what the demand response opportunities are in the PJM market context. Our demand response or demand resources - just end use customers if you wish - can participate in the energy market. And in the energy market it's really customers reducing their consumption in response to wholesale prices. We have approximately 2,500 megawatts to date of demand resources that could participate in the energy markets.

In the energy markets these reductions are compensated to prevailing wholesale market price which in PJM is based on location to account for congestion and marginal losses less the retail rate. And the reason the retail rate is deducted is because at the retail level when a customer decides not to consume energy, there is actually no billing for that energy.

And consequently there is no sale for resale, if you wish, as Miles was talking about in his presentation. And this way, to make load serving entities whole so that they are indifferent between demand responses or not having demand

response, we want to deduct that retail rate that way the load serving entity is no worse off in terms of the monies that is collected and that way it doesn't provide a disincentive for that load serving entity or anybody else to engage in demand response or from a retail perspective.

The thing about demand response like anything in PJM's market is that it's voluntary. There is no requirement that anybody who is even registered to provide demand response in the energy market actually must do so. They can do so when they so chose, it's purely voluntary.

In contrast though if we look at the capacity market which is just the commitment to reduce consumption during peak periods or emergencies to maintain reliability, there actually is a requirement for customers once they've made that commitment and once they're called upon by PJM to reduce their consumption, there is an obligation for them to do so. And in exchange for that obligation to reduce consumption, they're receiving the payment that I talked about before.

Now in the energy market, what's the incentive to reduce consumption? Think about the retail rate here which is in red and I'm highlighting it here with my cursor. In PJM we call this the generation transmission portion of the retail rate for – in our tariff. But if we look at that price level, let's say that it's close to \$0.09 a kilowatt hour, \$90 a megawatt hour.

In the wholesale market when energy prices are less than that, there is really not much incentive for customers to reduce their consumption because there is very little money they can get out of it. They would – let's say an hour ending 11 – get paid the wholesale price which is \$75, but then subtracting off the retail rate, there is no money in it for them.

And so we want customers to really reduce and shave the peak when prices are high so that say in hour ending 19 on this graphic when prices are over \$300 a megawatt hour, they reduce consumption and then they can actually make money doing that because the difference between the wholesale price and the retail rate is slightly over \$200 a megawatt hour.

So there are incentives in place to respond to wholesale prices when we want customers to do so to reduce system peaks.

As I mentioned before, here is the trend in total registered megawatts in our economic load response program or economic program for demand response. You'll see these slight dips in May and June of each year. This is an artifact of every year customers have to re-register per the terms and conditions in the PJM tariff and market rules and often times people forget to register so we get these huge drop offs in May and June and then they realize 'oh I need to register' and they bounce back up again. And so that's why we see these occasional dips.

We have fallen off from the highs that we saw of over 3,000 megawatts registered in the economic program. That's in large measure due to the fall in energy prices starting at the end of 2008 and continuing through the recession. As I am showing here in the next slide, the amount of demand response activity became quite large in 2007 and going into 2008.

And let's think about what's happening in 2007 and 2008. During that time period we saw natural gas prices rise to well over at times, well over \$10 per million BTUs (British Thermal Units). We saw wholesale market prices in energy max out at over \$100 a megawatt hour on average in June of 2008 which also coincided by the way with the last time we saw \$100 barrel oil.

Consequently there is a great incentive for the demand side to respond to those crises as you can see here in red, number of megawatt hours. In green are the payments that were made to demand response during those various months. Now two things have happened in our program since December of 2008. One is energy prices have essentially tanked as I mentioned.

But there are also some tariff changes that went into effect that also affected some of the incentives to respond to prices. Previously PJM was paying what is often termed full LMP which is essentially a payment to customers and not only the wholesale market but also they're able to capture the saving from not consuming energy at the retail level and that provided an extra incentive to respond to prices.

That policy sunsetted at the end of 2007. And so once energy prices fell after when the recession really started ramping up in 2008, we haven't seen that kind of demand response. We've also had different changes to our measurement and verification protocols which has clamped down on gaming behavior that we were seeing in the energy market from demand side resources.

And so consequently you're seeing that fall off here in this graphic. We do see in 2010 a slight uptick in demand response in the energy market. We had a pretty hot summer this year. In fact in PJM, we set new records for total energy consumed in June and July of 2010 compared to any other June and July on record. In spite of the economy recovering slowly, weather drove those results.

In the capacity markets what we have seen is really, it's almost explosive growth in demand side resources. Where we both have demand response and now we allow energy efficiency to compete as a capacity resource.

So this is really where the money is as we'll see in a moment. So going back to 2006 before we implemented our current capacity market construct which is known as RPM or the Reliability Pricing Model.

We had approximately 1000 megawatts of demand side resources in the PJM footprint. So if you think about 1000 megawatts of DR capacity resources relative to the all time system peak of 145,000 megawatts, that's less than 1 percent of our total system capacity is demand side resources.

Ramping up now to the 2013 -2014 delivery year in PJM, we are going to have, we've had made available to us over 14,000 megawatts of demand side resources. Now not all of these have actually cleared in our capacity market but they have been made available. What this, this is equivalent to upwards of 10 percent of our all time system peak now, getting close to that. So you can see this just explosive growth in demand side resources to help us maintain reliability of the demand resources in the capacity market also allow for generation resources who are making decisions about whether they are going to continue forward in the face of lower gas prices or environmental

regulation to have some option value to wait to make decisions about the retirement or maybe to go ahead and retire.

The same is also true for new generation resources because demand response is there, new generation resources have, are given time to wait and pull the trigger on their investment decisions until it really looks like there can be profitable to do so. That's especially true with natural gas units, so demand resources have played a vital role in filling a gap and need for maintaining resource adequacy. Of course as I mentioned this is where the money is, in 2010 our settlements for almost all the demand response settlements are in the capacity market.

Very little is being done in the energy market, in fact I would argue that in terms of just in normal energy market operation, the amount of revenue that flows to demand resources is even less than in synchronized reserves, which is an ancillary service the PJM provides. Which gives gets me to some of the other opportunities via synchronized reserves. For those who may not know it is a service that's provided either by generation or by the demand side that says it'll commit reduced load in response to a system emergency or contingency. And that contingency could be the loss of a large generator, it could be the loss of a transmission line, it could be something else that causes a deviation from our area control error which measures how much we are interchanging with other control areas such as the Midwest ISO, the New York ISO or our neighbors from the south in the Carolinas.

When a contingency occurs, PJM sends out an on call to all the resources, both demand resources and generation resources and they need to respond to that. And we have found that in general, demand resources response, just as well as generation resources to the synchronized reserve event. So they do help us maintain reliability, as it turns out right now there is a cap on the amount of participation from the demand side in this market, at 25 percent of the total reserve requirements. It was sort of, just to be honest, an artificial distinction just to ensure that we didn't have too much in the way of demand resources at a period of time where we weren't sure that they would respond. It's something that we are looking to increase the availability of those resources to provide those reserves.

I won't mention regulation too much except to say that demand resources are eligible to provide frequency response. We, to date, have not yet had a demand resource to provide that service in PJM. To see how the participation in synchronized reserves and the kind of money that's flowing into the demand resources, you can see that in contrast to the energy market, participation in synchronized reserves has actually increased over time, as well as the kind of money that been paid out on average in each year. This is becoming a more and more lucrative market for demand resources given the low energy prices.

Now to conclude the presentation, let's think about, often times we get approached by environmental groups asking 'well gee, if we see reductions in demands especially during system peak, what kind of emission reductions are we seeing thanks to demand response?' Well PJM also has a subsidiary that has a generation attributes tracking system, or GAT system, where we have all of the generation output from all of the units on our system. We know what the emissions rate from those units are and we can actually track the emissions rates of units when they are running, at least to an approximation, and we can actually provide at least some sort of approximation as to how much in the way of emissions would have been reduced had we either had a renewable resource or zero emissions resource, such as nuclear, come on to the system to displace fossil units and possibly even demand response.

And so we've been able to calculate an average CO<sub>2</sub> emissions rate from marginal units. As Miles mentioned in his presentation, those are the units that are the last things dispatched on the system at any point in time and then also the average emissions rate for the entire fleet.

Now one thing to keep in mind if we are talking about demand response, the nature of the demand response matters a great deal with respect to emissions reduction. So for example if we are talking about demand response that is using an in-home energy management system that could automatically curtail usage of hot water in hot water heaters, air conditioners, et cetera, that can have a large impact on emissions. However demand response in the form of an industrial customer which takes itself off the system and fires up a back-up



diesel generator has a very different emissions profile overall, in fact may actually make emissions worse, not better on the system. So these rates assume that it would be the kind of demand response per se that doesn't actually use a backup generator.

So we can see over time over the last five six years that the average CO2 emissions rates and the marginal carbon dioxide emissions rate have actually fallen over time. Now this is an artifact of two things. One is that units are actually operating a little bit more efficiently over time because of the incentives of the wholesale market place.

We are also seeing an increase in renewable energy on our system. That's helping reduce at least the average CO2 emissions rates. And we are also seeing a lot more natural gas fired generation on the margin and the emissions rates of natural gas units for CO2 are approximately half of their combined cycle units, half of that of a coal unit.

And so we are seeing this slight decline in this marginal and average emissions rates. What this would mean on this slide is that in 2010, at the end of the year, that if we had demand response at the end of the year, one megawatt it would displace a fossil fired unit that on average emits just under one ton of CO2. So that's what this is telling us, so if you look at any other point in time, if I took a look in the summer of 2010 in July when we saw the average emissions rate spike slightly, the marginal emissions rate both on peak and off peak are slightly higher. Again demand response during the summer periods would displace on peak approximately one ton of carbon dioxide or almost 2000 pounds.

And here's a table if you wanted to actually look at that data in tabular format it's the same data that I just used in the graphics to show what the marginal emissions rate and average emissions rate are by a month in PJM. And here is disclaimer but this is not a weasely disclaimer. We want make sure that no one is using the CO2 emissions rate information to make any bets in any markets or to make any claims where they can come back to PJM and say well you were wrong, I made a claim to a group to create offsets from my

CO2 emissions. This is for informational purposes only and we can go forward with that.

All right, I have concluded and I look forward to any questions.

Catherine Morris: Thanks a lot Paul, I'm wondering if you could move back to slide nine, there's a question on slide nine, in terms of getting a better understanding of the distinction between the term that you used to write your presentation on demand resources and demand-side resources that you are showing on that slide.

Paul Sotkiewicz: They are used interchangeably. Demand side – some people refer to them as demand side resources, our tariff language specifically calls them demand resources, but they're the same thing.

Catherine Morris: Well I guess maybe I misspoke, the difference between demand resources versus demand response?

Paul Sotkiewicz: It would be the same thing in this context.

Catherine Morris: It's still the same, all right. There were a number of question both for you and Miles on the issue of how the bidding systems works. One of the questions is whether or not all the generators who bid into your systems at an ISO level received the clearing price? Did they all get that same clearing price as their payment?

Paul Sotkiewicz: Yes they do. If you think about a system in which there is no congestion or marginal losses, everybody will receive see the same price across the entire system. In an RTO like PJM very similarly in ISO New England or New York or the Midwest ISO, we use something called Location Marginal Pricing which distinguishes by location the marginal cost of delivering one more megawatt of energy to any point on the system.

So depending on where you are at on the system the prices, will differ by location to account for transmission congestion and to account for marginal losses and moving power from one place to another.

Catherine Morris: OK, thanks, a related...

Miles Keogh: That's true. Catherine its Miles, I'm sorry to interrupt. That's true for states where there are RTOs. And RTOs the simple answer is If the marginal unit, is a \$5 unit and I'm a \$1 coal guy and I have made it into the bid stuck, I'll still get paid the marginal price. That \$4 differential will go into paying off the mortgage on my power plant or return to shareholders or rate payer benefits et cetera.

In states where there is still vertical integration and where there – it's very hard to find a place where this statement is true but just for the purposes of explaining it where there are no merchant providers of power. The merit order dispatch of power plants says that the cheapest guys get in and are paid the cost to their operation.

Like let's say I'm a vertically integrated utility. If I've got a \$1 unit and \$5 unit, I'm not going to pay myself \$5 to run my \$1 unit. I'm the guy who is owning the power plant, who's operating the transmission system and who's operating the retail end of the business. So in that context, in a non-organized market, in a vertically integrated setting without merchant competition, then each participant in the bid stuck would then get paid. It's not a bid stack, it's just a dispatch order and so the cost of operation is the cost of operation. So a \$1 unit would effectively through rates get paid back \$1 and not 5.

Catherine Morris: And I think you might have been getting to this answer as well Miles. This is a related question about bidding system. In some situations, particularly with renewables, you will have purchase power agreements between parties and how does that affect the bidding system and is there a distinction between somebody under purchase power agreement and somebody who is a merchant renewable generator?

Miles Keogh: That's a great question. Yes, that's a really good question. Most renewables in the – I don't know if it's most but renewables, for example the big scale utility wind units, do not tend to operate for the most part in the hour ahead or spot markets just because it's sort of hard to tell exactly due to intermittency, if you're going have the fuel to run.

Because like the wind may not be blowing in five minutes and you may bid in and say look I can give it to you a penny of megawatt hour and then the wind is not blowing and then you've made commitment that you can't back up. So a lot of renewable resources at utility scale enter into the market through purchase power agreements. Those purchase power agreements don't tend to be with transmission operators or system operators. They tend to be with the utilities themselves so that would be one piece of the utilities' energy portfolio, some of their energy in that portfolio would be energy that they're buying off of the spot market, the hour ahead market, the day ahead market.

Some of it would be energy that they wouldn't be buying from the RTO system entirely. They would have it in the bank, as it were, through a power purchase agreement that they'd already have. And there is still a transaction that comes into play there where they're actually paying for the movement of the kilowatt hours there but for the most part those are a different piece of a utility's energy portfolio than what they are buying in the spot markets and other markets that are operated by the RTOs. Is that more or less, that's a too simple answer but it's fundamentally a correct answer.

Catherine Morris: You want to add anything Paul?

Paul Sotkiewicz: No, I mean that's spot on, that's fine.

Catherine Morris: OK. Miles – just a clarification question for you. The electrical consumption growth chart that was in your presentation, do you know what assumptions were build into that about the use of electric power vehicles and recharging?

Miles Keogh: I totally don't, I stole that from EPRI (Electric Power Research Institute). Again originality is only the art of concealing your source. EPRI has fantastic assumptions that go into all their modeling. They actually have two models called Prism and Merge that predict all the resources that are available to help us reach ginormous carbon reductions and the like and this was part of their introductory piece to that I had to stole it from EPRI or EEI and I know that both of those guys bring a lot of geek horsepower to their assumptions underlying.

I do not believe that the 30 percent increase accounts for major dramatic conversion of the transportation system to electro mobility. I think it assumes a penetration rate that's pretty reasonable/conservative/not breaking anybody's neck with the speed of transformation there. But does assume something about it but I wish I knew the details of it. It's a stolen slide.

Catherine Morris: OK. One more question for you Paul before we go to our next speaker, can you explain a little bit about how the reliability of solar wind on – I'm assuming this is going to be intermittency question, how that is handled within a demand response market?

Paul Sotkiewicz: OK, well, solar and wind are treated like any other – are treated similarly to generation resources. So it's how they would be treated within the energy market or in the capacity market for resource adequacy. In the energy market, those resources would have the option of either choosing to be dispatched by PJM by price, putting in an offer or they could chose to self schedule their output which is more generally the case.

Because with wind and solar you don't know when you're going to have that resource and so if you make a commitment to be dispatched and you can't do so there are deviation penalties for not following dispatch. So often times these resources will just self schedule anyway.

In the capacity market though, wind and solar can't necessarily provide their name plate value of capacity for resource adequacy purposes. For example what we have found with wind in PJM is that on average during the peak hours on hot summer days, wind generally operates at a 13 percent capacity factor. That is, if you had a 1 megawatt wind turbine, on average you would expect the output of that wind turbine to be 130 kilowatts of energy or 0.13 megawatts of energy, equivalently.

And so it has a capacity value for resource adequacy purposes of only 13 percent of its name plate. The same is also true for solar photovoltaic, they receive a capacity value of 38 percent of their name plate capacity. Again, because on average during hot summer days, during peak periods they can

only produce about 38 percent of their name plate capacity output during those hours. And so we have to make sure that they can respond.

Demand resources in name also have what we call a DR factor, which is how much do they really respond when called upon during emergencies when they're actually needed to provide that resource. As a practical matter, that number is either one or very close to one for all resources.

Because as we have started testing them out, they actually test out at their committee capacity usually plus some. They can actually overproduce, if you wish, when we call on them for their capacity test. So the performance of demand resources vis-à-vis renewable resources as a capacity resource for reliability is actually much better because they're somewhat controllable, they've tested out much better.

Catherin Morris: Thanks very much. There was a number of other question but I want to move on and introduce Brian Turner. As Denise mentioned he is the Assisting Executive Officer for Federal Climate Policy at the California Air Resources Board but he has a second title, he is also the Deputy Director of the Governor Edmond Brown's office in Washington DC. So one of the reasons we've asked him to speak today is to talk a little bit about how specific California policies have an impact on their system and in his role with the California Air Resources Board he is also a liaison between that office, that agency and other state California state agencies, federal agencies, Congress and he focuses particularly on climate change and clean energy policy, so Brian will I think, Eilleen is going to move your slides forward for you.

Brian Turner: OK, can you all see my slides?

Catherine Morris: Not yet.

Brian Turner: OK, because I can't.

Miles Keogh: Any questions for Brian?

Paul Sotkiewicz: Some reason he still has me as the presenter on here and I don't know you want me to hit stop showing my screen?

Catherine Morris: Yes. I think Eileen can take those controls back from you. I'm not sure what the difficulty is.

Brian Turner: OK.

Catherine Morris: Why don't we, why don't we go back to a couple of questions and I will give Eileen a chance to, I know they were having some problem trying to get rid of the beeping and that might have caused some override issues but if need be, I think I can show your presentation on your behalf.

Brian Turner: Oh yes please.

Catherine Morris: Looks like they may have had an internet interference problem because I see that the network connection just been reestablished. All right, let me see if I can take over the controls here. My apologies for the delay, and while I'm doing that maybe I can ask one more question and have Paul and Miles if you'll just get back to this. One of the questions was whether or not NARUC has any resources that has actually has all this in writing, some of the issues that you covered in your presentation.

Miles Keogh: As far as an introduction to the electricity system in markets, that I'm going to answer that question by saying boy it would be great if there was such a resource. When Denise asked me to summarize the electricity system in 25 minutes we, she and I had a good laugh for about 25 minutes and then I said, I'm game I will try it, so it's a fairly difficult enterprise to try and summarize that. And like I said, I left 99 percent of the electricity system and how it works and what makes it work on the cutting room floor. So the short answer is no, NARUC does not have a brief introduction to the electricity system. The much cooler answer that I wish I was able to produce a little better for you is we do run a number of trainings for new commissioners, for new staff. I'm always game for trotting on out to wherever you want me to go and making a fool of myself presenting the stuff.

There is also some really good resources available - from the National Regulatory Research Institute, from the Regulatory Assistance Project, from the Edison Electric Institute - that summarize a lot of this stuff in less, maybe



less insanely succinct ways than that. But for the most part we try to do this through training rather than through the written word because otherwise the details and the nuance it's just too hard to figure out which of the 99 percent that you've left on the floor is actually the key piece for people to understand.

Denise Mulholland: Catherine this is Denise Mulholland if I can just interject, excuse me for a second but I do want to direct folks - We have background documents on the Web site. One is an overview of the U.S. electric system; (it) gives a bit of a primer. In the other resource (posted) you can find out more about - in the second background document - about assessing the multiple benefits of clean energy. There are two chapters: one on electricity benefits, and one on environmental benefits - chapters three and four in the guide - that also have explanations of the electricity system and how it operates. So I encourage folks to check those out.

Catherine Morris: Hey I hope you are seeing Brian's slides now.

Male: Yes.

Catherine Morris: OK, now we move on to the first one.

Brian Turner: Well thanks everybody and thanks for having me on here and just as Miles presentation was insanely succinct given that California is the, I think the world eighth largest economy now and largest state, and one of the largest electricity systems in the country, this will be an insanely simplified and limited selection of California's energy policies. But I hope to give you a brief overview of the six policy areas that I've outlined here. It will set up the kinds of impacts on electricity system and the environmental benefits we expect from that this series, I think, will be getting, this Webinar series will be getting more into later.

So if you can flip to the next slide, I wanted to mention one of the foundational policies of California's energy efficiency success, I think I can call it is based on known as decoupling and many of our states used decoupling of electricity and or gas markets and have for a long time. In California it's been since 1982, with a brief hiatus during our little experimentation with deregulation in the late 90s but we are now back to it, a

decoupled market and thus basically simplifying the policy dramatically: the PUC-regulated investor-owned utilities, their return on their investment is not connected to sales. This ends the rather counterproductive - from a social point of view - effort to increase sales by utilities and replaces it with a guaranteed return and incentives to reduce energy use. That's what I referenced, decoupling plus they, not only can earn a return on their efficiency investments but there are actually incentives for greater performance in their energy efficiency investments.

Now there has been, you'll sometimes hear criticism of decoupling programs as that the utilities will gain from private conservation efforts, this was one of the talking points during energy legislation in the 2009 Congress. And I think that's largely untrue, certainly in California we go to great lengths to try to try to separate out the efforts of the investor own utilities that are due to their investments, the efficiency gains from those that are, would have happened naturally, happened because of the price response of consumers, and other things that are, that should benefit consumers. We separate out what the utilities are truly responsible for.

So talking about California's loading order, this is been in place since 2003 again it has to do with the publicly, public utilities commission regulated utilities and their obligation to serve. We go through a long term plan, a procurement planning process every, well it's based on a three year procurement planning cycle and when the utilities come forward to say how they are going to meet the electricity load, they must do so based upon this order of preference. First they must use all cost effective energy efficiency and conservation that they can.

Second they must identify all and utilize all cost effective demand response options that they can. Third renewable resources and distributed clean generation sources. And then lastly only after all those other cost effective sources of meeting demand have been utilized do they meet demand through conventional generation. So that is, I would characterize it as the second foundational policy in California. I'll also mention this is before any mandates for say, renewable resources or energy efficiency which are in addition to this basic cost effectiveness obligation on the utilities. Next slide please.

So energy efficiency is the first resource in our loading order. That graph to the upper left there, sorry it's a little inelegant, but versions of this graph have made the rounds for years and years due to the great energy commissioner and guru – energy efficiency guru Art Rosenfeld. This is the Rosenfeld effect. You'll see the red line there represents U.S. average per capita electricity use and the green line represents California. The blue line there is a little innovation to the graph showing what Western Europe has been up to lately over the past couple of decades.

But what the graph shows is that largely due to California policies begun in the early 1970s, the per capita electricity use for California consumers has remained about level while U.S. energy intensity has risen. This is as we have developed ever larger televisions and refrigerators and video games and what else have you that utilizes electricity. In California we've instituted some energy efficiency policies that have kept that from meaning that each person's electricity use goes up.

You will notice some differences between the two in the early years already so that does include some differences in climate and other kinds of basic differences from California and other states. But then the increasing divergence over time is largely due to policy. So I would cite part of that as the third foundational part of California's energy policy which is what we call the 'market transformation energy efficiency policies' including building and appliance standard. California was one of the first places to implement appliance standards such as – a great example is refrigerators, we adopted the first standard for frost free refrigerators back in 1976. Today we use about a quarter for the same refrigerator services that you would have received in 1976. We receive about – we use about a quarter of the electricity to achieve the same purpose.

So we constantly update those appliance and building standards. There are national appliance standards at this time but there are still some states without building standards at all. And that's really going to have a tremendous effect over the long term on both the energy use but also the comfort and the expense of our residents.

The second graph there shows just some of the savings that we've achieved in total electricity use. It shows that we would have needed 50 percent more energy today if some of those policies hadn't been place. We estimate that today every year we're saving about 12,000 megawatts of electricity needs, the size of 24 large power plants at least in California larger power plant comes to 500 megawatts.

Next slide please. So this slide details our latest energy efficiently plan. The Public Utilities Commission, again, comes up with a strategic plan that guides the energy efficiency investments of the publicly owned – sorry the investor owned utilities over a three year period. And this latest strategic plan is really quite a piece of work and I recommend it to anyone to check out. It's available through the Public Utilities Commission.

It's – comprehensive is really the best word to describe it. It not only looks at all economic sectors and evaluates what kind of energy efficiency potential is there, it also looks at how you do market transformation in a really comprehensive and holistic way of looking at heating, ventilation and air conditioning, the codes and standards, getting into workforce training, how you do marketing to consumers and businesses and industry and farmers and ranchers about energy efficiency.

Research over the long-term, reaching out to local governments that can be such a large energy user. We are looking at \$3 billion invested over three years, \$1 billion a year, large new jobs potential with all that investment, the 15 to 18,000 new jobs potential that we've identified using the ARRA jobs calculator and, looking at just this three year saving potential, 7,000 giga watts hour, roughly equivalent to 15,000 megawatts of capacity and 3 million tons of CO2. So (that's) a major part of our goals here.

Next slide. So our last presentation talked a lot about demand response. This repeats some of that rationale behind it. California has long had some of the industry oriented large commercial users demand response programs where they have voluntary agreements to shut down their demand. We are increasingly moving into smaller users. We've got now aggregators of

demand response. We are instituting dynamic pricing over the next couple of years, mandatory for industrial and commercial users and a voluntary or it will be a default dynamic pricing model for residential users with some opt out and other protections worked in.

But this is where users will start to see real time pricing of electricity so that they can make rational economic decisions about when to run the dishwasher in residential cases and in industry it's much broader and more consequential decisions they make about just what time of day they perform activities so that we can just shave off those peaks that are most costly, most inefficient and most environmentally impactful to run.

In California at least a lot of – I believe across the country a lot of the peaker plants that we have are relatively inefficient, relatively dirty and often times located in areas that already highly impacted by criteria air pollutants and perhaps low income and other social and economic problems. So shaving off that demand for those resources can generate sizable benefits.

Next slide. This one gets into where we're headed towards. This slide by the way thanks to PG&E, one of our utilities. It looks at integrated demand side response. It doesn't – you don't see any kind of fancy pictures there for the basic energy efficiency programs we run with looking at the housing or agriculture or industry demand but you do see the smart meters which combined with dynamic pricing to allow this kind of smart response by consumers of energy and especially as we have smarter appliances that can say, turn themselves on and off in response to what they're learning from the advanced meters and some better software for consumers to manage their energy demand.

We are also looking at distributed generation and I'll talk about that where you're putting solar or other kinds of clean generation sources near consumption and local storage. And the electric vehicles we touched on that briefly, we expect that to be a major source of demand in the future. We are already looking at how we integrate that in a demand side management scenario where they are smart chargers themselves, so you're charging your vehicle at 2:00 AM or something where it's going to be cheapest for

everybody concerned and potentially in the long term, could be a storage option where the grid is able to draw some of that power back at peak times.

I'm going to skip over some things in the interest of time. So let's move on to the next slide. And I'm just wanted to mention our renewable electricity standard. You're missing my great pictures of Governor Brown signing the Bill that he just signed two weeks ago. Secretary Chu came out to join him where we raised our renewable electricity standard to 33 percent from what had been 20 percent, one of the highest in the country.

Those are by the end of that year so by the end of 2013 we should hit 20 percent, 25 by the end of 2016 and 33 percent by the end of 2020. The new law will apply to both our investor owned utilities, publicly owned utilities, energy service companies, community choice aggregators, all electricity load serving entities in the states.

We do have some restrictions on where that power is generated which I mention especially to talk about the kind of environmental benefits because we are requiring that by 2020 at least 75 percent of that renewable power is sourced in state, meaning that any of the power that it is displacing – the dirtier power that it is displacing will keep those environmental benefits in California.

No more than 10 percent tradable renewable energy credits, the RECs, means that those are the far flung resources in other parts of the country that we don't necessarily get the direct criteria pollutant benefits from.

And let's just skip to my last slide here – oh, I did want to mention that we're having tremendous development of renewables in California, I had a quote there that said that there are many benefits, that it's not just the greenhouse gas benefits, criteria pollutants, but also jobs, local community development, technology development, that we're all very excited about and we've seen a tremendous response to the signal created by an RES.

Last year in 2010 we permitted over 5,000 megawatts of new large scale solar and wind. And in 2011, we expect about the same amount, another 5,000 megawatts, which is a tremendous response especially in some of these

hundred, 200, 300 megawatt-solar projects, these are all – each one as they come online will be the largest solar project in the world, it's just a tremendous growth in the renewables.

We expect that we'll need about 20,000 megawatts to reach 33 percent, so I just named 10,000 megawatts, we're working on 8,000 megawatts of distributed generation, so we're very close to that 33 percent in the next few years. So when Governor Brown signed the 33 percent, he said that we should start work right away on a 40 percent RES soon after. So we're kind of setting a fast pace there but we're seeing tremendous response by industry and consumers to meet it.

And that pace of renewables will outpace load growth, so we'll see a definite phasing down of the conventional generation, both getting out of our coal contracts where we import coal from Arizona and Nevada and even the gas plants in California.

So here is a picture of – oh, and we've lost some of the details of this picture. This here just looks very basic, it did include some of the smart grid features both in distribution and transmission which allow more efficient use of available resources, some of the storage options that we're looking at and distributed generation which allows you to use the renewables better and phase out the – what's called base load generation, some of which is on the much dirtier side.

And then the smart homes including electric vehicles, including smart grid that is able to manage its electricity demand in a way that works with cleaner generation.

So next slide, that's my very quick – oh, oh look, here's all those pieces I was talking about. Yes. And so the-

Catherine Morris: Sorry, I-

Brian Turner: The lines there represent the smart grid of transmission and distribution and you're seeing the distributed generation storage and electric vehicles on the consumer side. So that was what I wanted to talk about.



And that's it, sorry for the whirlwind tour of California policy, but let's talk about it.

Catherine Morris: Well if I have to make a transition back to looking at our questions, I'm wondering if Denise, if you see some questions that came in while Brian was talking that you could field for him.

Denise Mulholland: Thanks Catherine, let's see, I have – I just have a question on how are consumers accepting smart grid technology into their homes, or how do you expect them to accept it or receive it moving forward, Brian?

Brian Turner: Yes, that's a fantastic question because we've certainly had issues – we're experiencing these issues, it's been a very hot issue.

So we had one instance where we deployed smart meters in a community at the same time as we had rate hikes that were totally unrelated to the smart meters and at the same time that we had an exceptionally hot summer. So everybody experienced these big jumps in their bills which started a public narrative that smart meters allow the utilities then to manipulate their bills and result in higher prices through some kind of fraud – computer hackery by the utilities.

So we have investigated that incident and other reports that have alleged that and found no such manipulation or distortion of rates at all, but that's certainly a narrative that's been going on with consumers and one we're having to push back on.

The other is one that maybe hopefully is unique to California and just a few other communities around the country, which is smart meters use radio frequency technology to transmit information to the distribution grid, and there are some consumers that are worried about the potential health effects even though no studies have shown any such health effects. People are still – some people are still worried about it so we've got that kind of backlash.

So we're dealing with this, with what I believe the PUC is currently considering an opt-out policy for smart meters. I guess the message coming

out of this is that we need – we need better education of consumers, coincident with smart meter roll out to address both those misperceptions, but also to talk about the benefits to consumers and society of having a better-functioning grid overall including the meters.

Miles Keogh: Yes.

Brian Turner: But it's been a little bit rocky.

Miles Keogh: Yes Brian, I would say that your point about consumer education is right on. What – I would say that California has had probably the roughest experience with it. In Texas, Oncor's moved out hundreds of thousands of smart meters. In other places there's been a lot of smart meters installed with merely a whimper, and I think some of those experiences are reflections of the consumer education and emphasis that was placed on using smart grid rollout as a technology rollout rather than looking at it as just replacing the meter on the side of someone's house.

Another well-storied smart grid bump-in-the-road or as it turns out not a bump in the road was the Baltimore Gas and Electric case that the Maryland PUC rejected the initial filing of BG&E to do a smart meter case, in part because there were concerns that there wasn't enough support put in the filing to consumer education. That was a real sticking point for the commission and they said, you guys have got to go back and take another stab of putting together your proposal before they'd approve it.

So that's certainly going to be a key to a successful rollout and like Brian said it's been pretty rough in California, there have been other areas where it's been rough but there have also been plenty of instances where the smart meter rollouts have gone extremely smoothly and we can talk more about that another time if you want to email me about it.

Catherine Morris: Brian, another question was whether or not you're seeing particularly distributed solar and wind energy playing a role during electrical outages to prevent some loss of power, at least at community level.

Brian Turner: You know I don't have any good – I haven't seen that or been aware of it. I don't know if other folks do?

Miles Keogh: The only thing I can say about that is that one of the instances where - distributed generation at largely the scale doesn't match the need when both power systems go out, there's not just enough of the stuff out there so that I'm sure there are customers out there who are glad they have distributed resources on their roof.

And in places like Minnesota where they've really invested in community wind, folks out on the farm routinely lose power which is why they put the stuff up on – they put the community-based solar – community-based wind scale projects into place – out in co-op territory and more removed circumstances from the big investor-owned utility footprints.

The one case I can point to where there was some success in using demand response and energy efficiency and distributed resources as a kind of insurance policy was in Southwest Connecticut in the beginning of the decade. There was a real concern that there was transmission and generation under investment in Southwest Connecticut to the tune of folks being worried that Southwest Connecticut was going to have an accident or some sort of thing that tripped off the system down there that would cascade throughout New England.

And while they were figuring out how to build new transmission to serve the needs of Southwest Connecticut which is a fairly lengthy endeavor, the – ISO New England rolled out some pretty successful distributed resource demand response, emergency demand response, energy efficiency, and the State of Connecticut put in some distributed resource incentive programs and lots of consumer outreach to basically act as an insurance policy in case something bad happened. They'd at least have something in place to bring things – to hold the line while they were – while they were putting a proper solution into place with transmission.

And again the reason the proper solution was transmission was just because we're talking tens and hundreds of megawatts worth of load and it's very hard

to get the scale of distributed and – distributed resources and energy efficiency up to that. But that was tried – it wasn't actually ever tested in Southwest Connecticut but it was something that they put on the track and got running.

Catherine Morris: I – we are – I know we've gone over a little bit but wanted to give people a chance to ask Paul – the questions that they have for him, there's one more Paul – excuse me, Brian, that I wonder if you could still field. It takes us a little bit more into the legal territory than technical. The question is whether or not you have seen any implications from the Commerce Clause related to your (RPS) requirement that requires at least 75 percent of the renewables come from in-State?

Brian Turner: We've heard that, I've heard about that, that'll be – I think that our lawyers feel confident that it is not – that we don't have to worry about those challenges but I'm sure there will be challenges. We're well used to being sued, so we'll see what the courts have to say about it but I think the law was designed to avoid any such challenges.

Miles Keogh: And you guys don't have an active legal challenge right now, do you Brian?

Brian Turner: Not on that.

Catherine Morris: There's another story behind that though. Well thank you for holding on a little bit longer and as well as – we have still over a hundred people on the phone, I appreciate you hanging on for us to be able to finish up some of these questions and as just as a reminder, the contact information is on the Website. So if you'd like to call our speakers they are willing to talk to you one-on-one, if you have – didn't get your question answered today.

Denise, I'll turn it back to you.

Denise Mulholland: Thanks Catherine. Well I would like to take the time now to thank Myles, Paul and Brian for speaking today. I think that the presentations were fantastic, and I certainly learned a lot about electric system as well as clean energy and how it affects it.

I want to remind everybody that as well – on that same Website that Catherine just mentioned, [www.epatechforum.org](http://www.epatechforum.org) , you can find the presentations. And also I guess lastly I want to remind folks that we do have two more Webcasts in this series that are coming up. One is going to be on the emissions benefits of clean energy, and the other is going to be on the economic benefits of clean energy, and how to estimate both types of benefits. So we'll send out those Save The Date notices as soon as the dates are set.

So with that I will wrap it up and thank everyone for calling in and staying on the line and we certainly hope that you are able to join us again for the next Webinar.

Thanks everybody.

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