FTC Workshop - Something New Under the Sun: Competition & Consumer Protection Issues in Solar Energy
June 21, 2016
Segment 1
Transcript

MARINA LAO: Good morning, everyone. May I have everyone take a seat please? Good morning, and welcome to our workshop on Solar Distributed Generation. My name is Marina Lao and I'm the Director of the Office of Policy Planning at the FTC.

First I'd like to thank all our speakers for taking time to come here and share their expertise with us. And I'd also like to thank the workshop team members and the staff for their considerable efforts in putting together this workshop.

Next I need to quickly review some administrative details before we get started. Now this is very interesting. Please make sure your cell phones are off or silenced. And if there's an emergency, please listen for instructions over the building PA system. If we have to evacuate, the door to use is the 7th Street entrance. Make a left for half a block and then cross the street to E Street and wait there until we're told it's OK to return to the building.

If you have to leave the building during the workshop, you'll have to go back through security screening again. So keep that in mind, especially if you're a panelist.

Lunch is on your own. There's a cafeteria on this floor.

The workshop today will be webcast and recorded. I'd like everyone to know that by attending you are agreeing that your image or anything you say or submit may be posted on the FTC website or social media.

So one final quick note on our use of the webcast and social media, and about the Q&A session from the audience, about Q&A from the audience. The workshop is being webcast live from the FTC website. We hope that those who are interested in the program but can't be physically present today will take advantage of the webcast.

Whether you're in the audience or watching on the webcast, you can also follow updates from the workshop on Twitter @FTC and using the hashtag #FTCSolar.

If time permits, the moderators of the panel will take a few questions at the end of the panel. So what I've asked you to do is to please write any questions that you may have on the index cards that are available from the registration desk. And also from a staff member here in the room. The question cards will then be collected by a staff member and brought to one of the moderators on the panel.

So with these housekeeping matters out the way, we turn now to the substance of the program. It is my pleasure to introduce Edith Ramirez, Chairwoman of the FTC, to open the workshop today. Chairwoman Maria Ramirez was sworn in as a commissioner of the FTC in April of 2010.

She was designated by President Obama to serve as the agency's chairwoman in March 2013. And she has served in that capacity since then. The Chairwoman has strongly supported our efforts in this project throughout. And we're extremely grateful to her for that support. So please join me in welcoming Chairwoman Ramirez.

EDITH RAMIREZ: Thank you, Marina. And good morning, everyone and welcome to the FTC's Solar Energy Workshop. Nearly forty years ago, the FTC held a symposium to examine the then developing solar energy industry. And that symposium looked at the emergence of new technologies including photovoltaic arrays for generating electricity and stressed the importance of competition and consumer choice.

Today we're exploring many of the complex issues that arise when consumers generate their own electric power using solar voltaic panels. A practice known as solar distributed generation, or simply rooftop solar.

There's a real possibility of a future in which individuals and small communities will generate a growing amount of their electricity needs at or near the point of consumption, instead of drawing that power via the electricity grid. But whether this decentralized future becomes a reality depends on how expensive distributed generation is compared to utility scale generation after factoring in all the costs.

The FTC believes that competition in the marketplace should play a key role. As the nation's Competition and Consumer Protection Agency, we want to ensure that rooftop solar, no differently from any other technology or product, develops in an environment of vigorous competition and responsiveness to consumer demand.

For solar power, however that environment is complex and multi-layered.

Rooftop solar necessarily competes in a much broader market for the generation and distribution of electric power. That market is regulated to varying extents at the local, state, and federal levels. Consequently, policies and decisions made by utilities and regulators, like those affecting net metering, which gives rooftop solar customers credit for excess electricity that they generate, could render the environment more or less hospitable for the growth of solar distributed generation.

Furthermore, solar power, similar to other renewable sources of electricity generation, receives certain federal and state subsidies, such as investment tax credits.

A patchwork of subsidies and incentives, however, may create an environment that leads to uneven or inconsistent growth of solar distributed generation, because they can cost a misallocation of the resources needed to stimulate competition and consumer-focused strategies.

The FTC has convened this workshop to gain a deeper understanding of the complex matrix of laws, regulations, policies, subsidies, and incentives that apply to solar distributed generation.

Our hope is this will help policymakers assess how best to protect consumers in connection with their purchase, installation, and use of rooftop solar.

Today's discussion will also help us identify and isolate competition concerns, such as use of the regulatory process to block or impede the adoption of rooftop solar.

Now as I noted at the outset, the FTC has had a longstanding interest in electricity markets, including in solar power. In the intervening decade since the FTC held its first workshop on solar power in 1977, the Commission has admitted numerous comments in an effort to inject competition analysis into the dialogue regarding how best to structure wholesale electricity markets.

We've also issued reports that detail consumer protection and competition issues in the electric power industry and have held several workshops related to energy and electricity markets.

More recently, states have been exploring ways to reform electricity markets at the distribution and retail levels of the supply chain.

The FTC has submitted comments in connection with a number of these state efforts and regulatory reviews including, most recently, multiple comments to the New York State Public Service Commission in connection with its Reforming the Energy Vision proceeding.

In June of 2015, the FTC issued consumer education guidance on issues related to rooftop solar. The guidance explains solar power options to consumers and provides advice on how to decide if solar power is right for them. It also discusses the issues and questions consumers might ask in connection with purchases, leases, and purchase power agreements for rooftop solar.

In the FTC's Green Guides, we've also provided guidance to businesses concerning marketing claims related to solar and other renewable energy sources.

And finally, where there's evidence of a law violation we will take action. For example, this past March in coordination with the Department of Justice, we brought a federal court action to stop a telemarketing operation that we contend made illegal robocalls promising consumers energy savings in an effort to generate leads to sell to solar panel installation companies. Although our complaint did not directly involve participants in the market for rooftop solar, it does serve as a cautionary reminder to all businesses to exercise care when selecting third parties to assist with their promotional efforts.

In addition to supporting our competition and consumer protection advocacy with respect to electricity markets, my hope is that today's dialogue will yield additional information to the many state legislators, regulators, and attorneys general who are grappling with the complex issues surrounding retail electricity rates and the consumer and competition issues that could arise when consumers turn their homes into sources of distributed generation.

For our program, we've gathered federal and state officials, academics, representatives of electric utility, solar industry, consumer and regulatory associations, and market participants.

We'll begin with a framing presentation by Dr. Severin Borenstein, a professor of Business Administration and Public Policy at the University of California at Berkeley. Who will explain some of the background economics of the electricity industry and the economic implications of incorporating solar distributed generation onto the electricity grid.

Our first set of panelists will discuss how solar electricity generation has grown in recent years and whether we should expect that growth to continue. They will explore the sources of that growth, how consumers and incumbent utilities have reacted, and what we might reasonably expect from the solar industry in the future.

The second panel will discuss some of the issues surrounding net metering and other ways to put a price on the excess electricity that rooftop solar customers generate. In most jurisdictions as you know, retail electricity rates are the product of rate-making proceedings overseen by state regulators. And there's significant debate about whether the retail price is the appropriate price at which utilities should compensate solar customers for the power that they generate, which our panelists will be delving into.

Then following the two morning panels, we're fortunate to have Chairperson Ellen Nowak, of the Wisconsin Public Service Commission and Commissioner, Ann Rendahl, of the Washington State Utilities and Transportation Commission, join us today to share their experiences relating not only to some of these rate making issues but also to competition and consumer protection issues as well.

In the afternoon, two separate panels will explore issues related to competition and consumer protection. During the first afternoon panel discussion, participants will explore the differing viewpoints concerning the roles of regulation, competition, and antitrust in the electricity markets and their underlying rationale.

The last panel of the day will examine consumer protection issues raised by rooftop solar. Our panelists will explore existing guidance, the legal and regulatory environment, the role of industry self regulation, and what more, if anything, needs to be done and by whom.

With increasing rates of adoption, we want to ensure that rooftop solar develops under conditions of free and fair competition. And that consumers are well informed about its pros and cons and the options that are available to them. As the nation's principal advocate for sound competition and consumer protection policy, the FTC is very well positioned to assist with such efforts. Thank you again for joining us and I look forward to our discussion. Let me turn the microphone back to Marina.

MARINA LAO: Thank you, Edith. It is now my pleasure to introduce Professor Severin Borenstein, who will provide the framing presentation to set the stage for today's workshop. Professor Borenstein has also graciously agreed to participate on the panel later this morning.

Professor Borenstein is the E.T. Grether Professor of Business Administration and Public Policy at the HAAS School of Business at UC Berkeley. And the Director Emeritus of the UC Energy Institute at HAAS. He's one of the foremost experts on renewable energy.

Professor Borenstein's current research projects include the economics of renewable energy, economic policies which are reducing greenhouse gases, and alternative models of retail electricity pricing.

Professor Borenstein has served on many boards and committees, including the Board of Governors of the California Power Exchange, the California Attorney General's Gasoline Price Task Force, the Emissions Market Assessment Committee, which advise the California Air Resources Board on the operation of California's cap-and-trade market for greenhouse gases. He's currently chair of the California Energy Commission's Petroleum Market Advisory Committee, and is also a member of the advisory board of the Bay Area Air Quality Management District. Please join me in welcoming Professor Severin Borenstein.

SEVERIN BORENSTEIN: Good morning, and thank you for inviting me to participate both to do this framing presentation and to participate in the panel later this morning.

The framing presentation, I was told, what my job is to cover two areas. One is to give a broad background on electricity markets to people who are not that familiar with electricity markets. And then partially to give a quick background on the solar industry so that we have a common set of facts to start working from.

So let me start by talking about electricity for those of you who are not as deep in electricity markets. There are some things that make electricity unusual, if not completely unique, in thinking about market competition.

To begin with we have to remember that there are, in fact, four different business aspects to the electricity market. The generation side, transmission, that is the high voltage lines that bring electricity around the country, and then the lower voltage lines that run through neighborhoods and that are the distribution lines.

Finally, and this is not an engineering part of the business, it's the monetary side. There's a retailing aspect to it. I'm going to come back and talk about those in detail.

First, though, to understand what's really different about electricity. The first thing, of course, is that electricity is not storable. Or is only storable at very high cost. Now that's not really that unusual. Service industries are generally are selling a product that's not storable. But just like in service industries, that means inter-temporal arbitrage is very difficult to do. And that means that prices, or at least marginal values of electricity, can vary enormously. So we can see days in which the price varies by a factor of 10 to 100. Which we, of course, would never see in a storable commodity whether it's oil or oats or corn.

Second thing is electricity transmission is very low cost to transmit-- electricity is very low cost to transmit up to a capacity constraint. But beyond that, it's actually very expensive. And when those compacity constraints bind, it can be impossible. Meaning that inter-locational arbitrage can be very limited. So we can get very different prices in different locations without the ability to smooth those by arbitraging the price differences.

Critically, all producers are delivering electricity over the same system. And they're delivering it in real time. So that electricity grid is a common carrier of the product. And at the same time, that electricity grid has to remain in constant balance. Second-by-second supply has to equal demand. So that makes this an unusual industry in that all of the sellers are transmitting their product through the same distribution network. And that network has this public good aspect to it that somebody has to make sure the total amount extracted from the network equals the total amount injected minute-by-minute, or second-by-second.

This is a figure of the last decade's electricity system, because it is uni-directional. We see generation, a step up in voltage to the high voltage transmission lines, transmission to local areas, a step down in voltage then, to do be distributed locally, and then the final use customers.

The model that we saw 20 or 30 years ago of a single vertically integrated utility doing everything is changing. The old utility model was there was a local company regulated, but did generation, transmission, distribution, and retailing. That is they were the ones who sent you the bill. And they were also the ones who were your procurement officer, or company. They went out and, on your behalf, procured electricity. Often by building it themselves, sometimes by buying it from other sellers.

The old model was that as long as you-- the utility went to the regulator and got permission, they could pass those costs through.

Experimentation began in the '80s and '90s, first with competitive generation. That is other companies did the generation and the utility purchased from them. It's worth noting that natural gas utilities have always had that business model. But in electricity, throughout much of the first 100 years of industry, the same company that did the transmission, distribution, and procurement also did the generation.

In the late '90s and early 2000s we started to see retail competition. So that last function I was talking about of retailing started to be done by other companies. A company would go out and procure electricity on your behalf. And then sell it to you. You would become a customer of somebody other than the utility. But that power still had to get across the grid to you physically. And that meant transmission and distribution lines. Those remained regulated, and to this day remain regulated, and are regulated as utilities.

Although that model of the late '90s and early 2000s of competitive retailing, continues in a number of states around the US. It actually was pretty much short-circuited by the California electricity crisis in 2000-2001.

When the California ran into a number of problems with their restructured market, the states that weren't already pretty far down the restructuring process just froze the process. However, in the last five years, we've seen a new form of retail competition. Not by a for-profit companies, but by non-profits. These are generally referred to as community choice aggregators, or community choice electricity suppliers. And they are generally some sort of governmental body, often a city or a collection of cities, that get into the retail business procuring on behalf of customers and selling to those customers. Generally the utility still has-- is competing with those CCAs in most

places. But in some places, including California where CCAs have gotten a lot of traction, the CCAs actually have a default opt-in. That is that customers, if they do nothing, are switched over to the CCA.

The incumbent utilities, however, are still providing service in the form of transmission and distribution services-- the delivery services. That's really not likely to change any time soon. As long as we need a grid to deliver electricity, it's very unlikely we're going to have competing grids. That is we're very likely to still have a natural monopoly in that transmission and distribution system. The economies of scale dictate that. And that's something that we have to think about when we think about what's the business model going forward. That those grid services still have to be provided.

Now distributed generation is changing the model further. Utilities now-- some people think of that as, Well now you don't need the grid as much. In fact you need the grid even more. Those grids are now providing two-way distribution services. That could change as storage becomes cheaper. But we're probably many years away from the point that many customers, particularly residential, are ready to cut the cord and actually go off grid.

Finally, and I think this is important to recognize, technology is really changing the way we can actually communicate with the customer. And actually even get the customer to respond. Customers have much greater computing power that can read prices, or read other aspects of the grid, and actually change behavior automatically. People aren't going to probably flip on and off lights in response to high electricity prices, but their computer very well could. Or could reset air conditioning by a degree or two.

So you need another slide now to understand the electricity system. This is one I pulled off the web. There are many of them. This is interesting-- that shows that there's going to be storage and distributed generation and so forth. It does, as often happens, equate clean with local power. And of course while it is true that solar photovoltaics generate no greenhouse gases and no ambient air pollution, that could also be done at the grid scale. And one of the discussions that's going on that I'll come back to is competition between grid scale renewable power, both wind and solar. And wind at this point really isn't economic at the distributed level. With a local distributed generation and rooftop solar.

So what I want to do is run through some models of electricity generation, distribution, and retailing. The old model of generation, of course, was central station. The new model is some central station generation, some distributed generation at consumer sites.

The value of wholesale power, of course, depends on its location and timing and the impact on the grid. And it's important to remember there are also line losses when you send power across a grid. Some of it is dissipated as heat. Over a standard grid system that's often 7 to 9% is lost from generation to the actual usage point.

Distributed generation that is consumed on-site is effectively just reducing demand. Which in electricity parlance is known as load. But a lot of distributed generation is actually not consumed on site. In fact for a typical system being put in today, about half or more of the power that

comes off that rooftop, residential rooftop, actually is being injected into the grid. So there's a real question of how do we value that. And that is the big controversy-- one of the big controversies that I'll mention at the end here.

There are many models of electricity retailing. Of course the old model is that you have a utility. The utility does the procurement for you. They go to the regulator. The regulator says, That was prudently done, and assures them recovery of their costs through rate making.

The new model is these for-profits, or nonprofit, retailers who compete for customers. There is sometimes a default provider if you don't choose one. The retail competition applies only to electricity generation, not to transmission or distribution. Regardless of who your retailer is. You still have to use the utility grid to get power to your location.

There's also a question of, remember I talked about keeping the system in balance that everyone's using. Somebody has to be responsible for balancing the system second-by-second. And that is a system operator. In California, it's the California Independent System Operator. There's the System Operator to the Pennsylvania New Jersey-- well it's PJM since it's now much larger than Pennsylvania, New Jersey, Maryland. And somebody has to make sure that there are reserves available so that the system can always-- enough generation's always going on to exactly meet demand.

The model of electricity grid services is unlikely to change. Hasn't changed much and is unlikely to change. It's changed only in who is the operator. In the old model they were utilities that also were vertically integrated doing generation, distribution, and retailing. Now the grid operator is generally some independent party that's at least operating the transmission lines. And that's likely to remain because of this natural monopoly aspect of it. And this is one of the rate recovery challenges that the system faces. And that is, that's a natural monopoly. And by definition a natural monopoly is one where it's cheaper to add a customer to your existing system than to build a new system. Or in economic parlance, its marginal cost is below average cost.

The efficient price, which I'll come back to talk about in a minute, in markets, is to have price reflect that short-run marginal cost. But if we do that the utilities are unable to recover all of their costs. So the question is, How do we recover all those costs?

It's made more difficult because in almost every utility system, they're doing things other than running the grid. They're providing what are often termed public purpose programs. These are low-income programs, energy efficiency programs, and so forth. And somebody has to pay for those. Those are essentially fixed costs to your consumption. And so again, price is set equal to marginal cost is unlikely to be able to cover all those costs. So the question is how to cover that revenue shortfall.

And then there's the issue of how do grid services change in a system with distributed generation? As Chairwoman Ramirez mentioned, New York is going through a reexamining of these questions. Of how the grid should operate and who should be paying for what services in order to incent efficient behavior and efficient competition.

Distributed generation is one aspect that's changing that. Demand side response. More dynamic pricing. The changes hour-to-hour. Retail prices historically have just been constant. While the wholesale prices and the actual stress on the grid has fluctuated wildly because of the non-storability.

And then there's the question of, What is distributed generation contributing to the grid or imposing on the grid? Depending on your view. That is, How much is it actually lowering the cost of operating the grid or potentially raising the costs of operating the grid? And there's some real differences of opinion we will hear today.

So I mentioned retail rate design. This is one of the other areas that's going through significant changes. Of course economic efficiency dictates that setting retail price equal to short-run societal marginal cost. That means that-- short-run meaning, if in that hour there's a real shortage in the market, the price should go up a lot to reflect that scarcity that's there right now.

Societal, meaning it should not only include the cost of the generation and transmission, but also the externalities. The pollution that's generated in that as a result of your consumption.

What that would suggest is time-varying pricing, location-varying pricing, and an inclusion of externalities in the prices. We essentially don't do any of that right now in residential pricing. We're starting to see some time-varying pricing. We almost never see locational-varying pricing within a utilities area. Although there have been some moves to do that. We see only very slight inclusion of externalities. California does have a carbon market. So does the Northeast. Those costs are included. Those costs are nowhere near the general-- the common estimates of the true cost of greenhouse gas emissions.

Even if you did all that, efficient prices are unlikely to cover all the costs. There is a problem that we don't allow generation prices to rise to clear the market. There might be a good reason for that due to the lack of price signals to consumers. But it also means there is what's called the missing money problem. When you don't get those very high scarcity prices when the grid is short.

And there's the grid natural monopoly that suggests that saying price equal to societal marginal-- or short-run marginal cost is still going to be less than average cost. Adding in those externalities may actually cover some of that if the grid doesn't actually have to pay the externalities, but charges for them. But that's unlikely to actually balance the books.

And then this need to recover the cost of public purpose programs. And the reality is prices are far from efficient. There is little time or locational pricing. And the distributed energy resources are making all of this much more complicated. So retail rate design is an important part of thinking about how we incorporate distributed solar into the system in an efficient way.

Now because I know many of the people here today are not economists and there is often skepticism when economists talk about efficiency, I want to just remind you efficiency is not some vague economic concept. It's real value. Or loss of efficiency is a loss of economic value.

If the true marginal cost to society of providing a good is nine and we charge 11, then there's some people who value it more than the true marginal cost and don't buy it. Deals that could have created value don't get done.

Likewise if the true marginal cost to society is nine and we charge seven, there's too much consumption of the good. People actually value it less than the resources that are going into making it. Are buying it and using up resources.

Both of those create dead-weight loss. Dead-weight loss is deals either that shouldn't have been made that were made. And as a result resources were directed into lower value uses. Or deals that should have been made but didn't get made because the price was set above societal marginal cost.

That sounds like sort of a vague concept. Let me give you a real application. Let's think about, for a minute, the very realistic scenario that the short-run societal marginal cost of providing electricity is $0.10 a kilowatt hour. But because we have to pay for the grid, to pay for public purpose programs, et cetera, we're charging customers $0.20 a kilowatt hour. That's a pretty accurate approximation of California right now.

That is the equivalent, if you're asking people to switch to electric vehicles, of making it cost equivalent at not $1.75 a gallon but at $3.50 a gallon. So by charging a price that is vastly greater than short-run societal marginal cost, you're actually giving people an incentive to stay away from consuming electric vehicles. You're making it much less economic to invest in EVs.

Now in California. we are in the process of creating special rates for electric vehicles because that's something we want people to do. But we still want people to conserve, so we're trying to keep rates high on other things. Economists really get nervous when regulators start doing that. And deciding which are the good uses and which aren't. And generally would much rather see prices that just reflect society's marginal cost of consuming the good. And some of the time-bearing pricing and location-varying pricing moves have moved us in that direction.

How do we cover these costs? If we do have a shortfall? Well the way we've done it historically is just by raising the price-- the volumetric price of electricity. We can recover all the additional costs from a volumetric adder. And this sort of has an equity appeal because it says, Well, if you're a big consumer you pay a larger share of those additional costs that have to be recovered. And I think there's actually something to that. That people find that an attractive notion. But when you start charging a price well above the short-run marginal cost, you do give these inefficient incentives for people to use the product.

Second approach is a fixed charge independent of quantity consumed. This has great appeal on an efficiency basis because it's very hard to avoid it. It's very hard for people to change their behavior in response. But it really has some equity concerns. And particularly how, where, who is included in that fixed charge. Should Severin Borenstein's house pay the same fixed charge as the Google campus on the other side of the Bay? When they are consuming millions of times more electricity than I am? Or at least hundreds of thousands. That seems to most people unfair to distribute the cost that way.

We have used increasing blocked pricing. This is as a household consumes more, the price goes up. That really has no cost basis whatsoever. But it appeals to some people on equity grounds. I don't have time to do the full rant on that, but I think it's not a very good match.

Minimum bills are often discussed now. That regardless of how much you consume, you have to pay a certain amount. At the levels they're generally discussed these days, they would have almost no effect and raise almost no additional revenue. California is discussing a $10 minimum bill. If you get up to a much higher level of minimum bills, then it would raise additional revenue from the lowest consuming households. But it also, effectively, is giving away free electricity up to that minimum bill.

And then demand charges, which we probably won't have time to spend much time on. But they are surprisingly coming back into vogue. This is a charge for your highest single period use. Whether it's hour or five minutes usage. That for the most part are now being reshaped to look more like time-varying pricing. Because they're starting to shape them to say, Well your demand charge will be based on your usage in a peak period. And sometimes even in the highest peak period. And my view is that they are generally trying to use demand charges to move towards dynamic pricing.

All of these have very different implications for DG solar. The solar folks generally love volumetric pricing and hate fixed charges. If you're a DG solar retailer, your product is more competitive when the volumetric price of electricity is high. And if the customer has to pay a fixed-charge regardless of whether they put in DG solar and that has a lower marginal price, it's less attractive to put in solar.

OK, I got to move along and talk about residential PV. This shows the growth in PV generally. The low part of this-- I think this might be a little small for people to see-- is a residential. Residential is growing very rapidly. Prices have been coming down dramatically. Residential is the highest of these three lines. And you can see a solar panel costs have come down, everything-- a price of whether residential or grid scale solar has all come down.

You'll notice these lines are pretty close to parallel. The gap between them hasn't changed that much. And so the price of residential and grid scale solar has come down. But proportionally, of course, now the price of residential solar is much higher relative to grid scale than it used to be. As solar panel costs came down for every one.

Prices are continuing to decline both for residential, which is the left hand set of bars. These are the most recent data going into 2016. And for grid scale solar. And in projects in between.

It's important to understand for the discussion today how residential solar works. Like these panels convert light into electricity. Not going through a process of heat. That is they actually change the light that comes into the panels to electricity. That electricity is then converted from DC to the AC that your household can use.

When the household's, consumption is greater than the flow from the panels then all electricity from the panel is used at the household. Plus they bring electricity in from the grid when the

household's consumption is less than from the panels. Then all the electricity that the household needs comes from the panels. Plus they export to the grid.

Now if you don't have storage, it means that every second of the day you are either importing or exporting. There's virtually no chance that you are consuming exactly what your panels are producing. And so distributed generation is still using the grid. If anything it's using it a little more intensively. And that's probably not right. Either way, you were constantly had flow on the grid.

Some facts you need to know about residential solar. First of all half of all new and installed solar is in California. California's had very aggressive programs and California has good weather for solar. So we in California continue to lead the nation in solar installations.

We're not even close in the density of solar installations. Hawaii has over 10% of all households now have solar. And there's some other areas in the country that are equally high.

Prior to 2009, virtually all solar was purchased by the homeowner. Gradually that has changed and over the last few years about 70% of all new solar installations are not owned by the homeowner. They are either leased from a company that puts them on your roof. Or more commonly, the homeowner signs a power purchase agreement. The company comes and puts them on your roof and I agree to pay x cents per kilowatt hour for the next generally 20 years. And that x rises these days 2 or 3% per year.

There are a lot of incentives for installing solar today. There's a 30% investment tax credit which has now been extended. There is accelerated depreciation that a company-- you can't take it as a residential homeowner. But a company can take accelerated depreciation. In my estimates, and other people's estimates, suggest that that further subsidizes it about 10 to 14%.

There are tradeable renewable energy credits to the extent that rooftop solar meets a state's renewables goals. They can get credits for that. That further incentivize solar PV.

And there are retail prices that are covering more than social marginal cost. And to the extent that they do, that also increases the incentives for solar PV.

We hear the argument often that there are also tax subsidies for fossil fuels. And there certainly are. They are much larger than the subsidies for solar in aggregate. But on a per kilowatt basis, they're actually very small. In fact I did a calculation using numbers by a group that is sort of a left-leaning group that did analysis of subsidies for fossil fuels for gas and coal. Since we generate almost no electricity with oil, and it amounts to about 1/10 of a cent per kilowatt hour. So it's probably not the major driver.

Of course the biggest subsidy of fossil fuels is they don't have to pay for pollution emissions. And that continues to be the case.

We're going to talk today about electricity tariffs. The second session will be on net metering in particular. The idea here is that the customer sometimes is importing, sometimes is exporting. At

the end of the month, or year, when they have to pay their bill. What they pay at the retail level-- at the retail price is the net of the imports and the exports.

There's variance to that. There's some that say, Well, we're going to do net metering by time periods. There's going to be a peak net metering period and off-peak net metering period.

And then there are varying treatments of the customer-- if the customer actually is a net exporter. That didn't used to be a big issue because very few customers were installing solar systems so large that they actually generated more electricity than the household uses. As the cost of these systems have come down that's becoming a much bigger concern.

The alternative to the net metering is what is largely termed feed-in tariffs. But there are lots of variance to that. Where the customer's compensated for the electricity produced separately from the retail consumption.

There is an all-buy all-sell form that is, you've got your panels on your roof that has a meter. You get paid for it. It is completely separate from the wire coming into your house. And you pay retail for the wire coming into your house.

And then there is what is often termed a net feed-in tariff. In which you pay over very short periods for your net imports. Australia is doing that these days. Where over a five-minute or one-hour period, you are net metered. But you don't carry it over. And when you buy-- and have to pay for your net purchases. In those cases, if you're a net exporter during a period you generally get compensated at a lower rate than if you were-- than the retail rate you have to pay.

So let me conclude by talking about some of the solar residential debates we're going to cover today. One is, What is the value of DG solar electricity production? Generally, how should we think about that? Both the value to the grid and the value to the environment.

And then what seems to be a similar question but actually turns out to be quite distinct is, how much value does it does the utility get out of a customer installing solar? The utility loses revenue, of course, when they sell you less electricity. But they also reduce their cost. One of the huge debates that we will revisit today is, How does that balance out? Some people argue that the utility is actually saving more money, at least over the long run, than they are losing in revenue. Other people argue that the utility is losing money relative to the revenue they get. Obviously, if the utility is losing money relative to the revenue, they're losing more revenue than the cost they are reducing. Then there's now revenue shortfall and somehow the utility has to make that up. Or the shareholders have to pay for it. And that is one of the big debates.

And then, closely related to that, to the value that solar is bringing. The question of how should rates for residential PV be designed to create efficient incentives and for installing DG. So that DG is actually incentivized when it's bringing net value to society. It is not under-incentivized because the solar household isn't getting fully compensating and it's not over incentivized because they're actually getting compensation greater than the value they bring. And how should we actually compensate the solar household while at the same time making sure that the utility can cover its costs?

So those are the questions that I think are going to come up, at least this morning. This afternoon we're going to face a different set of questions. As we talk about the competition aspect of installing solar PV and making sure consumers are well informed. But I'm going to set those to the afternoon. And I think leave it at that. Thank you very much.

MARINA LAO: Thank you, Severin. The first panel will be coming up shortly. I'll just introduce the moderators. Ellen Connelly, attorney adviser with the Office of Policy Planning, and Mark Hegedus, who is an attorney with the Office of General Counsel. So could we have the first panel? Thank you.

ELLEN CONNELLY: Good morning, everyone. I am Ellen Connelly, an attorney adviser in the Office of Policy Planning at the FTC. My co-moderator today is Mark Hegedus, an attorney in the FTC's Office of General Counsel. We want to welcome you to our first panel of the day, which is entitled Laying the Groundwork: The Past, Present, and Future of Solar Power. On this panel we will explore the development of the solar industry and solar technology, the environmental implications of solar, the operational and cost impacts of solar distributed generation on utilities, and the drivers of consumer demand for solar. Our discussion this morning will provide the foundation for the rest of today's discussion. We have an impressive panel of experts here to discuss these issues. First, Elaine Ulrich is a Program Manager at the Department of Energy, where she leads the SunShot Balance of Systems Soft Costs Team. The SunShot Initiative seeks to make solar cost competitive with other forms of electricity by the end of the decade. Doctor Ulrich will discuss the history of solar power in the US and DOE programs to support solar.

Next, we have the Vikram Aggarwal, Founder and CEO of EnergySage. EnergySage is an online marketplace focused on consumer education. It provides objective information on different solar options and allows consumers to obtain and compare quotes for solar systems. Mr. Aggarwal will discuss consumer demand for solar and trends and solar costs.

Allen Mosher joins us from the American Public Power Association, which is the service organization for the nation's community-owned electric utilities. He is Vice President of Policy Analysis and is an expert in bulk power operations, reliability, and wholesale market operations. He will help us understand the operational and cost impacts of solar on utility systems as well as the role of solar in utility power supply portfolios.

James Critchfield is with us from the Environmental Protection Agency, where he is Director of the EPA's Green Power Partnership. The Green Power Partnership, launched in 2001, is a voluntary partnership that encourages businesses to use renewable energy as an environmental alternative to conventional energy sources. Mr. Critchfield will discuss the environmental impact of solar and will describe the role of renewable energy credits in the solar marketplace.

Finally, from the Smart Electric Power Alliance, we have Tanuj Deora. SEPA is an educational nonprofit that provides a neutral space for education, research, and collaboration on energy issues. Mr. Deora serves as SEPA's Executive Vice President and Chief Strategy Officer. And he will help us look toward the future of solar, in part, by discussing SEPA's 51st State Initiative.

There are more detailed bios of all of our panelists in today's materials. A few procedural points before we get started. Each panelist will make a short presentation. At the end of each presentation, the moderators may ask a follow-up question or two of the panelists.

At the end of the series of presentations, we will have some time for additional questions from the moderators and from the audience. If anyone in the audience has a question, please flag down one of our conference staff. They have comment cards and will collect them for us. And panelists, if you have something you'd like to contribute regarding a particular question during this last segment, please just turn your name card on its side or otherwise signal us that you'd like to speak.

And now, I will turn it over to Elaine to start us off.

ELAINE ULRICH: Good morning. Thanks for having me. So I'm probably not going to go over too much that wasn't already covered by our first speaker. So, very quickly. If you look at that the installation of solar over at the past several years, you can see that the growth in the solar markets has been extremely rapid. I think many times when folks are looking at solar deployment in the United States, they often feel that solar is synonymous with residential programs-- programs where people are deploying it on their rooftops-- but as you can see in the slides here, annual installations are primarily dominated by installations made by utilities at the utility scale-- large scale installations.

In addition to that, the vast majority of solar is being deployed in just a handful of states. You can see that California makes up almost half of the market up to this point. Although, we see significant growth if you look state by state. As folks put in place policies and programs that allow them to enable solar, we do see rapid growth rates. But California really got out ahead of things and it also represents 12% US population. So it's a fairly large energy consuming state.

Solar is now about 1% of US electricity generation. And the years of 2015 and 2016 have been really huge in growth. When you look at projected deployment of solar, there are a lot of different ranges for what that growth may look like. Much of the projections that have been made in recent years have had a large dependency on federal programs, particular the investment tax credits. And so again, you can see a huge range in the projections.

In general, most projections that made have undershot what the market has actually performed at. And again, there are a number of factors that impact that. But probably the biggest factor that has led to the extreme growth in solar deployment has been the lowering of cost in recent years.

At the SunShot Initiative, we have done in our own projections. We started doing those back in 2011, when we launched the initiative. And under those initial scenarios, we were looking at growths that would bring the installed capacity to 14% of generation in 2030 and over 20% by 2050.

So just quickly to go over again, a few of the major policies and things you might be hearing about today. Here is a nice reference table for you. The investment tax credit. There are actually two investment tax credits. One for residential customers and another for commercial customers.

That originally was set to expire in 2016. That tax credit has been extended, but it will have a step down as opposed to just a straight expiration.

Another set of policies that are typically put out at the state level are renewable portfolio or renewable electricity standards. These are standards that require a certain percentage of electricity to come from clean energy. Some of those have inclusionary targets specifically for solar. And it's very common to see that the states that have renewable portfolio standards-- that's probably one of the most impactful policies that a state can put in place in order to signal that it is open for business when it comes to deployment of renewable resources.

Again, I know there'll be some more in depth discussion of solar renewable energy credits, SRECS. There are also other renewable energy credits that could be applied to other technologies, like wind. So RECS, SCRECS are credits that are awarded to help to account for the clean energy attributes. So for example, you may install solar on your site, but sometimes folks sell those credits to utilities and others who need to meet compliance to show that they are procuring a certain amount of electricity that is generated by clean sources. And again, when there's an inclusionary target, specifically for solar if it's an SREC.

And then there are also a number of performance-based or cash incentives that have been put in place over time by a variety of states or jurisdictions. Again some of those could be in the form of tax credits or rebates. They have a huge range of mechanisms that they're put in by. Some of them are performance based, they're based on the number of kilowatt hours that you put in. Others are capacity based, the number of kilowatts, the size the system. Or others like investment tax credit are just based on the price of the system.

There are again, a couple of different kinds of solar ownership models that are out there. In one, the host may be owner of the system and they consume some of the electricity, they may be injecting some electricity back into the grid-- and in that case, an installer puts that system in place for the consumer and then they own it.

There are also third party ownership systems or TPOS. Those may come under either, what we call, power purchase agreements-- and that's where folks sign up on a contract to purchase the electricity-- or under a leasing model, in which the host has as a lease payment that they're making basically in contract with the installer.

In addition to that, there's an increasing amount of interest in, what we call, community solar or shared solar programs and projects. And those are projects that may not be located on the same site as the consumer. But where the electricity is credited to the consumer's account. Respective again of whether it's on their site or not.

And so again, what is the Department of Energy SunShot Initiative? Where do we fall into things here? And what is the role that we had?

This is an initiative that was launched in 2011. It's a presidential initiative. And the goal of that program was essentially to bring the cost of solar electricity so that it would be cost competitive with conventional forms of electricity by 2020.

When this program was launched represented a 75% decrease in cost that was necessary. And the goal was essentially between $0.05 to $0.06 per kilowatt hour without subsidies. So not taking into account the investment tax credit, the federal investment tax credit. And again, our goal was to do that within a decade, by 2020.

And we've made some pretty significant progress there. I think within the past quarter, we've seen that there was a utility in northern California, Palo Alto, that recently signed a power purchase agreement for 3.676 cents per kilowatt hour with the investment tax credit. So there are some isolated instances where these goals are being met, but not something's happening across the US.

The SunShot program is again within the Department of Energy, which has traditionally functioned as a technology development institution. We have five separate program areas. One in concentrating solar power, which are there the large mirror systems that concentrate light and heat onto a power tower and drive a steam turbine-- much like a conventional power plant. We work also on the development of photovoltaic technologies.

And then we have three cross cutting programs. One on systems integration that focuses on the grid, grid operations, and how we integrate solar into the grid. We have a program that's called Technology to Market that works with companies on innovations and manufacturing.

And then I lead the program on soft costs. Again the overall goal is to reach $0.06 per kilowatt hour. On the soft cost team the work that we do is primarily-- if I was going to sum it up three terms-- connecting people to information. And so the way that we do that is essentially by-- 1 Generating the information that's necessary to create more transparency in the marketplace. So we do a lot of work on data analysis. We work with our national labs in academics and others to help put that data together.

We do work on finance and business models. So that includes, again, new business models that help to increase the access of solar to the full suite of consumers across the spectrum in the United States.

We do a lot of work on training education and workforce. And that includes everything from your solar installer and your power system engineer all the way through folks who work in real estate and finance. Folks who their entire job may not be to do work related to solar, but they need information about solar in order to do their jobs and to make decisions.

And then finally, we look at best practices in all of those areas. And do a huge amount of work in helping to support networks and technical assistance, at the state and local level, on how to design programs and policies. Against to increase consumer protection and increase that transparency in the marketplace. So with that, I think I'm to ready to hand it over to our next speaker.

MARK S. HEGEDUS: Actually I'd like to ask a couple questions. Thank you very much for that informative presentation.

You mentioned the dramatic reduction cost. So what have been the drivers of the cost reduction? And also what do you see in the future in terms of cost reductions?

ELAINE ULRICH: So the drivers of the cost reduction are a couple of different things. One is particularly photovoltaic solar technologies. Those are based on semiconductor technology, which had a huge amount of R&D investment was made in the semiconductor space. I know that you all are familiar with computers, and smartphones, and all those chips and things out there. And so because it's a fundamentally new technology based on semiconductors, all those advances in the semiconductor field basically have been able to be pulled into what's been happening in solar.

There's also been a scaling of manufacturing capacity globally. In fact there was some overcapacity for a while in the marketplace. But overall, that overcapacity has driven a huge amount of competition in the marketplace. And there have just spend a lot of strong advances in how to do manufacturing, how to do it in a very inexpensive manner, and also the buildup of supply chains that have made it possible for solar to be very inexpensive in cost for the hardware.

In addition, as we've grown lots of programs, we've seen, for example, that when we study the kinds of policies that are most effective at the state level, some of them we know-- for example, again, the renewable portfolio standard is incredibly effective and impactful. But for the most part, the longer a policy is in place, the better that market functions as people learn how to navigate and use that policy. And so having stability and policies has also created a place where people have been able to learn, and to navigate, and reduce their costs when it comes to putting in place programs that support installation.

MARK S. HEGEDUS: Great. Thank you. Let's turn to Vikram Aggarwal. Thank you very much.

VIKRAM AGGARWAL: Hello, everyone. Thank you, Mark. Hello, everyone. I'm Vikram Aggarwal. I'm the Founder and Chief Executive of EnergySage.

Just to set a little bit of context about who we are and what we do, I will give you a little review of the data that I'll be sharing after this slide. So we think about EnergySage as the Expedia or the Kayak for solar. Consumers, whether you're a homeowner or business owner, if you're interested in installing solar, you sign up on our platform. It takes you a couple minutes. You tell us where your property's located, how much you're spending on energy, and if you have any preferences for equipment or financing options. We send that information network of pre-screened high quality solar installation companies. Typically between three and seven installation companies will then custom design a system for you, submit that quote through our platform. We standardize those quotes and present to the consumer those quotes in a matrix format. So people can very easily and quickly compare their options in an apples to apples format.

So that's our platform. We are serving customers in about 31 states. Have roughly 350 solar installation companies providing quotes through our platform. And a number of data that I'm going to be sharing with you is collected from what we learned from our consumer behavior. How installers are behaving, what prices are we seeing, what transactions are going through. So

that's giving us a very unique insight into what's happening in the solar industry. If you're interested in downloading some of our detailed data, you can check out EnergySage.com/data.

So with that context, this is a little bit of a repeat slide. I think our former presenters have talked about the growth of the solar industry. This is a slightly different view on the growth of just the residential market alone. 2016, as you know is turning out to be quite a milestone year for the industry. We now have more than one million solar installations in the United States. That's a big number. It took us about 40 years to get there. And the industry is expecting the next million to happen in the next two plus years. So very, very fast growth.

By the end of this year, the revenues of residential sector solar installation companies will exceed 10 1/2 billion dollars, bigger than that of Major League Baseball. We're about 18 months away from saying that we are bigger than NFL. But it's getting there.

[CHUCKLES]

And the reason for this growth is very simple. It's about economics. The average solar shopper on EnergySage is spending over $2,000 a year on electricity. They are installing roughly 7.8 kilowatt systems on their roof, which is allowing them to offset about 85% of their annual consumption. And they're able to generate an ROI of about 13% or better, depending on where they are. Essentially getting their money back or payback in just under 8 years.

So this is a very high level national view. We have additional data on different states-- how these numbers vary. But this is one of the key reasons why solar is becoming more popular and more consumers are now interested in installing solar. It's all about economics. I know there's a question coming about environmental impact and environmental reasons why consumers are installing solar. We'll talk about that in a few minutes.

So what we are seeing is the consumer interest in solar is increasing dramatically. As more and more consumers become aware of the benefits that solar energy systems can provide, their interest is peaking. And of course the million installations are causing a significant multiplier or peer effect. Folks are seeing solar installation has come up in the neighborhood and getting curious and starting to inquire about that.

This chart essentially shows the Google searches for just one key word, which is "best solar installation companies". The number of searches has tripled over the last few years.

Based on our research, we have determined that in 2015 about 12 million US households were considering going solar. About 4 to 6 million of them were actively shopping. Essentially they had either talked to a solar salesperson or actually received a quote. And another 5 to 7 million consumers were interested in going solar, but were sitting on the sidelines not knowing where to start and how to start their shopping journey.

But even with all this growth, what we find is that this industry-- especially the residential solar industry-- remains highly inefficient and opaque. Because most consumers who are shopping for solar are doing so for the first time, they have a lot of questions. They are uninformed

consumers. They have a number of choices. And I'll talk more about in detail about their choices when it comes to equipment, solar installation companies, and of course financing.

And these consumers generally find that they do not have access to a lot of unbiased truly objective information. EnergySage is still pretty young. So in most cases, consumers typically depend on the solar installer, the salesperson, for that information.

And last but not least, there is very limited standardization. Think about when you're going to buy a car. You have somewhat of an understanding what the different models of the cars are and what the relative prices and benefits are. So what does this situation is doing is it gives an opportunity for some of the salespeople to embellish their quotes or mislead consumers. So that's one of the issues that we are seeing in the industry.

Let's say if some of you may have actually done this, or if you try to shop for solar, what you'll find is that solar prices are widely dispersed. On our marketplace, we are seeing solar prices range anywhere from $2.50 a watt to over $5.50 a watt. That can be an over $20,000 difference between the low and the high prices that the consumer may actually see.

Some of these prices can easily be explained by the quality of the solar equipment that is being offered. But at times it also is reflective of the installers understanding of the consumer's ability to pay. So these prices sometimes are not truly rational. They're still trying to maximize the margin on every deal.

As you know, this industry is very fragmented. That are over 3,000 solar installation companies. Over 50 plus solar panel manufacturers who are actively competing for business in the US. Over 25 solar inverter manufacturers. And over 100 plus financing companies. And I'll go into more detail about each one of these.

When it comes to solar installers, I think there is a very bifurcated market. There is the top five solar installation companies, like SolarCity, Sunrun, Sungevity, and then there is everybody else. The top five companies are operating in multiple states and they are primarily focused on marketing solar leases and power purchase agreement. And the rest of the solar industry, all of the other 2,995 plus solar installation companies, are primarily helping consumers with or offering consumers ownership models.

And we believe that in the long term the fragmentation in the solar installation companies is only going to increase. In terms of manufacturers of equipment, most likely we'll see some consolidation.

So not all solar equipment is the same. Just like in keeping with our car example. There are the compact cars, there are the Honda's, and then there the Mercedes. The different solar equipment that is being offered to the consumer also falls into different categories of either economy or premium. And the solar equipment, again, the drivers of those quality rankings could be based on the product quality, the performance, what kind of warranties these companies are offering, and how these panels or equipment looks.

What we're finding is that consumers are now focused quite a bit on the quality of the equipment. On EnergySage marketplace we are seeing consumers typically going for better quality product than less.

In terms of solar financing, there are now over 100 solar financing options available or companies that are offering solar financing. A little bit complex chart to see. On the x-axis, what we've done is we have a listed of how difficult is it to apply for a certain financing product. And on the y-axis, is what percentage of the total savings from a solar energy system does the consumer get to keep.

So based on that, if you look at the chart, of course, solar leasing is one of the easiest things that the consumer can apply for and get. But it allows a consumer to keep roughly between 10% and 30% of the solar savings.

And then the chart goes up from there. Some of the best options are for consumers to leverage property secured loan options that are generally offered by their local bank, credit union-- and Fannie May recently announced the Home Style Mortgage Program, which seems to be very, very exciting. On the EnergySage Marketplace, what we are seeing is when consumers get to compare their financing options, they are increasingly selecting ownership. Whether they pay cash or they are financing their installation through a loan.

As several of the previous presenters mentioned that, so far, the majority of the installations have been financed with solar leases and PPAs. On EnergySage Marketplace, we're seeing over 90% of the consumer selecting to own the system.

There are several issues that the consumers are facing as this industry's growing. I have limited time, so I'll flip through them very quickly. Number one, I think some of you may have experienced that misleading advertising. If you're browsing the web or on social media, like Facebook, you'll see ads for free solar panels. The government is giving out free solar panels. Claim your panels. That's one big issue we're seeing.

Number two is pretty high pressure sales tactics. You may have received cold calls or somebody may have knocked on your door and you put a high pressure on you to sign a contract right then there. Number three is that is lack of standardization among quotes. It's very difficult for consumers to actually make sense of what quality of product their being offered and what is the cost and benefits of the different financing options put on the table. There's a lot of opportunity for installers to embellish their quotes.

And last, but not the least, I think we are starting to see some indications of search engine's promoting their own proprietary solar products and limiting consumer choices. So I'll stop here and happy to answer any questions.

ELLEN CONNELLY: Thank you very much. I do have one question for you, which I think you gave a little bit of a preview. You mentioned that the key reason that solar seems to be coming so popular is for cost and economics. And we're wondering what role, or if any, does consumer interest in green energy or renewable energy play in driving demand for solar?

VIKRAM AGGARWAL: I think when the industry got started-- I think if you go five or so years ago-- a number of consumers were installing solar, because of environmental reasons. It was the right thing to do for the community and the environment. Those were the early adopters. Now, what we're seeing is solar is moving into the mass market arena. And most of the mass market consumers are very much motivated by the economics. They may have a reason. They may have an environment of reason to start shopping, but their final decision is very much based-- whether they go solar or not-- is based on economics. So very, very important reason.

ELLEN CONNELLY: Thank you. We'll move onto Allen.

ALLEN MOSHER: Good morning, everyone. I'm Allen Mosher, American Public Power Association. Thanks the FTC for inviting me to speak this morning. It's a great panel. APPA is a trade association for municipal and state-owned electric utilities. We have a very different business model than most of the entities in this room. We're not for profit local-owned utilities. Our interest is in reliability and serving our customers at least costs with reasonable environmental consequences.

Just as a background, here's a profile of the electric industry. You can think of it in two different segments. There's the bulk power side of generation and transmission. That's an interstate grid. There's three large grids in the United States.

And then there's local distribution utilities. That's really where APPA members are concentrated. There are about 2,000 public power systems and they're all in the distribution business, buying most of their power from the bulk power market.

What we see now with solar is really sort of a changing set of relationships between utilities and their customers. There's new expectations of customers on the quality of service. Customers are looking for new options. It's going to have broad reaching consequences on how we service going forward. But solar is just a start of these changes.

When you talk about renewables. If you look at this chart here, hydro is actually the biggest source of renewable energy we have in the United States. Wind is second. Solar, right now, is actually very small portion of the total. Conversely, though, when you go to capacity additions, what we see here is a rapid growth, particularly in the wind capacity, in the last couple years. Solar is picking up along with that. And about half of the solar is at rooftop and half of it is that the utility scale. With community and commercial installation somewhere in between.

But regardless of how you think about these sources of the solar power, you have to remember that solar it's really a non-firm energy product from a utility perspective. It doesn't have on-site storage. It needs to be backed up and replaced when the sun isn't shining by other sources of energy. And solar output is highly variable from day to day.

Let me show the slide here. In terms of prices, one of the things that's most important to remember is that there's about a two to one price differential between utility scale solar versus the rooftop solar. And we're really trying to drive down what are called the soft costs that Elaine was referring to earlier. Those are actually increasing the cost at the distributed level, both at

community solar and at rooftop. The panel costs are really more or less the same. Inverters they have some economies of scale. But really it's in the soft costs that make it much, much more expensive.

So from a utility perspective, frankly, it doesn't make a whole lot of sense to pay $2, when you get something for one. And that's the problem with rooftop solar right now. Really for society as a whole, it's not cheapest alternative to get solar energy into operation.

Variability is a big deal. If you look at this chart here. The green line is the chart of a community solar project for River Falls Utilities in Wisconsin. They built a shared solar project for the community here. You notice it has a very peaky attribute in the middle of the afternoon. Well, for River Falls it actually did coincide with the peak load in that system. But they've got to fill in the valley surrounding that load with other sources of resources here.

And by the way, if you look at the actual output of that plant. The chart on the left side. The actual moment to moment variability is much greater. We can have periods where the output of the solar project will go from 100% nearly to zero and back to 100% in 90 second period. That tends to cause some operational problems.

This is a version of the, we call, the California Duck Curve. How many of you have heard of the California Duck Curve? I'm surprised it isn't 100%, because it is sort of ubiquitous. But it is the example of the intended or unintended consequences of policymakers. It was intended by policymakers to do a number of things to push renewables into the California market, but it has a number of severe consequences.

So here's the normal load shape. And here's the wind output on the bottom. Here's your solar output. Bang. Hits it right in the middle of the day. And this red line shows the net low that the California ISO has to chase. It's sort of the equivalent-- I like to think of the electric grid as sort of transitioning from a period of big diesel trucks on the highway that don't change speed very quickly, but are really pretty fuel efficient to a bunch of Portia Turbos flipping in and out of the lanes and everybody has to adjust to it. You can take your own metaphor, people on their cellphones talking on the freeway, and slowing down, speeding up.

But the point is that, for operational purposes, this is pretty tough for the system operators. And what it leads to actually is negative locational marginal prices in California, where they're actually dumping energy in the middle of the day into other states, into Arizona, and paying them to buy it. And this is a pretty good indicator of some problems in the market assignment we have.

So here's again, just plot here. The most important part here for the California ISO is we've got about a 12,000 megawatt ram in the late afternoon. This completely changes the generation mix that California has to have to keep up with the load. It's doable. These problems are all solvable, but they're not least cost for society.

Let's go on now to frequency excursions. And I want to use this to illustrate some of the problems in Hawaii, in particular. But this is a [INAUDIBLE] slide that shows what happens on the grid when you have a loss of a large generating unit. Frequency dropped very quickly. And

then recovers as other generators respond to it. I won't go into to the technical details, but it's very important that they respond quickly or else the whole system could collapse.

And they have a safe period where you want to operate within. Here's the recovery period. The recovery state where you want generators to respond and make sure they pick up for the loss of the generator. Down below is where you get into the potential tripping of the generator. As some of the generators get to low frequency, they trip off and that reduces the resiliency of the grid. That is they're getting where they could be damaged.

And here's the red zone. That's where you don't want to be. And that's actually where Hawaii has ended up in some occasions. With actual under frequency load shedding, they've had to trip customers and generation to keep the grid operating.

So all of these factors combine to say that there are a lot of operational problems on the grid for electric utilities. They can have safety problems. These things are manageable. But again, we need to have an interaction between customers, so that they have reasonable expectations about what compensation they're going to get for their solar panels. And that we as utilities understand what our customers are doing.

One of the things that concerns utilities the most is safety and also the security of the local grid. If we don't have visibility of when solar panels are being installed, there could be actual real safety issues for utility personnel. Because if there's a generator that's hooked up and it hasn't been done to code, when there's an outage on the system, the utility personnel needs to be in a safe zone of operation, where the lines are not energized. And we could occasionally have a risk of a solar unit being connected to grid that we don't have visibility of.

Again if you go through the local zoning department and you go through the utility, these are all manageable problems. But what we want to worry about is a wild card. I see Carl over there shaking his head on this. These are manageable problems. But again, it requires an interaction between the utility and the customers to do it at least cost.

In terms of through the path forward, APPA has a strategic initiative, which we call Public Power Forward. It's our attempt to respond to the changes and expectations of customers and what our members are looking for. Again, solar is just part of the set of changes. Again, there's a whole group of new technologies that will allow us to better manage the utility load curve, that will allow us to save significant amounts on investment on utility infrastructure.

My simple answer on the question, does solar save utility investment today? The answer's no. It's actually the opposite. It's going to increase our investment, particularly at distribution. One of the examples we have today in this transition is-- we used to build a megawatt of conventional generation and a megawatt's capability of transmission and some reserves to go with it. Now we build a megawatt of wind, a megawatt of solar, a megawatt of gas combustion turbines, plus all the transmission to tie it together and the distribution grid.

What we're seeing at the distribution level now with larger panels is potentially the need to increase the size of some of the distribution lines and transformers we have. That doesn't have to

be the case. With good technology, and if we can flatten the load curve, we can actually produce a lower cost system to serve the public.

So in terms of rate design principles, the next panel's going to talk about that much more, but we have some basic principles that rates need to be fair and cover cost. Severin did a great job explaining the difference between social marginal cost and average cost. That is a dilemma for utilities. We've never been able to get it right, rates to be economically efficient and cover costs accurately. We have all kinds of social benefits that are included rates.

But the point is right now that with net energy metering, based on an energy only charge, it's never going to be an accurate price signal for customers or recovery utility costs. You can't solve a two variable equation with one variable. It just can't be done. So there are a lot of interesting great designs we want to pursue. Again, it's a matter of sending good price signals and meeting customer expectations.

The last slide on marketing. This is a really important issue and I'm glad the FTC is focused on it. The brochure on the left is one that I got through the mail. It appeals to both making money for my children, putting solar on my rooftop, keeping up with the neighbors, greed. The slide on the right is part of a flyer that one of our member utility sends out to its customers.

I have real examples of a colleague with a 93-year-old mother, who just signed a solar lease for 20 years. Doesn't make a whole lot of sense. There are other examples of utilities being-- in Colton's case-- low income customers being quoted rates based upon the neighboring utilities cost not their cost. When the utility just put in a five year rate break freeze. Again, these things can be addressed through good consumer education. And with that I'll end.

MARK S. HEGEDUS: OK. Thank you very much, Allen. That was terrific. Just one question. Is it possible for a retail customer to disconnect from the grid and just rely upon its solar panels, and enjoy the same level of service that they had when they were connected to the grid?

ALLEN MOSHER: It can be done, but it's not a very economic choice. A friend of mine's actually a solar installer from one of the major companies. He had a customer on 16th Street northwest in DC. He's an IT guy. He's made lot of money. He's completely off the grid, because he wanted to be. I mean but it's not-- with all the tax subsidies there, you could do it with a whole bunch of the storage.

But storage is really the key to it. You've got have energy sinks. Energy storage. Probably electricity storage combined with the solar panel. So it's like buying the transmission without the rest of the car if you just have solar.

MARK S. HEGEDUS: Right. Great. Thank you very much. Let's now turn to James Critchfield from EPA.

JAMES CRITCHFIELD: Great. Thank you. I just want to thank the FTC for holding today's workshop. It's been a really interesting discussion so far. And I think that it's an important

discussion to have, particularly given the importance that I think solar energy is going to play in our future.

I'm going to, in fact, sort of shift gears a little bit. I'm going to be talking a little bit more about the environmental aspects of solar energy and the role, in particular, that renewable energy certificates play in today's market. The US electricity sector represents a significant source of air pollution, which includes greenhouse gas emissions. Roughly about 30% of the US's total annual emissions comes from the electricity sector. Those emissions range from carbon dioxide, a leading greenhouse gas, carbon monoxide, NOx, SOx, there's also heavy metals.

All of these have profound health impacts ranging from different types of diseases, cancer, lung disease, bronchitis, chronic bronchitis, those types of things. And so the importance of solar to address those types of issues is an important element to think about.

As it relates to greenhouse gas emissions, the emissions from the electricity sector also have a lot of public health implications. Greenhouse gas emissions have health risks that include heat waves and droughts that involve worsening of smog. As well as the intensity of other extreme events, such as increased precipitation, frequency and intensity of hurricanes, all of those types of things, flooding. All of those have impacts related to public health as well.

To the extent that consumers recognize the environmental implications of their energy use or their electricity use, more specifically. This becomes a prime driver, as it was mentioned before, economics, of course, often plays the ultimate choice in their decision making process as to whether to choose solar or not. But environmental reasons is a big reason for why a lot of consumers, both organizational as well as residential, are choosing to go with solar.

So as far as solar energy. Solar energy is one of the most abundant and reliable renewable resources available. It is also a very clean source of energy in the sense that solar is a zero emitting technology and resource. And helps reduce pollution and greenhouse gas emissions associated with electricity sector.

There are also a lot of other benefits that solar offer that can sometimes be in other areas--environment, water savings, as well as land use benefits. Obviously if you're deploying solar on rooftops, you're not taking up land resources that could be used for other uses. Water savings. Conventional power plants use a lot of water for cooling. To the extent that solar doesn't use as much, in some cases, is also an advantage. Although, solar does require some water use for cleaning panels on a regular basis.

And then there's the implication of how solar actually reduces emissions. Solar typically aligns with peak demand. And so it tends to reduce the emissions associated with our power sector that are at its most intense including the emissions of marginal units of generation, such as natural gas plants and other peakers that are used to respond to that peak demand. And so the extent that the value of the emissions themselves tend to be at its highest is another benefit of solar.

Just shifting to a little bit of renewable energy markets here in the US. Renewable energy markets are broken into both compliance as well as voluntary markets. Compliance markets are

defined through state policies, state RPS's-- we talked a little bit earlier about the SREC carve outs that some states have to incent solar development. These are RPS's, or compliance markets, basically set a minimum requirement of how much solar energy or renewable energy that a utility must generate as a percentage of their total generation.

In contrast, voluntary markets are comprised of non-regulated entities or consumers. And these are organizations or households that are doing this through other reasons. Oftentimes first and foremost an environmental reason. Sometimes it's economic. Or maybe they have some sort of goal or objective in mind to use a certain amount of renewable energy for sustainability objective. These markets inner relate to each other.

Voluntary markets by definition are interested in ensuring that their purchase-- the consumers in these markets, that their purchase is above and beyond what would otherwise occur through mandate. So most consumers in the voluntary market are interested, when they make a purchase, that it wouldn't have otherwise occurred because of the mandate. They want it to be incremental to that. That's a concept called regulatory surplus.

And another important concept for voluntary buyers is this issue of double counting. Double counting is demonstrated when you have a single megawatt hour of renewable energy that two parties are counting the same environmental attributes or benefits. And interestingly, compliance markets and voluntary markets use the same type of market instrument to verify both generation and usage claims. And so there's a natural tension that occurs in the market between those two competing market opportunities.

So just a few words about the role of Renewable Energy Certificates. Renewable Energy Certificates are tradable instruments that represent the attributes of renewable energy for every megawatt hour of electricity that is delivered to the grid. They are used by utilities to demonstrate compliance towards the state RPS's. They're used by voluntary consumers to make claims about renewable electricity use, or solar energy use. They also are used for substantiating environmental marketing claims.

Because the flow of electricity-- the actual electrons on a shared grid-- tell you very little about where they're from or what generated them, they're indistinguishable from each other. They're not little green electrons and little brown electrons. The Renewable Energy Certificate, which is generated at the power source is effectively the only way to allocate the benefits that renewables has on a shared grid. So the generation of a Renewable Energy Certificate is produced at the solar array and then can be utilized by participants in the market to validate their ownership of that renewable energy generation on a shared grid.

This is really important simply because most of the organizations and consumers in the market definitely want to be getting something for the money that they're investing in these types of projects. The ability to have a Renewable Energy Certificate that provides you that ownership over the attributes and the claims that can be made from those attributes is an important part of just consumer interest.

RECS have a strong legal standing in our renewable energy markets. Note that there is a really good document that the Center for Resource Solutions publishes called, "The Legal Basis For RECS". It is a soup to nuts type of review of all the case law, all federal, state, and local jurisdictional policies that give RECS a legal standing as an instrument for conveying attributes between parties. As I mentioned utilities use them in compliance markets. Voluntary buyers use them for making renewable energy use claims as well as environmental claims.

Now the pricing issue is kind of an interesting one. Under these two markets, the compliance market and the voluntary market, you see a wide range of pricing or cost for these Renewable Energy Certificate instruments. The differences in prices are driven by obligations placed on certain buyers and penalties that the utilities often have to incur for not meeting their compliance obligations. So those pricing implications play a lot into the decisions that developers as well as consumers need to incorporate into their decision making process.

Just quickly. The voluntary market is not insignificant. In fact in 2009, the market was as big or bigger than the RPS compliance markets. RPS compliance market have since increased beyond that. But they are a significant portion of the development of solar in our country.

These are some consumer motivations. We've touched on a few these already. Environmental motivations. Cost stability and energy savings are common particularly amongst homeowners. But I think with respect to consumer issues, there are tensions that occur between this interest of the utility to meet their compliance obligation and using the REC to substantiate that. Versus being able to give that REC to a consumer, who also wants to know that their purchase is doing something more than what the utility is regulated do.

I think there's issues of having understanding around contract language. Of course understanding the trade offs of monetizing your RECS. And the types of claims that not only consumers need to make, but developers in the market, who are selling a product have to make sure that the sale of that service or product is, in fact, substantiated by similar arguments.

ELLEN CONNELLY: Thank you very much. I'd like to just give you the opportunity to expand a little bit on those last points, the consumer issues around RECS. And I'm wondering if you could speak a bit about what information you think consumers should have about RECS and the role that they play in decision making process for retail consumers.

JAMES CRITCHFIELD: Sure. Yeah I think interestingly a lot of retail consumers don't know what a REC. I think first and foremost understanding what REC's are and what role they play within not only project economics, but also on the environmental level. It really represents the solar-ness of the energy that you're using. And without the REC, you are not actually using solar energy. That claim is being sold to somebody else. The REC has value. And so understanding that value, the pricing implications, what options you have, or how those RECS can be handled within a contract are all things that I think consumers need to have better awareness of.

We've, on a number of occasions-- particularly with small businesses and in some cases with residential-- have received questions about just general contract language. It's not particularly clear or standardized of how RECS are described, what the implications of the REC within the

contract are-- those types of things need to be improved on for the market for consumers to make better informed choices.

ELLEN CONNELLY: Thank you very much. We'll move on to our last presenter, Tanuj.

TANUJ DEORA: All right. Thanks, everyone. For having me here. I'm Tanuj Deora, the Chief Strategy Officer at the Smart Electric Power Alliance. I need to apologize apparently my phone was causing some interference. The reason I was on my phone was, Vikram mentioned Major Lead Baseball-- and since he's a Boston guy and we're a little closer to Baltimore, I was checking out the standings to see how the Red Sox and Orioles were doing. I'm actually a Nat's fan. But we actually all should be 2003 Oakland A's fans, which I'll explain here to of us in the room in a little bit about why that is.

A lot of great panelists. Really appreciated Severin Borenstein remarks. He's one of the best primers that I've heard in my dozen years in the power industry as far as laying out the foundation. And of course our panelists have provided a lot of interesting information here. Really, really important, critical information. And so I'm going to focus a little more on process and what we're doing with our 51st State Initiative as the FTC has asked me to do.

Before I jump too far in though, I do want to mention our name change. I mentioned I'm from the Smart Electric Power Alliance, which until April, we were known as the Solar Electric Power Association. And a lot about the initiative I'm going to talk about today and one of the things I encourage all of us to be thinking about, is not just solar or distributed solar in isolation, but really thinking about distributed energy resources more broadly.

In our organization we really do believe that the solutions to getting an optimal level of deployment of distributed solar really is wrapped up in the solutions around getting an optimal level of DER more broadly, including energy efficiency, including demand response, including energy storage, and perhaps on the commercial scale, things like CHP and other things as well.

So panelists have already talked about-- I think multiple folks have already talked about the growth of solar. And I wanted to just add a few bullet points about the typical utility responses. So pretty much any place where utility has seen adoption of solar or is anticipating adoption of solar, they started some combination of these four activities.

On the bulk power system, they're starting to include procurement of utility scale solar into their systems, as such increasingly become cost efficient. I think there's a critical mass, if not a broader consensus, that solar, or utility scale solar, has a place in most utility portfolios across the country.

They're starting to explore community solar options, which has also been mentioned I think by Elaine, as an interesting viable option where utility can get involved in centrally locating a resource that consumers can take an ownership interest in. And of course, they've been talking about redesigning rate structures, which is the bulk of the panels that follow. As well as getting smarter about visibility of deployment. And Allen shared a lot about some of the implications of not having visibility on deployment of PV and not making investments to respond.

But a smaller number, maybe about a dozen or so utilities across the country, are thinking a little more beyond. They're thinking about this from our a DER perspective. They're thinking about a new paradigm of engagement with consumers. Utilities across the country, so the big California investor owned utilities. Primarily prompted by their commission, but also on their own initiative. Utilities like Green Mountain Power in Vermont, Steele-Waseca in Minnesota, a number folks are starting to look at this from a more holistic perspective.

But it's still not be the primary-- if you look at all utility employees, and the entire utility perspective, and especially what's being filed at PUCs across the country. It's not the primary perspective. The perspective we have is a little more this. And I think this is where we get into process and our role that we think in helping DER deployment-- is trying to help overcome what has developed.

Although utility folks understand that there is some value to [INAUDIBLE] generation. And folks in the consumer side, the third party finance companies for solar and the like, aren't saying, let's get rid of the grid. Some of them are, but most of them are not.

What's happened with the existing adversarial processes is that most of the filings have seemed to fall into these camps, where you get utility perspective, which is the grid provides all the value and DGPV just imposes a bunch of costs-- we may have heard a little bit of that in a previous presentation-- and the consumer perspective, which is, my bill is just a cost. What I really want is empowerment. And so DGPV provides all the value, which creates an inherent conflict.

And of course this is complicated. This conflict is complicated by a laundry list of factors. I've listed some of them there. It's not an exhaustive list. Most fundamental is that fact that we don't have much clarity in the trade off between the different things we expect from our power system-- so low cost, clean, reliable, safe, least risk, just those are challenging enough, trying reconcile those in the short term and long term. Questions. I think Professor Borenstein mentioned the need to consider both temporal and locational price differentiation for consumers. That's actually very controversial. I think less so the temporal, actually maybe not at all the temporal, but definitely the locational is something that I think a lot of utilities and commissions would say is not something that they would consider.

But there has been a fundamental challenge. We've seen it in places like Arizona, in Nevada, in large parts of the country. And so at SEPA, we've been thinking for a couple years now about how we can make sure that the conversation-- that adversarial clearly has its place-- but is there a space? Because there's lots of smart people in this space who fundamentally want to do the right thing as far as seeing a transformation of a cleaner grid and a more consumer friendly grid that meets all our societal aims. Is there another platform that we can provide that helps get those smart folks thinking together about how we can move forward?

And so we developed, a couple years back, our 51st State Initiative. It's a phased approach. As I mentioned, is a platform. It is primarily crowd-sourced from an insight perspective.

We're in the middle of our phase two of that. So phase one was about building, or starting, a community of subject matter experts to have conversations. Starting with a blank slate approach.

So saying, if we assumed we had no existing regulatory or statutory infrastructure, what kind of world, what kind of state-- what kind of set of rules and market, rules regulations we want to see to help enable an optimal DER future? Not a maximal, but an optimal DER future. Recognizing and the assumption is that we're not there today.

We actually got a couple of interesting papers-- one from Allen and one from out here in the audience-- that make the case that maybe you don't have to change. A pretty good case actually. But we wanted to ask that question and get a lot of thoughts out there. And Carl Abigo, who will be speaking later, wrote an excellent paper on that as well. We've got about 14 to 15 different divisions for what that optimal future might look like in our phase one.

We started workshopping that with a variety of different stakeholder groups. Culminating that in a summit that we had in April of last year. And that got us ready for our phase two, which is to say, all right, here's some really thought provoking ideas. We don't have consensus on any of these models, but we have some interesting conversation going and definitely some minds being opened and eyes being opened. Let's think about continuing, resetting that process, but also looking now about how you might transition from where we are today into those future markets. Well, those future market structures. And I'll talk a bit more about that in a second.

And then that's anticipation of a phase three-- which we hope to be launching in the fall-- which is, OK, we have these visions of the future. We have the tools that have development out of this phase two. Now do we have a tool kit in which we can actually engage with states about their own transformations? So starting with the end in mind, the blank slate, then thinking about the challenges of how you transition-- making sure we're holistic, and measured, and internally consistent in our thinking as we go forward. And now do we have the tools to actually let state's policy makers, the stakeholders in the industry, figure out what that future state will be?

So for phase two, I mentioned we asked-- again a crowdsourced effort-- we've got about 15 different submissions. Again, APPA, NRECA, Siemens, APS, PSEG, a number of utilities, a number of advocates, unique concerns scientist, other subject matter experts, eccentric consultancies, the like all came together and provided these road maps.

We asked them to address six different lanes in these road maps to make sure that we had truly comprehensive transition plans, or transition proposals. And we brought that together with an Executive Leadership Council-- which again provided a balanced folks of DER technology solution providers, utilities, advocates, other folks together-- and had a total of about 120 folks participate-- including a few folks in the room-- to participate in a summit to discuss these road maps. And we got some key takeaways from that. There's a lot, as you can imagine, with that much expertise, with that many submissions to go through. We're pulling out right now what the key takeaways are in several different formats.

So one of the formats is something we call, No Regrets Moves. I'll dive into these in a second. Besides these, we're also working on customer and regulatory journey maps. We're working on some sample lanes, or sample roadmaps, as well. Some guiding principles that we think we have consensus on.

But these No Regrets Moves were something I thought I'd share here, particularly interesting. You can read through those. The slides will be available. One in particular-- this is where Moneyball comes in or the 2003 A's come in.

So as folks who've read the book or seen the movie know, Billy Bean somewhat revolutionized baseball by getting away from evaluating players based on a bunch of heuristics-- rules of thumbs, the gray-haired scouts kind of knowing what a good shortstop looks like, or knowing how to assemble a team-- and actually moving through to a system that was driven by data analytics.

Well, our distribution systems today are primarily driven by rules of thumb and a level of just the experts kind of know. I think the case in Hawaii is a great case study of that. Whereas HIKO, the Hawaii utilities, said, we only think that we can host 75% of the minimum daytime load of solar DGPV on our system before we start having problems. And that just politically wasn't feasible, so they blew through that 75% minimum daytime load constraint. We got to 100%. They said, that's a problem. They went up. They want up. There really wasn't a strong sense that we knew for sure what that level of limit would be.

I know I'm out of time, so I'll turn it over to questions. But I do want to encourage everyone to engage with us. Check out the website. Come engage with me afterwards. I'm happy to share where we think this process is going.

MARK S. HEGEDUS: So just one question regarding the role of storage. Can you talk to us about the role of storage in increasing the penetration of solar generation?

TANUJ DEORA: Sure. So I think it is an enabling technology. I mean there are companies that are very compelling business models, or very interesting business models-- companies like Sunverge. What SolarCity is offering Hawaii that are pairing directly solar with storage on a customer site. Those applications are interesting, but we think there's a broader benefit of storage on the grid, thinking more holistically. Right? So we don't need to firm the solar generation behind each customer's meter. We need the whole system to hang in the balance and work well.

And so if you look at the combination of energy storage, demand response, efficiency, EVs that portfolio overall needs to balance. There's a bit of danger in thinking about storage just as a way to integrate renewables. Storage provides value, even if we didn't have distributed renewables onto the system-- or can provide value. The cost is still pretty high, but as the costs come down, we think storage will be increasingly important regardless of renewables penetration. But because it makes for a stronger, more resilient grid, it will have those benefits to deployment of distribute solar as well.

MARK S. HEGEDUS: Just a follow up on that. Where do you see us on the storage path? Are we at the early stages of the technology? Or are we pretty far along? What might we expect?

TANUJ DEORA: Well, I'm not a technology expert, but we're definitely seeing some very positive signs. Folks are talking about storage being on a similar type of cost to client curve that solar has been on. And so if that's the case-- while solar is not cost effective in every market in

the US, especially at the distributed scale today-- we can see that path. And so if storage is on that same path, which there seem to be reasons why that's the case, then it should be a very promising technology for us going forward.

It already is in the money in certain applications. There are folks who've deployed solar grid scale for frequency regulation markets in PJM. We've seen it to replace transmission upgrades in places like Texas. So there are some niche applications where storage is already in the money. And we expect those to continue and potentially be as big a deal as solar.

MARK S. HEGEDUS: Great. Thanks.

ELLEN CONNELLY: OK. Thank you, to all of our panelists. We'll now move to the open question and answer session. And I would like to start that off by asking the panelists whether there's anything you heard from your co-panelists to which you'd like to respond or whether any of the presentations raised any questions for you that you would like pose to any of your co-panelists. If you'll just either flag or turn your card up. Yes, Allen?

ALLEN MOSHER: Just for Tanuj's discussion, the 51st State, I thought that was a really interesting dialogue. What it points out is sort of a collaborative enterprise between different market segments, that haven't been used to talking to each other, to work together to build a better integrated grid-- as [INAUDIBLE] talks about is really important if we're going to make this whole system work well for consumers.

We got changing customer expectations and lots of different visions, but frankly-- that was one of the points I emphasized at the last summit is that there's a role for everybody that was in that room to work together, particularly for my members who are small municipal utilities in general. They can't do it alone. They need partnerships with solution providers in the industry. And that's a very diverse set. We're really early on the technology maturity scale for technologies other than solar.

In terms of smart grid applications, the main benefit for smart grid is in distribution automation, so that we know when our customers are out. But on top of that, that provides a lot of integration possibilities for solar to reduce the cost and again and the solar output.

ELLEN CONNELLY: Thank you. Anyone else?

MARK S. HEGEDUS: OK. Let's turn to some questions from the audience. We've gotten some really terrific questions. We're not be able to get all of them. The FTC however, is going to make your questions part of the public record of these proceedings. So they will certainly add to the dialogue and conversation that we've continued here today.

So the first question I want to ask-- and this is for any of the panelists to take on. We've heard talk about microgrids. What are they and what role do they have in this sort of future electric supply that we've been talking about?

ALLEN MOSHER: I hate to play jeopardy of being the first out. Public power system are the original microgrid. We were operating in isolation separate from other utilities. Because in the early 1900s, men from small towns in Iowa went to Chicago and saw the lights were on there. And wanted that and brought it home. So they hooked up generators. They pretty soon figured out as soon as they could get interconnected with other utilities, it would rapidly reduce the cost.

In just about every infrastructure, every industry, we see the benefits of integration to larger networks. There are very big network economies for society as a whole and for the economy. I don't think electricity is any different.

The rule of microgrids though, is in power quality for those specific applications where you need a superior power quality. And that's the main benefit. Whether it's a military base that has mission assurance rules that they have to accomplish-- or a university that wants to maintain certain levels of power quality and integrate with the combined heat and power on campus for server farms, that's where a microgrid really makes sense. In terms of regular customer applications and residential, or small communities, maybe. But I don't think the economics payback.

MARK S. HEGEDUS: Tanuj?

TANUJ DEORA: Yeah. Thanks. I think just to build a little bit on what Allen had mentioned. Really a microgrid through the application seem to be for somebody who's looking for some sort of premium service. So power quality. But I think resiliency is also another place where microgrids could be interesting.

There's different models for how a microgrid could be created. If you're bring power to some location for the first time, you might think about making a microgrid so you have that either power quality benefit or that increased resiliency. If the rest of the grid goes down, you can island yourself and keep going. Other folks are retrofitting, effectively, a microgrid by trying to do some islanding work.

But it really is right now a premium product. And I think most of the interest that we're seeing, in places like New York, is really driven by a resiliency benefit, where with the bulk power system we have, we get a ton of efficiency, really, really effective cost, and we get increased reliability.

But some folks are saying the resiliency, if something does go wrong, then I want to be able to be in control of being able to restore my power. And if you're part of the bulk power system without a microgrid, you can't really do that.

MARK S. HEGEDUS: Just a real quick follow up. Explain for us what we mean by power quality and by resiliency. For those of you who go to [INAUDIBLE] meetings and things like that probably understand what that means, but there's probably a lot of us here who don't. Well, Allen you can take power quality. I'll take resiliency. Resiliency is basically being able to recover from an outage quickly. Reliability is not having an outage. And resiliency is being able to recover quickly when it does occur.

ALLEN MOSHER: That's a good short answer for it. In terms of power quality a minor voltage blip for a server farm is not acceptable, because you could damage equipment or cause an outage. If that happens to Google at a server farm, they'll probably be backed up, but that's a mission critical for them. So they're looking for very high power quality. You can do that by conditioning equipment on-site.

But again, if you had a wider grid area problem, they want to maintain that service. And so can have on-site generations, for example, to back it up and bulk power, high EHV, or extra high voltage connection potential.

MARK S. HEGEDUS: Any other comments on microgrids? OK. I want to ask a question about demographics of residential solar power customers. What do we see? Who is adopting rooftop solar? Do we see differences in terms of socioeconomic groups, racial groups? Or urban verses rural? Any insight that you can offer on that from any of the panelists?

VIKRAM AGGARWAL: Sure. Actually we did some pretty detailed research. I don't have exact data in front of me, but I can actually provide that data. In terms of demographics, in terms of age groups, the biggest age group that is shopping for solar is the 40 to 55. There's a pretty strong uptake among near retirees and retirees, because it helps them fix their energy costs. So there's definitely a lot of update there.

In terms of other demographics, ethnic backgrounds and another, we actually see pretty even if not an even distribution among different groups who are adopting solar. I would not say that one particular demographic group is overtaking the installation, but it's pretty widely spread out.

ELAINE ULRICH: Yeah. So we have a program called, Solar Energy Evolution and Diffusion Studies. And so we look at why people make the choices to go solar. Retirement is a big time period when folks start to think about considering it.

But in terms of attitudes and interest, as Vikram was saying, it's fairly universal. Different marketing messages are more effective for different demographic groups, but overall the interest tends to be very, very broad.

We've seen some early studies that indicated that the majority residential systems were installed by households that had incomes between $40,000 and $80,000 a year. And we do know that there is a gap in that low income customers represent only 5% of solar installations. But nonetheless, the interest level is high across demographics.

MARK S. HEGEDUS: Tanuj?

TANUJ DEORA: Thanks. I would encourage us, again, to think more broadly about DER options across the board. So while there might be certain products or DER technologies that are attracted to certain demographics, there are a lot of different options. If you look at demand response efficiency. There are things that can be done, put in combination, that should be able to not only fit within any individual consumers pocketbook or may resonate with different consumer groups, but really can be coupled together. So if you can couple together energy

efficiency, and demand response, and solar you could buy down the economics and make them more attractive.

Some utilities-- I think the question is, there are probably some broad trends when we think about actual deployment. It's going to depend on service territory to service territory. And so some utilities are starting to actually look at and model propensity to adopt as part of their work. So not only understanding the distribution system grid from a physical perspective, but also the propensity to adopt. And the consumer engagement and how you influence a message to consumers together to put together a really comprehensive look at their service territory. SMUD for example, the Sacramento Municipality Utility District, is doing lots of interesting work there.

VIKRAM AGGARWAL: Just to add to Tanuj's point. EnergySage is working with National Grid, where we are combining an energy efficiency program with solar program. And the consumers are being encouraged to take energy efficiency actions and being rewarded with better incentives for installing solar.

ELAINE ULRICH: Right. And again through the studies that we've seen, there is actually-- for residential installations-- there's a clustering effect. Because people can see the technology and it makes them ask the question, what does my neighborhood know that I don't? So we've been able to do advanced modeling. To do what's called, Agent Based Modeling Behavioral Economics. To show how those clusters spread. And that can help with distribution planning and also with program design, because you can get out ahead of and understand where-- utilities can look at where the strengths and weaknesses of the grid might be along with the consumer behaviors, so that as they can work design their programs and either get ahead of those upgrades that need to be had or help encourage folks in different neighborhoods.

So I'm thinking in Texas, they've done some really innovative work on this. So for example, CPS, a public power organization, they actually are deploying solar on rooftops in low income households. And then basically giving those folks a discount, like a $0.2 or $0.3 credit on their utility bill, for hosting that solar. Because they weren't getting uptake on the residential program in a certain low income section of their grid.

MARK S. HEGEDUS: James?

JAMES CRITCHFIELD: Yeah. I'd add that the community solar space is one that is particularly focused. There's a lot of dialogue going on with respect to the low income. And DOE, and EPA, and HUD, and USDA have a national community solar partnership that is focused on community solar in particular, but also has a distinct focus on the low income element of that. And how traditionally low income communities don't, perhaps, own their buildings. They don't have taxable income levels that allow them to take advantage of a lot of the incentives and other things that are otherwise available to others in the market. And being able to leverage different models for deployment to effectively make it more accessible to these other communities is something that's actively being discussed.

MARK S. HEGEDUS: Allen, yes?

ALLEN MOSHER: We just had our national conference for APPA in Phoenix. The sessions on community solar in the breakout sessions were packed. The palpable interest among APPA members in pursuing that option. They really come actually in a couple different flavors.

One is the one we've talked more about, shared solar, where is the utility or a third party arranges for customers to buy in. And there are a variety of different approaches for doing shared ownership or control of the project. There's also the community scale project that's owned by the municipal utility. Both are good ways of getting solar into a community. And there's actually a lot of pride that the communities have to say that they're embracing new technologies and trying to green up their power supply portfolio.

So I expect to see a lot of that. And it has a major price advantage too. In addition to overcoming the problem that the vast majority of households, their the roots aren't suitable for rooftop solar. So let's find the best way to do it.

ELAINE ULRICH: Yeah. We have a recent NREL study that indicates that 49% of households can't host a solar ray. And even the ones that can, the size that we're looking at was 1 and 1/2 kilowatts, which is very small. And so, yeah. The citing benefits, the economy of scale benefits, you can really start to do some interesting work when you look at those transactions, enabling those transactions. And really there's no reason.

Folks sort of act like you either have to have solar and be 100% and it's on your roof or you just have to take what's in the utility. As though folks can't have a transaction, where the choose 20% or 40%. Or they may be getting more or less power from a particular resource on a seasonal basis, depending on how it's generated.

So there's been this sort of false discussions, as though this is not transactable-- Much like, RECs even. And even in the REC marketplace, we've seen folks can potentially sell one set of RECs and buy another set of RECs at a different price and still have those green attributes. So really enabling those transactions helps to create that flexibility in the marketplace that's highly enabling for a number of players.

VIKRAM AGGARWAL: And just to add to that. I think community solar could be a really good product. We are hoping that the product actually that is being offered to the consumer is pro-consumer. Today at the early stages, we are finding that the economics are being kept by the community solar providers. And the contracts that they're offering the consumers are very complex, long term, not easy to understand and get out of. So as those products become more consumer centric, I think community solar could be a very net positive.

MARK S. HEGEDUS: Tanuj?

TANUJ DEORA: DOE is actually funding some work that SEPA's leading up with some other partners on what makes communities solar attractive to consumers. In fact, we just received back the results of some market research of about 2,000 different consumers from four different regions in the country, looking at how they think about the minimum term. Do they want to pay

up front? Do they want to pay over time? All those types of factors. That report will be coming out here pretty shortly.

But two other points I wanted to mention about community solar. First, not only does it have economy scale and signing benefits from a consumer perspective, it has signing benefits from a utility perspective, or potentially could. In fact, Madison Gas And Electric-- when they designed and applied to the commission for approval of their community solar program-- actually included half the cost of the inverter should be borne not by the community solar participants, but by all customers as part of a system benefit, because of the Volt-VAR support and their after power support that the community solar project can create.

And distributed solar could do those same types of things. It's just a little more complicated to do 100 systems as opposed to doing one system from that perspective. So it's the first step to that. But the other point I wanted to make was there are consumer protection issues around community solar, which were alluded to. And one of which we actually wrote a member brief on this side in February was are consumers actually buying renewable energy when they subscribe to community solar if the RECs are being sold. And there some lack of clarity there. I'm sure FTCs were familiar with some of those issues. But something to keep in mind that doesn't get away from some of those consumer protection issues.

ELAINE ULRICH: I'm just shaking my head, because a number of these folks are talking about stuff that we're finding. I'm like, I don't have to talk about everything thank you. [INAUDIBLE].

MARK S. HEGEDUS: So I just want to throw out one last question. And then we've talked about solar as this renewable and green resource, but how long do solar panels last and what you do with them when they're worn out? Are there any environmental issues associated with that?

ELAINE ULRICH: Sure. So the typical solar product has a warranty around 25 years. We certainly have seen products that have been out in the field longer than that. And in terms of what happens at the end of life. Right now, there's not a very strong supply chain in place for recycling and reuse.

But I'm going to go back in time to around the Recovery Act, when there was a program that was called Cash for Clunkers-- I don't know if you guys remember this-- to take vehicles off the road that had some emissions related issues. And basically you saw that the automotive recycling industries found out very quickly to be able to accept all those vehicles. And solar has similar kinds of materials that are involved, aluminum, or steel, concrete, glass, silicone is inert, there are some recoverable metals. For awhile solar panels had a lot of silver in them in the contacts. Although now, they've moved to less expensive kinds of contacts.

So I would imagine that folks who are in the automotive recycling space would probably pretty quickly pick up on and start to get in the supply chain-- be able to get involved in that when there's sufficient volume.

MARK S. HEGEDUS: All right. We're out of time. But I want to thank our panelists. It's been a really interesting discussion. We'll be going to break, so I'm sure any of them would be happy to

have you come talk to them. The next session is going to start at 11:15. Join me in thanking our panelists.

[APPLAUSE]