BEFORE THE
FLORIDA PUBLIC SERVICE COMMISSION

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In the Matter of:

DOCKET NO. UNDOCKETED

REVIEW OF TEN YEAR SITE PLANS OF ELECTRIC UTILITIES.
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PROCEEDINGS: COMMISSION WORKSHOP

COMMISSIONERS PARTICIPATING:
CHAIRMAN ART GRAHAM
COMMISSIONER JULIE I. BROWN
COMMISSIONER DONALD J. POLMANN
COMMISSIONER GARY F. CLARK
COMMISSIONER ANDREW G. FAY

DATE: Monday, October 29, 2018

TIME: Commenced: 1:00 p.m.
Concluded: 2:38 p.m.

PLACE: Betty Easley Conference Center
Room 148
4075 Esplanade Way
Tallahassee, Florida

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I N D E X

PRESENTATIONS

P R O C E E D I N G S

CHAIRMAN GRAHAM: Good afternoon, everyone.

Let's try that one more time, again. Good afternoon, everyone.

THE AUDIENCE: Good afternoon.

CHAIRMAN GRAHAM: Glad to see you guys are all here safe. I know we've had a lot of stuff happen since the last time we were here. And noting that, at privilege to Chair, we have one of our commissioners here that actually was closer to the epicenter of all this stuff than most. So, I'm going to give him a couple of minutes to talk about the effects that Matthew had on his -- his area.

Commissioner Clark.

COMMISSIONER CLARK: Thank you, Mr. Chairman. I appreciate the time.

I wanted to just say a -- a couple of words of thank you to all of the folks that have lent support and help to the areas that were devastated during Hurricane Michael.

If you've had a chance to travel through the area, I think it's pretty obvious that the devastation was somewhat overwhelming. I've had the opportunity to work a number of storms over the years and lend assistance to other utilities working storms and to look at -- see some of the damages on a -- on a firsthand basis. And this is, to me, an exception to what I have ever seen in the past.

It has also been a -- a really neat blessing to watch the people in these communities come together. And to see the family and to see the response that has occurred over the last couple of weeks has just been absolutely amazing. I think that the spirit of the people has never been more evident than it has been in the last two weeks. And it's an incredible sight to see these folks coming together.

I also wanted to speak just for a second on the tragedy that occurred in my hometown, probably an accident that happened about three or four miles from my house, actually. And on behalf of this Commission, I wanted to extend our sympathies to the family -- families that lost loved ones working the storm this week.

I had the opportunity to work with James Ussery -- Bo Ussery, as he was known to us -- for over 25 years. Bo and I actually started to work in the utility business about the same time.

And Bo was definitely the definition of a servant and no -- probably no one else expressed the love of the community and the people that he served more than Bo Ussery did. And I just want to extend our sympathies to the family.

You know, we do a lot in this industry to protect the linemen, the people that are serving, the people that are working in a dangerous environment, with safety, and rules and regulations. I think that's why it's so hard to comprehend such a senseless and selfish act that actually takes a human life. That's probably the more difficult part to understand.

But on behalf of this Commission, I sincerely express our deepest sympathies to the families that that -- of these victims. And we wish them a strong recovery in the near future.

Thank you, Mr. Chairman.

CHAIRMAN GRAHAM: Thank you, Commissioner Clark.

Yes, it was definitely devastating. And my hat goes off to all those men and women that were out there, trying to get everybody's lives back to some sort of normal and the ones that put their lives on the line.

It's -- it's truly unfortunate -- I know we had quite a few fatalities during this hurricane, which, you know, everybody says to themselves, you know, I've been through four of these already; it's not going to be that big of a deal, but it's always that one. And this was that big one that made the difference.

Okay. Again, good afternoon, everyone.

THE AUDIENCE: Good afternoon.

CHAIRMAN GRAHAM: Okay. This is a ten-year site plan Commission workshop. We will call this workshop to order.

Staff, would you read the notice, please.

MS. DZIECHCIARZ: Thank you, Chairman. Rachel Dziechciarz on behalf of Commission staff.

By notice issued on September 27th, 2018, and subsequently revised on October 8th, 2018, due to Hurricane Michael, this time and place was set for Commission workshop to review the ten-year site plan of electric utilities. And the purpose of the workshop is set out in the notice.

Thank you.

CHAIRMAN GRAHAM: Thank you, staff.

We have -- FRCC is here today to discuss the 2018 regional load and resource plan, and will be followed by Duke, and Florida Power & Light.

Sir, welcome to the podium.

MR. SENKOWICZ: Thank you, Mr. Chair. Good afternoon, everyone. My name is Eric Senkowicz, I'm the director of planning for FRCC. I'm here on behalf of Stacy Dochoda, our president and CEO. I also have the brains of the operation here. I have Ryan Deptula and Christina Rau, who are here. And those are FRCC staff that are primarily responsible for compiling and aggregating and -- and eventually publishing the load and resource plan that -- that serves as the basis for our ten-year site plan.

Again, our vision at FRCC -- although our complexity has increased over the years, it -- it is still fundamentally to maintain a highly and reliable secure bulk-power system for peninsular Florida.

We originally met -- we originally established the organization as a forum for periodically meeting and talking about operations and planning. And eventually, we migrated to almost a daily interaction across our members, through our reliability coordinator function, and through our planning authority function. And we continually coordinate the operations across the grid in peninsular Florida as well as the interconnection with the eastern.

Our agenda today -- again, we're going to give you an overview of the FRCC load and resource plan. We'll talk about -- a little bit about the methodology of how the resource plan -- it comes about. We'll talk a little bit about the integrated resource planning process that occurs at the individual utility members, a little bit on load forecast, demand-side management.

We'll give you a brief overview of the generation addition and reserves margins for our region, review the fuel mix. And we'll touch on renewable resources as well as the natural gas infrastructure in -- in Florida.

Firm peak demand -- again, an overview of where we are with the 2018 load and resource plan. Firm peak -- firm peak demand and energy sales forecasts are slightly lower than the 2017 forecasts. Some of the key points are showing 11,000 megawatts of generation additions are planned. And our planned reserve margin is -- is maintained above 20 percent for the ten-year planning horizon.

Demand-side management continues to be a significant component of reserves and an effective way to -- to manage our resource-adequacy goals.

Continuing on, the change in the fuel mix over the region -- natural gas continues to be a significant part of our -- our resources. And we've got an incremental increase over the ten-year horizon from 64 percent to 66 percent.

Our renewables increase from 2 percent to -- to 8 percent, with another step change as -- as was reported last year. We had another significant step change in renewables with solar increases this year as well.

Coal decreases from 15 percent to 10 percent. And overall, our solar energy is projected to provide over 16,000 gigawatt hours of energy by the end of the ten-year period.

CHAIRMAN GRAHAM: Eric, we have a question for you.

Commissioner Brown.

MR. SENKOWICZ: Certainly.

COMMISSIONER BROWN: Thank you.

MR. SENKOWICZ: Sure.

COMMISSIONER BROWN: Thank you for being here.

MR. SENKOWICZ: Uh-huh.

COMMISSIONER BROWN: The jump from renewables, from 2 percent to 8 percent -- I'm assuming that's primarily solar-generation increases?

MR. SENKOWICZ: Yes, ma'am.

COMMISSIONER BROWN: What are the other -- what are the other increases, if any?

MR. SENKOWICZ: I do have a slide --

COMMISSIONER BROWN: Oh.

MR. SENKOWICZ: -- specifically on renewables. And we'll get into the details of that, if -- if you --

COMMISSIONER BROWN: Yeah, I'll wait.

MR. SENKOWICZ: Okay.

COMMISSIONER BROWN: Thanks.

MR. SENKOWICZ: Thanks.

Okay. Load and resource plan. How do we get this data and what impacts the data, what impacts the forecasts. We'll go over a few of those elements.

And -- and they're really -- there's a variety of ways that the utilities plan and do their resource planning across their membership, but there are some common elements: Load forecast. They look at demand energy; fuel as far as their trends; and their local systems on how to forecast their loads across the ten-year horizon. They look at their existing resources and contracts and purchases and ways of meeting those demand forecasts.

And all that comes into an evaluation process that looks at some supply-side options, some demand-side options. And then you balance that with your -- your cost and economics of your alternatives, and you come up with an integrated resource plan for the individual utility members.

What we do at FRCC is we take those annual integrated resource plan information from our different members and we integrate that into our load and resource plan, and we compile all that information, the resource information, retirements, additions, and we compile that into our load and resource database. That database becomes a fund- -- becomes a basis for this plan and the ten-year site plan regional look as far as resource adequacy.

The added benefit is these resources also get added to our regional model and our transmission model to make sure that the resources and where they're being sited -- we have deliverability of those resources over the ten-year planning horizon as well.

And finally, the added benefit is that meets

our compliance obligations through the North
American Reliability Corporation standards, the
reliability standards that we have to meet as a
planning authority as well as our members have to
meet with planning authorities.

Okay. Load forecasts -- so, we -- we compile
all this data and we create the regional load and
resource plan. At a high level, load is expected
to grow at 1.2 percent for the summer across the
ten-year period. And it's projected to grow at
1.1 percent per year through the ten-year period
for the winter -- winter periods.

Net energy for load is projected to grow about
.8 percent per year and forecasted energy sales are
slightly lower than what was delivered to you in
the 2017 ten-year site plan.

CHAIRMAN GRAHAM: Eric, we've got another
question for you.

MR. SENKOWICZ: Yes, sir.

CHAIRMAN GRAHAM: Commissioner Polmann.

COMMISSIONER POLMANN: Thank you,
Mr. Chairman.

The growth that you're projecting -- is that
based on additional customer growth or is -- are
you seeing a change in a demand pattern?

MR. SENKOWICZ: Both. Both. So, at the utility level, you're looking at your customer growth. You're looking at all your inputs to population increases, pop- -- you know, new permits, all your -- your relative inputs as well as your -- your takeaways, efficiency, different economic models that are occurring in your system. And you come up with that load factor -- or that load forecast.

And again, that load forecast is projecting growth across a ten-year period. And I'll -- I'll detail a few more of those --

COMMISSIONER POLMANN: Thank you.

MR. SENKOWICZ: -- load fact- -- forecasts.

And again, as an overview of our load forecasts and demand-side management, demand-side -- demand response reduces that firm summer peak by approximately 6.4 percent on average over the ten-year period, which is, again, not insignificant.

These are programs that are on-call, reductions of load. They're utility energy-efficiency programs that are utility-sponsored, and they help to mitigate some of that load -- the resource needs to meet the load forecasts.

We do have the energy-efficiency delivered through some mandated code and standard. We started tracking this information. And right now, we're estimating approximately a four-point reduction in the load forecasts by 2027. These are appliance-efficiency improvements and so forth that are mandated by -- by standards.

So, your load-forecast factors -- again, here, you have unemployment rate. A utility will look at unemployment, population growth, wage and income growth, impacts from standards, and -- and efficiency standards, and also some of the commercial activities that are going on in -- in the State and they're going on across the country. They will forecast -- they will use that inter-load forecast to create their expected loads over the next ten-year horizon.

Talked a little bit about these energy-efficiency codes and standards. Right now, we're projecting by -- by 2027, a reduction of approximately 2,000 megawatts based on those standards that are coming into play over -- over the last few years.

CHAIRMAN GRAHAM: Eric, we have another question for you.

Commissioner Brown.

COMMISSIONER BROWN: Going back to your Slide 11, you have an area that says one of your fact- -- load-forecast factors includes commercial customer-based challenges presented by online commerce.

Can you elaborate on what that means and what the challenges are?

MR. SENKOWICZ: So -- yes, some of our -- some of our members are dealing a little bit with looking at the impacts and the Amazon effect. So, the impacts of the loss of local distribution centers, local manufacturing, local retailers, and being replaced by, you know, the online commerce activities that are going on.

So, you -- you're looking at more of those retail impacts as far as your industrial -- you know, your industrial loads for your -- the member utilities.

COMMISSIONER BROWN: Even though the economy is doing well in Florida and population continues to increase, you're still suggesting that there still is that online commerce migration.

MR. SENKOWICZ: Well, that's what the utilities need -- that's what we look for in our load forecasting. And they're trying to -- to weigh the impact of that on their system and how they figure out, okay, what is this going to look like five years from now; what are the trends; and are we seeing a -- you know, lower number of retail stores, brick-and-mortar-type establishments that are not using electricity.

However, you have the online -- or the online commerce that's replacing some of that traffic at the retail level. So, those are all part of the load forecast --

COMMISSIONER BROWN: Thanks.

MR. SENKOWICZ: -- algorithm. Uh-huh.

Any other questions?

Commissioner Polmann, did I cover the forecast?

COMMISSIONER POLMANN: (Nodding head affirmatively.)

MR. SENKOWICZ: Okay. So, what you're seeing here is a comparison of the 2017 load forecast for the summer peak demand compared to the 2018. And what you're seeing is a -- is a slight shift downward.

Again, what we're doing is looking at a lower forecast. It's a comparable growth rate over the ten-year horizon. And it -- what it's doing is projecting a growth of approximately 5,000 megawatts across our member system over the next ten years.

Now, the -- again, you'll -- you'll see the shift that the starting point is, again, trying to adjust that load forecast due to increasing impacts of codes and standards.

Right now, we're forecasting a little bit of impacts of customer self-generation and so forth. So, you're seeing our models have to shift that forecast down. So, that starting point is -- is shifting lower.

You'll see a similar slide here for our winter projections. And again, you'll see a similar shift starting lower compared to the 2017 ten-year site plan. And we're projecting a growth of approximately 4,000 megawatts of demand over the ten-year forecast.

This is your net energy for load. This is your energy compared to -- for 2018 compared to your 2017 site plan. And again, this is pretty comparable, from an energy perspective, total energy, looking at a projected growth of approximately 18,000 gigawatt hours over the ten-year horizon. Rates are similar.

I'm going pretty fast over this. So, questions?

CHAIRMAN GRAHAM: You're all good.

MR. SENKOWICZ: All right. Next slide is showing you -- and again, this -- this load forecasting is part art, part science. And it's -- the inputs and outputs change, obviously. And it's hard to know what you're doing ten years from now and what your loads are going to be doing.

So, our utilities -- this graph shows an overlay of -- of the actual load from 1990 through our forecast period. And what you see is a trend line for the last 20 years. So -- so, the last 20 years would be more relevant than -- than 30 years, obviously, but we do have a mix within our utilities where, if some are going back 30 years, some are going back ten years.

And so, what we do is we take that data, we compile it, and we bring it to the FRCC. And what you're seeing is a trend line, a 20-year trend line. And we're balancing that against our forecast over the next ten years.

CHAIRMAN GRAHAM: Eric, question for you.

MR. SENKOWICZ: Uh-huh.

CHAIRMAN GRAHAM: Commissioner Polmann.

COMMISSIONER POLMANN: Thank you, Mr. Chairman.

I -- I'm wondering if you have a -- a proxy group elsewhere, where you feel like this is a -- a reasonably-good ability to forecast. How would you compare this to work by others, say, in another state, another market? I mean, this looks pretty good to me, but others might say, well, this is -- you know, you're not really projecting very well or I -- I don't know. Do you -- have you done comparisons to -- you know, to other --

MR. SENKOWICZ: We have not. We have -- we have not. I have not personally done benchmark studies across load forecasting across the country. I could check, you know, with our member utilities and see what kind of benchmarking data we could compile and -- and bring it back at some point, but -- again, this is a -- this is as much an art as a science. And it is definitely, you know, something that the utilities revisit on an annual basis to -- to adjust according to what's going on in the -- in the actual world, so --

COMMISSIONER POLMANN: Sure. Yeah. I'm not asking for anything.

MR. SENKOWICZ: Yeah.

COMMISSIONER POLMANN: I was just wondering if you had done any comparisons or any -- any utilities in your group had -- had done any work of that type.

MR. SENKOWICZ: We have not that I know of --

COMMISSIONER POLMANN: Okay.

MR. SENKOWICZ: -- at FRCC, but again, I can check with my resources subcommittee and find out if we can get some information for the --

COMMISSIONER POLMANN: Okay.

MR. SENKOWICZ: For the Commission --

COMMISSIONER POLMANN: Yeah, I was just curious.

MR. SENKOWICZ: -- on benchmarking.

COMMISSIONER POLMANN: That's fine. Thank you.

MR. SENKOWICZ: Uh-huh.

CHAIRMAN GRAHAM: Actually, I think that's some pretty good information I wouldn't mind having at maybe one of our future IA meetings. I'll have my -- my office kind of chase that down, see if we can get it from you or from somebody else, but especially just in the southeast here, to kind of see comparables, what it looks like.

MR. SENKOWICZ: Yeah, I -- I think you have a lot of opportunities to do that, with the ISOs, the RTOs, and -- and so forth, so -- so, there's definitely some peer groups that we could benchmark against.

And yeah, if -- however you guys want to -- to make it happen, we can certainly look into that --

CHAIRMAN GRAHAM: Okay.

MR. SENKOWICZ: -- and try to bring back an answer.

CHAIRMAN GRAHAM: Thank you.

MR. SENKOWICZ: Uh-huh. Okay. Again, here -- here, looking at the details of our -- our forecasted peak summer demand, what you're looking at is -- the orange line is actually your firm lo- -- firm-load obligation as a region. That's our firm-load obligation.

The orange line is the load with demand response excluded and -- and the yellow is the load with demand response and our energy -- energy-efficiency programs excluded. So, it's easy -- a relative trend line over the load increases over the next ten years.

And then, finally, here's your historical compounded average annual growth rate. This -- this chart shows you, you know, we're stabilizing a little bit here in the out years, but what you see is, again, back in the '0- -- '05, '07 time frame, you were looking at 2-percent growth rate in those -- out -- in those years. And now, we've reduced that -- you know, that growth rate down to about 1 percent is what we're looking at. So, over time, it gives you an idea of that load forecasting and how it is dynamic.

Okay. Going into generation additions and reserve margins -- again, noted this earlier; we've got 11,000 megawatts of new generation planned over the next ten years. The planned reserve margin, again, is projected to remain above the 20-percent margin. DSM, again, continues to be a sig- -- significant component of reserves.

The generation additions are made up of about 8,000 megawatts of firm natural gas generation. We've got 3,000 megawatts of solar -- firm solar generation. And then that's coupled with the retirement of about 5,200 megawatts of -- of generation, older coal or older gas generation.

This chart -- what this chart, again, tells you -- it's a good view of our generation additions over time, over the next ten years. And I'll just note that you've got your scale there, starting at

40,000. So, it's a little bit -- it's a little -- you've just got to keep that in mind.

It's a little misleading on the impact of the changes, but what you see is that the new gas generation, again, is at 8,000 megawatts of generation coming in over the next ten years.

Out of that, there's about 5,700 megawatts of green field generation, and about 2,300 megawatts of gas that's repowered gen- -- sites. And again, you've got the 3,000 megawatts of solar coming in across the ten years.

This is -- again, this gives you a little bit of a time stamp, as far as that generation addition and the retirements and how they're going to occur over the ten-year site plan.

As far as the nuclear -- nuclear outlook is stable over the ten-year horizon. You're looking at about 3,600 megawatts of nuclear generation that's going to remain within the ten-year planning horizon.

You've got a couple of incremental increases. One is going on right now and one is actually going to go on, I think, in early '19, for the Turkey Point sites.

So, we've got our load forecasts and we've got our resources and our capacities over the ten-year horizon. What we do is we compare those to find our reserve margin. And again, looking at the firm load obligation across the ten-year horizon, you can clearly see here we're remaining over the 20-percent reserve margin criteria.

There is a bit of a downward trend in the outer years, you'll see. And that's due to some non-utility purchase reductions as well as continued load growth.

This is a similar chart except it excludes the impacts of demand response and utility efficiency programs.

Okay. Looking at benchmark -- or talking about benchmarking data, here, this chart actually shows you the demand response as a percentage of peak demand based on our 2018 ten-year site plan and how we compare across some of the peer groups across the -- North America.

And you see the demand response is definitely a -- a significant piece of our reserve margin. And it's still an important planning asset that -- that's effective in our resource-planning efforts.

So, this chart really brings everything together. It's -- it's a little busy, but it --

it's a great thumbnail of the ten-year site plan for 2018. You've got your forecasts, and it's overlaid over capacity. And it also has the fuel-mix information blended within it.

On the fuel mix, you'll see that, again, for 2018, our firm capacity, fuel projections are 72 percent gas. We're going to move, by 2027, to 75 percent gas. You'll see the corresponding reduction in coal generation. And you'll be -- you'll see the increase -- corresponding increase in renewable energy over the ten-year horizon.

A little bit of a different look as far as fuel mix, but -- but, again, this chart shows the relative amount of natural gas versus our other fuels.

And Commissioner Brown, this is your forecasted renewable mix and -- and again, the changes in solar generation over the -- the ten-year planning horizon. And we're going from 482 megawatts of solar to 3,000 megawatts of solar by 2027, is what we're forecasting at this point. You'll see that the other renewables are -- are relatively static over that time frame.

Okay. And finally, on the forecast, again, a little bit of the art part in resource planning.

This chart shows a little bit of the shift that we brought last year; and again, another more -- more of a step change this year on solar generation, but it shows you three years of the ten-year site-plan data relative to forecasted solar generation.

Okay. And then, this is your forecasted fuel mix, again, for energy, relative to energy over time. And again, we are -- we are significant as -- we are fortunate, as a significant amount of that gas generation is backed up by firm natural gas contractual rights to get that gas and -- and serve that energy. And then this is the energy slide for our expected renewables.

Okay. A little bit on natural gas infrastructure in Florida. Again, we do have the three main pipelines, FGT, Gulf Stream, Sable Trail, the Southeast Connect as well as the -- now the hub that is -- is in operation.

Again, natural gas continues to be a critical partner in meeting our resource needs and -- and we do, at FRCC, continue to look at that infrastructure on a regional basis to -- to make sure we understand where some of those vulnerabilities might be on -- on getting some of those resources in place.

We do look at gas-infrastructure expansion plans and -- and as part of our charter at the resources subcommittee. And again, the expansions appear to be on pace with the generation additions over time and -- and they're reasonable.

And then, finally over the ten-year forecast, we do have gas generation that has alternate fuel capabilities on-site, the fuel oil. And that's an important part of our resiliency plans to make sure that, if we do have threats to our natural gas supply, that we can maintain those resources.

Part of maintaining those resources, whether it be in an emergency -- part of those resources and -- and maintaining gas and -- and fuel in place, we do have a group at FRCC, the fuel reliability working group. And again, we do look at the interdependencies of fuel availability, reliability, how they're impacted.

We do look at the pipeline systems and -- and some of the contingencies -- contingencies on the pipeline systems. And then we also are able to coordinate on regional responses to fuel issues in -- in an -- almost real time in good relationships with the natural gas pipeline operators as well. And then, again, we do commission some periodic studies on analyzing gas infrastructure. And our operating committee gets that information.

Again, energy production from natural gas -- you'll see that has become increasingly -- increasingly important since 2004, our resources in Florida. And they are very important to us meeting our -- our customer loads.

CHAIRMAN GRAHAM: Eric, I have a couple of questions for you.

Commissioner Clark.

COMMISSIONER CLARK: Thank you, Mr. Chairman.

From a strictly reliability perspective, does FRCC have a position on what is an appropriate fuel mix? We've talked about the reliability and -- not necessarily the reliability, but the vulnerability of natural gas infrastructure.

As we continue to pour more resources into natural gas energy production, where do we -- where do we draw the line? Where -- where is -- what is the FRCC's position on what is the appropriate mix?

MR. SENKOWICZ: So, the FRCC, I would say, does not have a position on the appropriate mix. What we do have a position on is making sure we identify vulnerabilities and risks from a reliability-standard perspective, from a reliability perspective and so forth.

So, how we -- we obviously don't get into the market, the -- the cost elements of decisions and how they're made. What we do delve deeply into -- well, what -- the what-ifs, the what would happen and -- and how significant is this and what-would-we-do kind of scenario.

So, the answer to your question, no, I don't -- we do not have a position on what the right mix is. Obviously, there's a lot of controversy across the country today on that, but -- but we do -- are very interested in -- in making sure we understand where the vulnerabilities on the grid and the resources are.

COMMISSIONER CLARK: Can you -- can you discuss any of the contingency plans for natural gas interruptions? You mentioned the -- the alternative fuel supplies that are on-site. What are we looking at realistically in terms of production capabilities in the event of two pipeline -- double pipeline disruption, for example?

MR. SENKOWICZ: So, what you're looking at right now is -- is the natural gas alternate fuel capability of our generation gas fleet. And what -- where we're at right now is, I believe, somewhere around 60 percent of the gas fleet has on-site liquid storage. How that translates into a double pipeline outage, that, I couldn't tell you right now. And I probably wouldn't tell you, if I knew.

COMMISSIONER CLARK: Understand.

MR. SENKOWICZ: So -- but -- but there are -- there are ways and -- and there are ways to mitigate that, especially with the new Sable Trail Southeast Connect hub that we've found some operational flexibilities. And obviously, some of those have been designed into the pipeline infrastructure to accommodate and probably look at some of those scenarios, but --

COMMISSIONER CLARK: Okay. But -- but the systems have been evaluated from that perspective, looking at how long a supply would last, those kinds of things.

MR. SENKOWICZ: Yes -- well, they -- we have looked -- at FRCC, we have looked at selected pipeline outages, selected segment outages and -- to understand what the impact would be and how to mitigate that, using the liquid fuel.

COMMISSIONER CLARK: Okay. Thank you, Mr. Chairman.

CHAIRMAN GRAHAM: Commissioner Polmann.

COMMISSIONER POLMANN: Thank you, Mr. Chairman.

I had similar questions to Mr. -- Commissioner Clark, and this may not be the time or place to discuss those things that you can't tell us, but I would appreciate information that you, perhaps, could share with appropriate staff and -- so that we would be more knowledgeable as a Commission.

And the -- the issue -- particularly looking at your Page 34, fuel reliability, this Commission has had some -- I would say, maybe Commissioners have made some comments publicly, similar to Commissioner Clark's expressions, and you know, the issue of growing reliance on -- on single fuel type and so forth. So, I'm not quite sure how -- how to provide additional information to Commissioners, but I think we are seeking that.

So, maybe appropriate staff here can work -- work with you and your group so that we can gain some -- some greater comfort along the lines of what -- what you just discussed. I think we're looking for some more information.

So, the other questions I had was, on DSM, you've got some -- some points in here, you've made earlier on -- I think it's Page 19 -- but regardless of what page it is, you bring it up again in your -- your conclusions -- that it's a significant component -- it almost looks like a source. You know, we're talking about the demand-side management, I assume, and -- and that being, in my experience, a short-term solution to a short-term problem.

Is -- is that how you're -- you're describing it? It's not really a fuel source. It's -- it's a demand abatement. Can you clarify that?

MR. SENKOWICZ: Yes. So -- so, I -- I think it -- your load varies every four seconds in our -- and our utilities are constantly chasing that load, serving it with generation, raising generation up, down.

So, for a certain period of the day, you're going to be at peak load. And that's going to be -- you know, in the summer, it's going to be a window, an hour; say, at 5:00 in the afternoon, you'll be serving that peak load. The rest of the day, you're not going to need generation level for 23 hours, if you will.

So -- so, what demand-side management does -- it allows you to shave that peak off to serve, if you need to, from a -- from a reliability perspective, that load, without having to build another generator.

So, in other words, it's -- it's helping your reserve margin to try to be able to re- -- plan resources effectively and efficiently.

Does that make sense?

COMMISSIONER POLMANN: Yes, I understand that from a -- from a peak-shaving perspective, provided that it's -- it's something that can be sustained; whether it's a change-out in technology for -- for, you know, base population, you know, more efficient appliances and so forth, provided that -- that, you know, is adopted by general population.

What I'm concerned about is that not become a paradigm for base-load reduction. You know, it could be, in terms of reliability, when you -- when you do have a catastrophic lost, it can be a temporary solution. And I anticipate that that's something that you've taken into account in your evaluations. You know, it's -- it's an emergency reduction. People, you know, are essentially just reducing their overall demand --

MR. SENKOWICZ: Right.
COMMISSIONER POLMANN: -- in the general sense. So, I --
MR. SENKOWICZ: Well, and these are controllable. These are controllable at the utility level --
COMMISSIONER POLMANN: Yes.
MR. SENKOWICZ: -- where you can reduce that -- that demand --
COMMISSIONER POLMANN: So, I think I'd be looking for some additional understanding on how, from a planning perspective, you're taking into account the DSM, both from a peak perspective as well as an emergency treatment on the overall system-reliability perspective.
So I'll just leave that with you --
MR. SENKOWICZ: Yeah.
COMMISSIONER POLMANN: -- and perhaps we can --
MR. SENKOWICZ: And I may have not been clear on this slide. This slide is actually starting to look at a little more of our generation-only reserve margin and -- and how we balance that margin out. It's going to become increasingly important, again, with the renewables that are --

that are --

COMMISSIONER POLMANN: Yes.

MR. SENKOWICZ: -- coming onto the system as -- as those are less controllable than, you know, traditional resources.

So, our member utilities are looking at those reserve margins and will mix up that reserve as well.

COMMISSIONER POLMANN: I appreciate that distinction.

MR. SENKOWICZ: Uh-huh.

COMMISSIONER POLMANN: Yeah. Thank you.

CHAIRMAN GRAHAM: Commissioner Brown.

COMMISSIONER BROWN: Just a question on natural gas storage. And obviously, in Florida, we have minimal natural -- underground natural gas storage capability unlike, in other states, where they have aquifers and salt domes.

What is FRCC doing to look at tapping into that, if -- if at all?

MR. SENKOWICZ: So -- so, again, we -- we incorporate that into some of our assessments and our analysis that we do in-house, and we look at -- our members voluntarily provide us some pretty sensitive, strategic information on the amounts of storage they have, the amounts of contracts they have, the withdrawal rates they can take out of that storage.

And obviously, it's upstream. It's up in Louisiana's areas and so forth. And we incorporate that into supply slide -- you know, it was a little more relevant back in '05, '06, '07, when a lot of the supply was coming out of the Gulf and the hurricanes would cut off that supply.

A lot of the supply is on land now, so it's a little less, but you can still use it to mitigate other compressor-station outages and so forth; is used in that -- or other supply-side shortages, but -- so, we do have that information.

Obviously, the natural gas information is very sensitive. We -- we don't -- you know, our operating committee and our board is very engaged in -- in wanting us to look at that information, but it's a very limited audience that we want to share that information with because of the sensitivity of that -- those potential vulnerabilities that might be out there.

COMMISSIONER BROWN: Absolutely. Thanks.

CHAIRMAN GRAHAM: Commissioner Clark, can I come back to you after he concludes?

COMMISSIONER CLARK: Yes.

CHAIRMAN GRAHAM: Eric, go ahead.

MR. SENKOWICZ: Okay. You guys have a lot of questions today.

CHAIRMAN GRAHAM: It's not over yet.

(Laughter.)

MR. SENKOWICZ: So, in conclusion, again, on our -- based on our ten-year -- 2018 ten-year site plan, our reserve margins are -- are above 20 percent for all peak periods for the next ten years.

Again, DSM is part of that reserve margin and continues to be important from an -- from an effectiveness -- from a resource-adequacy perspective.

Energy-efficiency codes and standards continue to reduce the demand and energy forecasts over time. We're seeing that increasingly.

Planned gas-infrastructure capacity increases are in place that we've seen to support planned generation additions near term.

And then finally, existing gas-infrastructure expansion capabilities can support the -- the outer-year increases as well.

Changes to the fuel mix -- again, we've talked about natural gas quite a bit. We're looking at natural gas from -- going from 64 percent to 66 percent, as far as energy served over the ten-year horizon.

We're looking at a significant increase in renewables, mostly due to solar, from 2 percent to 8 percent. And we're seeing that decrease in coal from 15 to 10 percent. Again, solar is projected to provide over 16,000 gigawatt hours of energy by 2027 on our member systems.

And talked a little bit about solar reliability, but at this point, the solar penetration levels -- right now we're not identifying any reliability impacts to -- to grid operations.

With that --

CHAIRMAN GRAHAM: Commissioner Clark.

COMMISSIONER CLARK: Thank you, Mr. Chairman.

I -- I wanted to follow up on Commissioner Polmann's line of questions regarding DSM programs. Understanding the difference between direct load-control DSM and supply-side controls -- looking at Page 17, it seems to indicate that there is going to be, as time goes on, less and less benefit or positive economic impact from DSM.

Am I reading this graph correct?
MR. SENKOWICZ: Let me get you there.
Actually, it's -- it seems to be increasing.
COMMISSIONER CLARK: So, if the orange line is projected demand with demand-response impacts excluded versus --
MR. SENKOWICZ: Right. So --
COMMISSIONER CLARK: So, I'm read- -- I am reading it wrong.
MR. SENKOWICZ: Yeah, it's the opposite.
COMMISSIONER CLARK: Okay.
MR. SENKOWICZ: Yeah. So, again, it's a component that's helping that reserve. If you were to use it --
COMMISSIONER CLARK: So, you're saying that DSM programs are increasing -- going to help increase the impacts.
MR. SENKOWICZ: Right.
COMMISSIONER CLARK: And that includes -- are you including direct load control as part of DSM programs?
MR. SENKOWICZ: Yes. Yeah.
COMMISSIONER CLARK: Okay. Thank you.
MR. SENKOWICZ: Yeah, what's not included in -- in Slide 17 -- if I can get to it -- is the

estimates on codes and efficiencies standards that are out there. Again, that's -- that's -- that is not measured data; it's utility and resource planners estimating what the impacts of those standards -- having them on their systems.

COMMISSIONER CLARK: Do you differentiate, at any point, the difference between the capacity controls on direct load control versus just traditional demand-side management programs?

MR. SENKOWICZ: We do -- well --

COMMISSIONER CLARK: How much can we reduce in direct load control?

MR. SENKOWICZ: I'd have to give you the exact numbers, like real time, but -- but again, they're estimates that are updated in -- in operations -- in the operations horizons.

And then every year, they're updating those estimates in the planning horizon on -- on what they can do from direct load control, industrial -- you know, customer load -- had load curtailments and so forth, and -- and those things that are controllable.

I don't have the exact numbers.

COMMISSIONER CLARK: One final question, Mr. Chairman.

Do you do any -- do you overlay heating-degree days, cooling-degree days on any of your peak-demand projections?

MR. SENKOWICZ: I'm sorry --

COMMISSIONER CLARK: The effects of heating-degree days or cooling-degree days on your projections -- as you see the variants in peak demand over the last five or six years, do you have calculations showing what the impact of the heating-degree days or cooling-degree days was on that peak demand? I know it's --

MR. SENKOWICZ: I don't know --

COMMISSIONER CLARK: -- included in the load forecast --

MR. SENKOWICZ: -- that we do that regionally. I know our members are probably doing that, but I don't know that we aggregate that and do that regionally.

COMMISSIONER CLARK: Okay.

MR. SENKOWICZ: I would have to get back to you.

COMMISSIONER CLARK: Thanks.

MR. SENKOWICZ: Uh-huh.

CHAIRMAN GRAHAM: Eric, I have two quick questions for you. Going back to Page 29 --

actually, make it 32. The landfill gas -- why do you see that number dropping? Is it trending down now?

MR. SENKOWICZ: The landfill gas -- okay. So, going from 40 to 35, you're talking about?

CHAIRMAN GRAHAM: On Page 32?

MR. SENKOWICZ: Yes -- oh, I'm sorry. Yes. So, you're going from 392 to 336?

CHAIRMAN GRAHAM: Yes.

MR. SENKOWICZ: So, yeah, I -- that's -- that's just what's being reported to us as far as what the projections are for that category of generation. And it's all coming out in the map.

It looks more significant, obviously with the -- the chart -- the bar chart -- or the doughnut chart here, but that's --

CHAIRMAN GRAHAM: Are we --

MR. SENKOWICZ: -- what's being reported.

CHAIRMAN GRAHAM: Is it trending down now, though?

MR. SENKOWICZ: The landfill gas?

CHAIRMAN GRAHAM: Yes.

MR. SENKOWICZ: I'd have to go look at the details of -- of that specifically, but --

CHAIRMAN GRAHAM: What would be -- what would cause that to drop off? I mean, now, granted, it's not a big number, but it's just curiosity. I would think that that would be constantly going up. Or is that something we should be looking more at here?

MR. SENKOWICZ: That -- it's just, again -- maybe the retirement of a unit or two units is affecting that amount. Again, it's not a large amount. You're looking at five megawatts.

CHAIRMAN GRAHAM: Yeah.

MR. SENKOWICZ: So, how that -- I can -- again, we can dig down into the details of that and get you that information, if you like, and -- and figure out exactly where that's coming from.

CHAIRMAN GRAHAM: The other question I have is, planning-wise, what are we doing to deal with -- because we're talking about going up some 500 percent with solar, 600 percent.

What are we doing to deal -- to get ready for that, I mean, as far as load on the system? I mean, I know some of the problems they run into on the west coast when it's a sunny day, and then all of a sudden, the clouds come out, and the sun comes back out again. Are we --

MR. SENKOWICZ: Yes.

CHAIRMAN GRAHAM: -- learning, planning, anticipating all that stuff?

MR. SENKOWICZ: We are intently looking at California, New England, Carolinas. They're seeing a lot of penetration on the retail level. California has both. They've got a, you know, utility scale and retail level. And they're -- they're seeing it on their load curves.

For us right now, it -- it's still in the noise, but what we are doing is we did establish a solar task force last year to look at the different operating aspects of high levels of solar penetration. And we're -- we're collecting data.

So, we have several facilities now in service and are actually collecting operating data, looking at those things, geographic diversity, how much is enough. You have a cloud over here. If you've got, you know, four sites in one place and there's a cloud that shows up, how is that going to impact you.

So, we are very sensitive to that. Our operating committee and our planning committee are very sensitive to gathering operational data to better understand these facilities, how they operate so that we can integrate more and more levels of penetration of solar resources.

CHAIRMAN GRAHAM: Is this task force generating any reports that maybe we could take a look at?

MR. SENKOWICZ: Yeah, I -- I can find out from our operating committee and our planning committee on the distribution of that, but yeah, we -- we do have some recommendations that we continue to follow up on, again, over time on how to address the -- the impacts of these resources.

CHAIRMAN GRAHAM: Okay. Thank you.

Commissioner Brown.

COMMISSIONER BROWN: Just one last question regarding EVs and if FRCC has looked at load forecasts for the penetration of the EVs on the -- on the grid.

MR. SENKOWICZ: So -- so, I'm not a load forecaster, but I know they've talked a lot about the electric vehicles and how -- how that plays into their systems. So, we are sensitive to it. I know, as a region, we're sensitive to it. That's probably all I can say.

COMMISSIONER BROWN: I haven't seen much data for a ten-year period, so I would be curious to see what the -- what the growth rate is and how that

would affect the -- the grow- -- the load.
MR. SENKOWICZ: We did have an EV workshop -- I believe we did have an EV workshop. And maybe we could get you a summary of that workshop as well, but yeah, we did look at the expected penetration levels. And it seemed like it was --
COMMISSIONER BROWN: Modest -- was it modest?
MR. SENKOWICZ: No -- yeah, it was not significant at -- you know, as -- even from a forecast perspective and looking at some aggressive forecasts as well, so -- but we can get you some information on it.
COMMISSIONER BROWN: Thank you. Thank you for coming here.
CHAIRMAN GRAHAM: Eric, thank you very much for your -- your time, your presentation.
MR. SENKOWICZ: Yes, sir. Thank you.
CHAIRMAN GRAHAM: As you can tell, we were very enthused with it.
MR. SENKOWICZ: Thank you for your engagement.
CHAIRMAN GRAHAM: Thank you.
Okay. Next, to the podium, we have Duke. Come on down.
MR. KUZNAR: Good afternoon, everybody. So, my name is Zach Kuznar. I lead up a group at Duke

focused really on distributed generation and how we're starting to integrate it into our -- into our portfolio.

And my group is primarily focused on a couple of technologies. One is regulated by the power facilities, similar to the Eight Flags project that was done down here in Florida. We also look at energy storage and microgrid applications, when you're pairing storage with solar.

So, today I'm going to talk really about where we are with the 50-megawatt pilot that we're -- that we're working on here in Florida.

So, quick agenda, you know, I want to just hit a little bit on some -- just some background for folks who might not be as familiar with electrical chemical battery storage; talk a little bit about how we're integrating it into our business; and some of the use cases we're looking -- and then really kind of lead that into some of the really specific use cases that we're looking at.

So, if you look at background -- I mean, the concept of energy storage isn't new. It's just been very geographically limited for some time. I mean, you look at -- pumped hydro, is -- is, you know, a popular form of it. We've got a lot of pumped hydro in the Carolinas, but you need a lot of water and you need a big mountain, and they're -- it's tough to build. Compressed air as well -- you know, you need some kind of underground kind of salt dome.

The one thing with electric chemical storage, which I think we're excited about, is just the scalability. You know, you can go from kilowatt-size to very large megawatt-size projects.

And I think the use cases, you know, kind of speak for themselves, right. You've got, you know, the ability to shift energy. I mean, it's -- it's a supply chain for -- for the electric grid. You know, it's got a transmission and distribution value.

So, a lot of the projects we're looking at have T-and-D value, but then, on top of that, you can layer in kind of bulk-system generation value when you're looking at how to use it to provide regulation, how to use it to integrate more renewables like solar, you know, how do you use it to peak shave.

So, there's a lot of different use cases and applications, which I'll hopefully hit on and kind of give you some idea of where our thoughts on --

on how storage can -- can benefit the grid.

So, just some background. You know, I think if you look at where the technology is today, you know, we really see lithium ion, you know, dominating for the foreseeable future based on costs and really supply chain.

But with that said, you know, we are always monitoring and looking at emerging technologies. We're very interested in flow batteries and metal air batteries and ones that could have a lower cost going forward.

But if you'll just look at the supply chain right now, lithium ion seems to be at a -- seems to be one of the best technologies for the foreseeable future. We're seeing costs come down at a rapid pace. You know, we're -- we're surprised on how fast we've seen system costs decrease.

You know, I would expect breakthrough press releases to be very common. You know, you're always reading about the next best battery, the one that's going to last 50,000 cycles, the one that's going to cost, you know, very -- very small amount. So, you know, I -- that's just something to keep an eye on.

And you're seeing a very steep growth, though, in deployment. So, there's -- about 295 megawatts were deployed last year, right around 300. If you look at a lot of the reports, you're seeing it up to maybe 2,500 megawatts by 2022, and that's driven by a number of factors.

One, you've got, you know, some states with mandates; two, you know, you've got declining costs; and three, you're seeing utilities really start to utilize it as part of their planning process from both the transmission and distribution standpoint, but also the generation standpoint.

So, where we've been -- I would say we started -- we put in our first small battery at Duke -- it was about 2010. And we -- we've had about seven or eight pilots over that period of time. And these were all less than one megawatt. It was really to kind of get our -- get our feet wet, understand how to integrate it to the grid, what applications could we use the assets for. And on the commercial side of our business, we -- we deployed a very large battery in Texas, at a wind farm.

Now, what we're really getting at, in all of our territories, is how do we take the pilot, get to more of what we call a scalable demonstration where you're not necessarily -- you know, you're not going straight from zero to 500 megawatts or a thousand megawatts. You're kind of easing in.

And this is where this pilot, I think, is going to be extremely helpful for us in Florida. And we're looking at these kind of in all of our territories.

And then, getting it out there, where -- you know, I think where we see it going forward is this could be a tool that our planners use, our distribution planners, if they need to do, you know, an upgrade to a substation, what's the more cost-effective solution: Is it storage; is it traditional.

When you have circuits that have high penetrations of solar, how do you deal with that intermittency. And this could be a tool that we really want to see kind of be ubiquitous on the grid going forward.

So, this is a bit of an eye chart, but you know, I think it captures and -- and really talks about the value streams well. And it has to really get you thinking, with a technology like this, how you capture all the benefits.

And so, what do I mean by that? If I have a project -- and I'm going to talk about one of the examples -- you know, that is focused on the transmission and distribution system -- well, I might only, you know, need it for that application a certain amount of time.

So, how do I use it the rest of the time to provide some bulk-system benefits. How do I use it if it's a very intermittent cloudy day and I've got a lot of solar on my system to deal with intermittency instead of cycling a gas facility. If it's a very hot day, how do I make sure all my storage on the grid is charged up and ready to shave peak.

And so, the way we've really approached this particular pilot is we've been working very closely with our distribution planners and some of our gen- -- and our, you know, generation-planning team to really hone in and identify where do we find the best sites where we could deploy this, which is best for our customers in Florida, and to prove out these concepts.

What we've done to date -- we've identified seven sites, which is going to make up that 50 megawatts, and then we've got a couple kind of in the pipeline, if there would be an issue with those.

And we're not ready to announce the sites publicly yet, as we're working through some commercial terms on acquiring land and don't want to make public announcements, but hope -- hope to be able to make some of those announcements soon.

But what I want to do today is just kind of talk about three specific use cases that aren't, you know, saying exactly where the projects are or the size that we are looking at for -- for our deployment plan.

So, first one, you know, I mentioned is, you know, here is one which is focused more on the distribution system, but captures bulk-system benefits as well.

And here is a particular use case where, you know, you've got a radial feeder and it's got very sharp load growth, but it's just a certain time of year. So, you know, you've got certain areas where it might be, you know, wintertime. It could be summertime.

In this particular instance, it's a location that has very peaking summer loads, especially on the weekends. And what you're going to need -- what we're going to need to do is actually do a substation upgrade because we're going to exceed the capacity on that substation; however, when -- you know, you need to make that investment just for a certain time of the year.

And this graph here -- what it shows is just one weekend. You can see where we currently are, where we expect to be by 2025, and then going forward, but we're going to have to invest and upgrade the substation to deal with this excess -- excess load growth there.

If you look at it from a yearly standpoint, though, you're really going above. This is present day. You know, eventually, it will go up more. You're only going to go above the capacity of that substation a very small time of the year.

So, if I do just a traditional upgrade, I'm investing. I'm increasing the capacity of the substation, but that's the only value it provides. In this case, you could use the storage for that capacity increase, but then also, the rest of the year, where you're below that, you can use it for peak shaving needs, you can use it for providing regulation service.

So, this kind of shows you at least the stacked value of capturing distribution value, but then not underutilizing the asset and capturing bulk-system value as well.

Another use case -- and we've done -- we've done two projects like this in other -- in our other states, which I think is a very good application for storage -- is, when we're talking about using batteries for bulk-system value, you know, we mentioned, you know, how does solar affect the grid, right.

Well, you have solar. We have a perfect example -- I don't have the graph up here, but you know, in North Carolina -- because that was brought up -- during the solar eclipse. It was interesting we lost 3,000 megawatts of solar within a matter two minutes. So, we had all these gas turbines, you know, spinning reserves. And then a minute later, it came back on. And it shows that kind of severe ramping and, you know, duck-curve issues that storage provides, so -- or that solar can provide; so, having, you know, down the road, where you have a couple hundred megawatts of storage on the grid to help deal with the intermittency, solar; also, you know, provide some peak shaving needs and maybe some distribution value.

You know, one thing we've thought about is, if you're using it for bulk-system benefits, is there a way to partner and site it at critical facilities.

So, 99 percent of the time, I'm using it for peak shaving, but if I site it at, let's say, a shelter that's used for hurricane evacuation, it's got some customer-sited benefit as well. So, you know, can I make sure it's charge- -- you know, it's providing back-up for that facility, or at least critical load.

So, in this case, you're looking at the grid-system value, but how can you site it at critical facilities. And we did a similar project -- just as an example -- where we've got a battery in one of our substations in North Carolina sited a substation.

The substa- -- this particular circuit has quite a bit of solar on it. So, we use it most of the time for, you know, dealing with the solar intermittency on that circuit. During a grid outage, it actually provides back-up power to a fire station.

So, it's, I think, thinking creatively and siting these at the right locations on the grid.

CHAIRMAN GRAHAM: Zach, I've got --

MR. KUZNAR: Yeah.
CHAIRMAN GRAHAM: -- a quick question for you.
Commissioner Brown.
COMMISSIONER BROWN: Thank you. Thank you Mr. Chairman.
Two questions, with regard to the lithium ion --
MR. KUZNAR: Yeah.
COMMISSIONER BROWN: -- that is being used, how many hours of batteries does it provide?
MR. KUZNAR: So -- very good que- -- so, right now, lithium is typically limited to about a four-hour duration. So, if I have a five-megawatt battery, you know, it could provide 20-megawatt hours of -- of kind of energy to the grid.
What we've done is, you know, if you're looking at -- okay. Let's say I'm siting -- to really get the bulk-system benefits, you know, you have to have five, 10, 15, 20 -- you have to get to the point where you're scalable, where -- you know, you showed a 50,000-megawatt system here in Florida, you know, five megawatts by, itself, isn't going to have a huge impact.
But if I have, you know, ten five-megawatt systems, and I go up to 20, and 30, and 40, you

know, you can get to that scale where you can get bulk-system benefits.

You know, some of these critical facilities, like, let's say --

COMMISSIONER BROWN: That --

MR. KUZNAR: -- a fire station is -- could be, you know, 250 KW. So, that five-megawatt, 20-megawatt-hour, battery, which has a lot of bulk-system value -- you know, that size asset, even though it's a four-hour duration, might be able to provide 48 hours of back-up for those smaller loads. So, it's all about the sizing and how you -- how you look at it.

COMMISSIONER BROWN: And you're familiar with the cost, then, of the lithium ion on different project sizes.

MR. KUZNAR: Yes.

COMMISSIONER BROWN: So, in some of those states that mandate battery storage --

MR. KUZNAR: Yes.

COMMISSIONER BROWN: -- component, how -- do you know what the incremental costs of that would be?

MR. KUZNAR: You talking about the per -- so, I understand the question, per hour?

COMMISSIONER BROWN: Yeah.

MR. KUZNAR: You know, it's -- we've gotten some -- I can't -- I don't want to say a number. As you go from, like, a five-megawatt/five-megawatt hour battery to a five-megawatt/20-megawatt battery, there is an increased cost, but it doesn't necessarily scale linearly because, if you look at the overall costs of these systems, the battery is a big component of it.

But you've got the battery, you've got the inverter, you've got the container, the controls. So, it's not necessarily scaling linearly, but we've got information on that; I just don't know it off the top of my head.

COMMISSIONER BROWN: And then, just for land purposes --

MR. KUZNAR: Yes.

COMMISSIONER BROWN: -- when -- you know, land is the big part --

MR. KUZNAR: Right.

COMMISSIONER BROWN: -- of these large-scale solar projects.

MR. KUZNAR: Yes.

COMMISSIONER BROWN: How much would a battery -- you're trying to break these -- the

50 megawatts up into --

MR. KUZNAR: Yeah.

COMMISSIONER BROWN: How much would it occupy?

MR. KUZNAR: Pretty small. So, the way you look right now -- I mean, you have solar -- you're right. I mean, it's -- one megawatt could be six, seven, eight acres, depending on the size.

Typically, the way most vendors are going to now is -- initially, like, our project that we built in Texas, which is 36 megawatts for a comm- -- it was for a wind farm -- when that was built seven, eight years ago, the mindset was it was in a big building, it had all the batteries, all the cooling there.

The way the vendors are going to now is very modular. So, imagine, like, a typical 40-foot truck, shipping container -- those will typically hold two megawatts. So, if you needed five megawatts, roughly, you have three forty-foot containers. So, the land use -- and that will have your battery system, your inverter -- is very, very small.

COMMISSIONER BROWN: Okay. Thanks.

MR. KUZNAR: Great. So, I just wanted to touch on one last use case. And again, I think we -- we've discussed this. You know, again, like I've mentioned before, we've -- we've got that 50-megawatts currently broken out to about seven projects.

And they're -- fall into these -- similar to these three buckets. We've got a couple of other use cases we're looking at, but we think these are, you know, probably the biggest hitters, you know, capturing the distribution value, critical facility, transmission value.

But as we mentioned -- I mean, as you -- as you increase your solar on the grid, it does start to create -- you have to plan for it, right, you can't just throw it out there. You know, you're constantly balancing supply and demand.

Having something as a sink or to store and react we think is very valuable. So, you know, I think you talk about the four biggest -- I don't want to say issues, but challenges for grid operators with -- with solar is intermittency.

And you know, we see that any solar farm -- you know, clouds come over and you lose it. You know, you have a solar eclipse, which is rare, you know, you could lose it very quickly and bring it back on.

You're balancing -- you know, when you get to the point where you have a thousand, 2,000, 3,000 megawatts of solar down here, it's something you have to plan for.

Ramp rate -- you know, the eclipse is a perfect example, but at the end of the day, when you lose that generation, and let's say you're peaking in the evening, you've got to have standby generation to do that.

Batteries could be a -- you know, a way to deal with some, and maybe eventually all of that, energy shifting. You know, you've got -- you could have instances where you have those kind of cooler shoulder months and, as you increase your solar penetration, you know, do you ever dip into your -- your kind of base-load generation. You know, that's down the road, but something to think about, how you capture that and shift it to the peak needs.

And then just enable to increase capacity. You know, a lot of times, you'll oversize the solar on the DC side of the inverter so you're producing max output, but there's clipped energy there. So, again, we see a lot of value.

You know, we're excited about getting these

50 megawatts out in the grid to kind of get to that scalable piece where we can truly start to show the value and, you know, hope to start at least announcing some of our initial projects in the next -- next few months.

So, you know, in summary, we've kind -- we've been following this for a while. We think it's reaching that kind of tipping point for adoption. You know, I think, when you look at the business case for storage, you've got to think outside the box a little bit because, like, when I showed you that -- that distribution upgrade, right, you've -- I could increase my substation capacity, I could use storage to do that, and I could also use that battery for a lot of other functions the rest of the year.

You know as costs, obviously, continue to decrease, use cases will increase. You know, you've got to try to capture the stacked benefits of looking at how you capture the transmission distribution generation value. You don't want to, you know, really, I don't think, undervalue what this stuff can do and the flexibility it can just provide to the grid.

And so, you know, as -- we're preparing, you know, as a Florida grid operator to use storage in many functions. So, we're excited about getting these projects out.

And that's -- that's all I have.

CHAIRMAN GRAHAM: Zach, I've got a quick question for you.

MR. KUZNAR: Yep.

CHAIRMAN GRAHAM: You mentioned the -- the eclipse in the Carolinas. What exactly happened up there and how did they handle that?

MR. KUZNAR: Right.

CHAIRMAN GRAHAM: I mean, that's an extreme case, but --

MR. KUZNAR: Very extreme.

CHAIRMAN GRAHAM: I guess you've got to -- you've got to plan for that.

MR. KUZNAR: Right. So, at the time, you know, it was done -- this is, I think, something we're thinking about just overall. So, the way that was handled was we had a lot of spinning reserves. We had a lot of our gas facilities, you know, on standby. The -- the sun dropped off, the gas facilities ramped up; as the sun came back a couple of minutes later, they ramped down.

But when -- you're talking about how do you quantify that, right. You know, when I -- when we think about base-load generation, when I think about a gas plant or a new plant or coal plant or whatever it is, the optimal way to run those is at, you know, peak capacity and, you know, kind of maximum peak rates to get the most value.

You know, as you start having more and more intermittent generation, you start turning on, let's say, peaking facilities that you otherwise wouldn't turn on. It's just to deal with the supply-demand balancing.

So, you know, I think you want to make sure you're doing it the most cost-effective way, but as we see storage come down, tech- -- like, if you're just taking technology -- take costs out of the equation, I think, you know, the application of using storage for fast response just makes a lot of sense.

So, it's, how do you eventually have that right mix of, you know, you're ramping CTs versus I've got something that can, you know, basically respond immediately, doesn't have a fuel source. You're operating it in the most optimal way, but I think it's also a balancing act with, is it the most cost-effective I'm just using for that application.

But in the Carolinas, it was -- and in other places like California, with the duck curve, they're fo- -- they're using a lot of natural gas to do that.

CHAIRMAN GRAHAM: Thank you.

Commissioner Clark.

COMMISSIONER CLARK: Thank you, Mr. -- thank you, Mr. Chairman.

When it comes to capacity and output of the -- the systems with energy storage cap- -- solar with energy storage --

MR. KUZNAR: Right.

COMMISSIONER CLARK: What are you seeing in terms of its -- its contribution toward firm peak? Normally we're seeing -- I think you see 50-percent contribution of solar toward firm peak. What do you --

MR. KUZNAR: Right.

COMMISSIONER CLARK: -- up it to when you go to bat- -- when you put energy storage on top of it?

MR. KUZNAR: Right. I don't know if I've got a good answer for you there. I think it's something we're starting to really think about with, if you have storage paired with solar, what kind of capacity value can you give that, but you know, I would say, right now, where we see a lot of the value is kind of the distribution side, the transmission side, in dealing with the intermittency. And I think, as costs come down and durations become longer, I think that's where you're getting that, you know, solar-plus-storage peak-capacity needs.

You know, at the end of the day, like, the way I view it is you don't -- you don't necessarily have to have the storage at the solar location. I think there's a mindset that, like, if you have solar, you put a battery there and you get this, you know, firmed-up kind of, you know, base-load generator.

To me, the most valuable spot is finding the location that gives -- has the most distribution value, and then layer in those bulk-system values. So, you know, if I could have a solar farm, you know, on land somewhere, I don't necessarily have to have the battery paired with that.

COMMISSIONER CLARK: From -- from a regulatory perspective, I think the -- the idea of being able to displace potential transmission costs --

MR. KUZNAR: Yeah.

COMMISSIONER CLARK: -- is -- is -- that's a very interesting perspective. But I am curious how we began to look at what the cost justifications are when it comes to adding these components, for example, when you start looking at what are the true capacity costs of that unit --

MR. KUZNAR: Right.

COMMISSIONER CLARK: -- with storage, without storage versus what your traditional generating capacity costs are, based on what your contribution to firm peak is.

MR. KUZNAR: Right. I'm probably not the best person to answer that. I don't know. You know, we do have, like, our -- I think it's something that's being -- it's going to be integrated into kind of part of our IRP going forward when you're looking at what's the cheapest sort of, you know, peak -- peaking costs, but I would say, you know, like I said, right now, where we are, I think the -- kind of the use cases I discussed are probably the most cost-effective now, but as the lithium-ion costs continue to come down, I think that's where you're going to see, okay, where is solar, where is storage. If I pair them, how do they compete maybe

with a future peaking unit.
COMMISSIONER CLARK: Thanks.
MR. KUZNAR: Yep.
CHAIRMAN GRAHAM: All right. Zach, thank you.
MR. KUZNAR: Great. Thank you.
CHAIRMAN GRAHAM: I appreciate your time and your presentation.
MR. KUZNAR: Thank you.
CHAIRMAN GRAHAM: Next up is Florida Power & Light.
Dr. Sim, welcome back.
DR. SIM: Thank you. It's always nice to be back.
All right. Our presentation today covers essentially three perspectives of how FPL is -- is viewing storage facilities. First of all, I'll talk a little bit about some of the smaller-scale storage projects we've been looking at and examining the results of over the last couple of years.
Then I'll turn to what we're doing right now, which is the 50-megawatt pilot project that was part of the settlement agreement.
And then finally, I'll close with kind of a look ahead as to what we're doing now to provide

proper valuation of batteries in terms of resource planning; how we see batteries being used on our system.

So, essentially, this is the -- the same overview, the -- we initially began deploying smaller-battery projects, roughly a total of about four megawatts, distribution-connected projects starting about 2016.

Then, later in 2016, we reached the settlement agreement, which authorized 50 megawatts of pilot projects. These are larger utility-scale-type batteries. We have 14 megawatts of those currently on our system in solar-plus-storage applications.

We have another 10 megawatts about to go in, in early 2019, and we think that all 50 megawatts of the storage pilot projects are going to be in service by the end of 2020.

And we have one additional pilot that's outside of the pilot program that I'll talk a little bit about as well; and then, finally, close, as I mention, with how we, as resource planners, are looking at batteries and how they might best be applied to the FPL system.

The smaller pilot projects began about two years ago. In Miami-Dade, we had one project where we were looking at using what we call second life of car batteries. And we were installing them to try to look at how fuel-cost savings might be gained on the system from this small project. It was 1.5 megawatts, four megawatt hours.

Another one was out in Everglades National Park. We had essentially what was a fishing camp or village out at the end of a very long feeder that was having some problems in terms of reliability. So, a battery was placed there to see if we could ameliorate some of those service problems out there.

Then -- and in -- in addition, in the Broward, Dade, and Palm Beach County areas, we tried some, what we call, community energy storage, which was, at various residential sites, we would put very small-scale batteries to see if we could reduce some of the momentary outage problems we were having.

And then, finally, in the smaller-scale effort, we had a mobile, uninterrupted power supply service, which was essentially a big truck with a big battery that we could move from place to place at various locations and see if we could service special events. And I'll talk a little bit more about those, each one of them.

The one in which we did the second life of car batteries -- we got the batteries at a fairly-low price; however, we -- we ran into problems with pretty high integration costs of connecting it with our system and integrating it with our system control.

So, overall, probably the best thing that came out of that is we had a lot of learning that came out of the integration into our system, which was valuable to us.

In regard to the Florida Bay Project, which was the remote fishing village -- it's one in which we don't have a lot of those type of customers out there. And we did have some problems in integrating an indoor system so that, when our power and the battery were trying to switch in and switch off, we had some problems in tripping the system for that customer.

But we learned quite a bit in terms of that integration, which we think we -- is going to be helpful for larger scale microgrid projects where there might be solar, batteries, and utility connection.

The community energy storage at the

residential sites -- it was very effective, but at the time, those batteries were quite expensive and it wasn't a cost-effective application, at least at that time.

And then, finally, on the mobile uninterruptible power supply system -- we used it at a couple of sites. One of them was the Sony Tennis Open, down at Key Biscayne, but it was a -- turned out to be a limited opportunity.

This very large truck with very heavy battery was affectionately known as the "bridge-buster." And so, we couldn't take it to too many sites, but it was -- it was very useful in term- -- in learning in terms of how we would have to integrate a remote battery that was moveable in term- -- in case of a natural disaster or other type situation where we would need to supply uninterrupted power, at least for short periods of time.

Moving on to the larger-scale 50-megawatt projects, the first two of those are in. One of them was an existing -- actually, the first two were existing solar sites. One is at the Babcock Ranch solar site in Charlotte County.

And this was a solar-plus-storage application of a 10-megawatt battery with a four-hour duration.

And it was connected on the AC side of the -- of the facility. And this went in about six or seven months ago.

There was a second one at our Citrus solar site in DeSoto County. This is on the DC side, is where the connection of the battery was. It was a four meg- -- it is a four megawatt, 16-megawatt hour or four-hour-duration battery going in about the same time. And I'll talk about those and the other items on this page in a little bit more detail on -- on subsequent slides.

In Miami-Dade, we currently are going through the permitting for a ten-megawatt battery that will be part of our distribution system. As Duke Energy Florida just mentioned, this was one in which we were just trying to defer an upgrade that otherwise would have been needed on our distribution system. And that is proceeding and, in mid-next year, that will be in service.

Then the last one in this upper table is a vehicle-to-grid application. We're looking out at automobile manufacturers projecting that, by 2023, there may be as many as 100 to 120 new car models that are electric cars.

So, we're seeing a lot of mobile batteries being added to Florida and to the rest of the U.S. And what we're trying to do here is get a first step in and look to see, is it possible to integrate use of those batteries at peak times in order to discharge those batteries into the system.

And then, finally, there is one that is mentioned here that is not part of our 50-megawatt pilot program. And this is one in which we will put small-scale, five- to eight-KW batteries, directly on residential batteries, in order to test how they work for the customer and how we might be able to control them remotely to discharge back into the system.

And I'll talk a little bit about each of those now. The two solar-plus-storage projects -- I mentioned earlier, one is at Babcock Ranch, one is at Citrus. The Babcock Ranch is ten megawatts, four-hour duration, essentially. And it's connected on the AC side of the system.

Citrus, DC coupled -- it's a four-megawatt, four-hour duration battery. And those have been in service a little bit more than a half year. And we are learning a lot from them. And what we have learned from it, we like. And we'll get into that towards the end of the presentation as to -- as to where we may be going next with such.

Okay. And part of the idea of the solar-plus-storage is to get more solar energy out of a solar facility. And what I've drawn here is a -- it's a very simplistic conceptual design.

As you know, our solar -- current solar facilities are 74.5, or let's call it 75 megawatts. They're limited to that output. And if we were to design a solar facility which would never go above that 75-megawatt limit, it would -- it would operate similar to the blue line here, and we would essentially have the DC output, which is the solar arrays, putting out no more than 75 megawatts at any time.

But what we've learned is that's not the most efficient way to do it. It doesn't maximize the solar output nor does it minimize the cost of dollars per megawatt hour of solar output.

So, what we've designed is shown on the next slide. This is more like what -- how our current solar facilities operate. And as you can see, there's a dotted line that goes above the blue line.

And what that represents is the output of solar facilities, greater output, above the blue line, in other words, the area between the dotted line and the blue line, up to the orange line, both on the morning side of the curve and then on the afternoon side of the curve. That area represents additional megawatt hours from solar that are generated by our facilities.

But what happens is, by putting in more DC than the AC inverter limit -- and our facilities are typically a 1.5-to- -- DC-to-1-AC ratio, you see -- above the orange line, you see a shaded area, which would be additional output capable from the solar facility that is clipped by the inverter. It's just not allowed to come through the point of interconnection to our system.

So, the idea behind solar plus storage, on the next slide, is by installing solar facil- -- storage facilities connected with the solar, we are taking some of that shading above the orange line, storing it, and then releasing it in the later afternoon and early evening hours so that we capture a greater percentage of the megawatt hours that are generated from the solar.

And we think that this has significant benefits for -- for our customers.

CHAIRMAN GRAHAM: Dr. Sim, we've got a

question for you.
Commissioner Brown.
COMMISSIONER BROWN: Thank you.
Not an engineer. So, say you get the peak sun solar at 12:00, but your peak demand is at 5:00, 6:00, how -- but the battery is only four hours in duration -- so, that additional clipped energy that you're storing at the -- the peak of the sun gets to -- does -- how does it -- does it get depleted during that -- or when it turns on? When -- how does the actual technology work --
DR. SIM: It would actually --
COMMISSIONER BROWN: -- in use?
DR. SIM: Once -- once the solar output exceeds the 75-megawatt limit, the storage facility would begin capturing that. And it would simply hold it until the 4:00-to-5:00 p.m. hour when we peak.
And at the time, as the sun is going down and the output of the solar facility is dropping off and comes below the 75 megawatts, then the storage facility will begin releasing that energy onto the system.
COMMISSIONER BROWN: Got it.
DR. SIM: So, it charges it when it otherwise

would have been wasted and then discharges late afternoon.

COMMISSIONER BROWN: Got it. Thank you. That was good.

DR. SIM: All right.

CHAIRMAN GRAHAM: Doc, quick question for you.

DR. SIM: Yes, sir.

CHAIRMAN GRAHAM: So, you're showing here in your graph -- and I'm kind of picking on you, but this solar plant is rated for 74.9 megawatts.

DR. SIM: Or 74.5 -- just under 75.

CHAIRMAN GRAHAM: So, when you go over that, are you in violation of your permit that we gave you?

DR. SIM: We don't go over that.

CHAIRMAN GRAHAM: Okay. Just checking.

DR. SIM: Is this a trick question?

CHAIRMAN GRAHAM: No, just checking.

DR. SIM: All right. Yes, sir.

In terms of the AC-versus-DC connection, we don't have a winner yet. Our current view is probably something like this: The AC connection is probably a technology that's better known.

The ability to capture a great amount of the clipped solar energy with our current designs of the solar facilities -- probably the advantage would go to a DC connection, but -- but we could change the solar design and that answer might flip.

The cost -- we don't see a -- a definitive winner there. It's going to depend upon the design of the system and the -- and the specific case in which we're applying it.

The round-trip efficiency -- because we typically lose 10 to 12 percent of the energy that goes into the battery before it comes out, DC seems to have an advantage there.

And either one of these can be charged, not just from the sun; they can be charged from the grid if we run into a number of cloudy days or we need to charge the batteries at night.

So, it -- it's an open question as to which one we see as being the winner for our system, and we'll learn more as we gain more data coming out and as we do more analysis over on the side.

CHAIRMAN GRAHAM: Question for you, Dr. Sim.

DR. SIM: Yes.

CHAIRMAN GRAHAM: Commissioner Brown.

COMMISSIONER BROWN: Thank you.

Just going back to that clipped solar energy, being able to capture that, doesn't it make sense that that would be -- that it would be more cost-effective to capture that and then take advantage of the DC-connected technology?

I mean, if the AC -- it looks from your graph that the AC-connected -- you can't take advantage of that additional clipped energy, right?

DR. SIM: It -- in part, yes. Again, it depends upon the design of the system. And it depends -- also, there's a -- there's a cost component of this as well. And we're trying to figure out how you optimize the amount of energy that one could capture and the amount of cost that's involved into it. We're try- --

COMMISSIONER BROWN: Is DC more expensive than AC?

DR. SIM: It depends. That's the -- unfortunately, that's --

COMMISSIONER BROWN: You talk like a lawyer.

(Laughter.)

DR. SIM: I've been up here too often.

That's one thing we are finding, is there are a -- there's a lot of information about batteries that we're just starting to know. And it's going to take more experiment, a lot more analysis before we come up with a winner. And the winner may not remain the winner as we look at different applications.

CHAIRMAN GRAHAM: Dr. Sim, I apologize for my colleague calling you a lawyer.

(Laughter.)

DR. SIM: My brother is a lawyer.

Moving on to another project that's -- that's on the drawing board right now -- it will go in service in mid-2019. This is the ten-megawatt four-hour battery in urban Miami. It's designed to defer a distribution upgrade by about four years. We're learning a lot about how you design and permit batteries in a dense urban area.

And one thing we'll be looking at is to see if we can stack benefits, which means you design and operate the battery to address the distribution system, but at the same time, can you also capture system-generation benefits. Can it reduce the system peak load as well as the distribution-system peak load. And that's one thing that we will learn more about once the battery goes in service next year.

Another one we're interested in is this vehicle-to-grid approach. And we're starting small with an electric bus pilot. This is scheduled to go in service early next year.

We're looking at a private school bus system and looking at ten electric buses. Each one has batteries of about 70 KW. FPL will own the batteries; the host company will own the vehicles.

And the idea is to see if, during the day after the bus charge- -- the school bus routes are run, particularly in the afternoon, after the children are let out, is there still sufficient charge left on the batteries to where those vehicles could discharge back into the system during our peak hour and help to meet peak load. This is an interesting one, and I'm looking forward to -- to seeing how this works in practice.

The next one we've got is -- this is one that we're going to do outside of the 50-megawatt pilot project, primarily because we're going to go into residential homes. And there is the potential for unintended consequences there.

So, up to, perhaps, 20 employees will be used for these -- as sites for the initial batteries. And I volunteered for this program. I'm interested to see how this works. The idea is to see how it saves -- or how it best serves customers; the idea being that these batteries will be of a sufficient size that they could run, perhaps, refrigerators, lighting, and certain plugged loads for up to 10 to 12 hours.

So, in the event of a storm or an outage, this might be a boon to customers, but we also want to see, just like with the vehicle-to-grid application, do we have the ability to discharge the energy that's stored in those batteries back to the grid as kind of a reverse load-control application.

And that -- this one should be up and running early in 2019.

CHAIRMAN GRAHAM: Dr. Sim, what is the dimension of that battery? Is that about the size of a small refrigerator?

DR. SIM: I would say it is the size of a relatively small television.

CHAIRMAN GRAHAM: Okay.

DR. SIM: And if I get one on my home, I will know for sure.

CHAIRMAN GRAHAM: Thank you.

DR. SIM: Yes, sir.

All right. Now, for battery valuation, this is where we're looking at -- at batteries as -- with my resource-planning hat on. In addition to the solar-plus-storage or the T-and-D applications, we're trying to look at how batteries might generally be used on -- on a utility system, particularly FPL's system.

Now, from a planning perspective, we look at it as capacity. You could -- you could have a battery that could meet reserve margin or help to meet reserve margin the same way that a new combustion turbine or combined-cycle-type power plant could.

Also, there are a number of operational aspects of it. One of them is energy arbitrage where you charge it during low-cost periods and you discharge during higher-energy-cost hours, in order to -- in order to low- -- lower energy costs for our customers.

Contingency reserve is one where you keep the battery in a state of charge and you discharge it only when you have immediate capacity needs such as if a power plant goes down or a transmission line goes down.

Frequency regulation reserve -- we keep the battery charged. We dispatch it only to maintain system frequency near the 60-hertz level. Voltage support, you keep it -- the battery in a full state of charge and then you either absorb or provide reactive power to maintain the grid voltage or a stacked application, which could be a combination of some or all of these operational applications.

And we're just beginning to do the analysis of how this would work on the FPL system, but our current view right now, subject to change, is the biggest potential benefit category for FPL is to use these as if they were power plants in meeting reserve-margin needs.

Energy arbitrage on the FPL system -- the analysis we've done to date says it's significantly less benefit than is the capacity benefit. And that's largely because there's not a big difference in marginal energy cost on our system between on-peak hours and off-peak hours because nuclear energy -- we've got a lot of very low-cost gas fuel being burned in very highly-efficient gas-fired units, and we're adding more solar as we go.

So, you need a fairly large on-peak-to-off-peak differential and energy cost for energy arbitrage to be a significant contributor. And on our system, we just don't have that.

Contingency reserve, frequency-regulation reserve, voltage support -- all of them are even less than energy arbitrage on our system. And when we looked in our analysis at stacking these applications, if you stack energy arbitrage and the three items -- or three categories below them, you're getting a negligeable increase over energy arbitrage alone because, at certain times of the day, they can either do one function or the other; they can't do both. They're a limited amount of output or discharge from the batteries. So, we're not seeing a lot of benefit here other than from capacity.

And I guess that brings us to where does FPL go next with this. And I think what you will see in the -- in the next year -- perhaps as early as our next ten-year site plan -- is I think you will see that FPL will be doing more solar-plus-storage, probably with 20 to 30 megawatts of storage on our solar facilities.

And I think you may see batteries being added for capacity purposes, for reserve margin, and loss-of-load-probability reasons, and the -- the extent to which that will occur -- well, the analysis is still ongoing, but I think you will see that in our next ten-year site plan to some degree.

CHAIRMAN GRAHAM: Dr. Sim, I've got a quick question for you. Is battery storage the most economical storage -- energy storage? I'm sure you guys have done some sort of comparison like looking at water towers, looking at pressurized this or that. I mean, is it the most economical or is it just the most efficient?

DR. SIM: I think it's the most economical, certainly for utility-scale applications, yes, sir.

CHAIRMAN GRAHAM: Any questions, my colleagues? No.

Dr. Sim, thank you very much. Thank you for your time.

DR. SIM: Thank you.

CHAIRMAN GRAHAM: Thank you for coming down.

Okay. It is time for public comment. If there is anybody out in the public that would like to come and address us, we'll give you three minutes. If you'll just give us your name and address, and we'll go from there. Going once, going twice -- okay. No public comment.

All right. Then I believe this concludes our ten-year workshop. I do thank all of our participants very much for their time and their effort in putting together this presentation.

The clock we have in the back -- looks like

it's 20 minutes to three. We will reconvene for
our next meeting at ten 'til three.
We're adjourned. Thank you.
Travel safe.
(Whereupon, proceedings concluded at 2:38 p.m..)

CERTIFICATE OF REPORTER

STATE OF FLORIDA)
COUNTY OF LEON)

I, ANDREA KOMARIDIS, Court Reporter, do hereby certify that the foregoing proceeding was heard at the time and place herein stated.

IT IS FURTHER CERTIFIED that I stenographically reported the said proceedings; that the same has been transcribed under my direct supervision; and that this transcript constitutes a true transcription of my notes of said proceedings.

I FURTHER CERTIFY that I am not a relative, employee, attorney or counsel of any of the parties, nor am I a relative or employee of any of the parties' attorney or counsel connected with the action, nor am I financially interested in the action.

DATED THIS 7th day of November, 2018.

ANDREA KOMARIDIS
NOTARY PUBLIC
COMMISSION #GG060963
EXPIRES February 9, 2021