The National Academies of Sciences, Engineering, and Medicine

The Role of Net Metering in the Evolving Electricity System

Meeting #1

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CONTENTS

P R O C E E D I N G S

Agenda Item: Welcome and Opening Remarks

DR. HEARD: Hello everyone and welcome to the first open session for the National Academies' study on the Role of Net Metering in the Evolving Electricity System. My name is Brent Heard and I am the program officer with the Board on Energy and Environmental Systems and I will be the study director.

In the interest of time, we will not be taking questions from the public directly. But you can contact us regarding this study at bees@nas.edu. There will be a public comment period at the end of this event, however. And you can submit comments for that at nationalacademies.org/deps-webinar.

This is our provisional committee slate. You will hear from the Study Chair Janet Besser in just a moment. Bios and information on the committee members are available on our study website.

Finally, as our first open session for this study, we will hear perspectives on the study tasks from our sponsors at the Department of Energy, Chris Irwin from the Office of Electricity, and Kevin Lynn and Michele Boyd from the Office of Energy Efficiency and Renewable Energy.

With that, I will pass it over to our chair,

Janet. Take it away.

DR. BESSER: Thank you very much, Brent. As Brent mentioned, I am chairing this study. My name is Janet Gail Besser. I am currently a vice president at the Smart Electric Power Alliance. The study is on the role of net metering in the evolving electricity system. I am chairing this committee meeting as well and welcome everyone to this session.

The task of this National Academies' committee is to study the issues associated with net metering, including the medium to long-term impacts of net metering on the electricity grid and consumers. The committee will give recommendations on key principles for policymakers when considering that metering and alternative policies and their potential to contribute to a decarbonizing, equitable, and resilient electricity system. This study was mandated by Congress and is sponsored by the US Department of Energy.

This is an open, on-the-record session meant to inform the committee as it answers its statement of task. The meeting is being recorded and broadcast online. The committee seeks to hear outside perspectives on its task during information-gathering meeting. This meeting will feature comments from staff within the sponsoring agency,

the Department of Agency, from the Offices of Electricity and Energy Efficiency and Renewable Energy as well as from relevant congressional staffers.

Please note the committee is only beginning the process of information gathering and has made no findings, recommendations, or conclusions. Such results will only appear after the committee's final report has been written, reviewed, and formally released. Importantly, comments made by individuals, including members of the committee, should not be interpreted as positions of the committee or of the Academies. In addition, committee members typically ask probing questions in these information-gathering sessions that may not be indicative of their personal views.

I think, as Brent mentioned, the Q&A period after each presentation is for committee members only. Please use the raise hand function and wait to be recognized by the session moderator. To allow more participation in the public comment period, we encourage viewers to submit their comments at the link displayed or that was displayed on the screen, nationalacademies.org/deps-webinar. All comments will be made available to the committee and will be included in the public access file for this study.

With that, I will say welcome to everyone, and I am looking forward to hearing from our sponsors on this

very important project.

Brent, I do not know if you are going to moderate or would like me to do so.

DR. HEARD: First we will hear from Chris Irwin from the Department of Energy's Office of Electricity. Chris, take it away.

Agenda Item: Opening Remarks on Behalf of the Department of Energy's (DOE) Office of Electricity about this Congressionally Mandated Study

DR. IRWIN: Very good. Thank you, Brent. And it is great to meet the committee, not that we give ribbons to committees anymore, but I think it is a blue one if I were in the giving mood. This is really – it is an exciting topic. I think it has had its share of controversy as well, which is why Congress is directing us to conduct an assessment and to use such an august group to try to think through the possibilities.

We felt that this was a collaborative effort within the Department of Energy. You see representatives from the Office of Electricity, being myself, and my colleagues, Kevin and Michele, from EERE.

In a matter of speaking, we represent parties on both sides of the meter even though EERE of course goes well into the bulk grid and things like that. There is

distributed solar. There are electric vehicles. There is really a lot of dynamics at this interface. And that is kind of what I wanted to start the context on a little bit.

But before I do that, I wanted to make a couple of things clear to the committee is that we really are putting an emphasis on going through the conceptual basis for net metering, questioning some of these assumptions, going through the technical basis for metering at the edge of the system because we want to pursue that, not just for the public good and for the public purposes so that states and other entities can learn about this, but also reflecting DOE's new mission is that we are undergoing a reorganization to acknowledges that we are emphasizing a dual mission of both research and deployment. We have a wholesale reorganization of the department that is going on where a large portion of us will be continuing to do research and development. But we have colleagues within the department who are charged with deploying these technologies and making these systems and capabilities available.

So with that eye, is when we talk about needing pragmatic and implementable observations and learnings from this process. We are not just talking about for other people to implement and other people to find practical

solutions for. We need that for our own mission purposes.

To that end, we want to have your emphasis not just on the conceptual domain, but on the implementation domain. How can we go to a deployment with some of these observations that you are going to be able to share with us over time?

The other thing to maintain that we request of the committee is that you think about how to abstract this to a national perspective. There are lots of regions of the country where there are extremely passionate debates about the nature of net metering and the purpose and the way it should proceed. Certainly, we are going to acknowledge that in this process. But this is a charge to the Department of Energy, which has a national mission and it is for the National Academy of Sciences. I think that we need to understand the regional differences. But your service is to the national interest. Anything that you discuss, perhaps there is a litmus test or something that says does this speak to the national interest or are we refining it perhaps for a regional case.

I think those are the top line observations as we have this new mission. We have an entirely new organization. We have capital B, billions of dollars moving into modernize our entire energy sector. It is a terribly

exciting time. To a certain extent, I wish we could go back in time, a year or two ago, and initiative this study. But such is not to be.

Net metering is a policy enabled by a technology. In some ways, the limitations of the technology dictate the policies that are possible. In this case, the technology most responsible for shaping what is possible both yesterday and today is the meter itself. The meter is the demarcation point between customer in grid in most jurisdictions. And it can be considered as a witness to value exchanges. There are ways to distribute value across the customer-to-grid interface that do not involve measurements. However, in this system, in this domain of research, we are talking about the ability to measure and recognize value at this customer-to-grid interface. I think that is very important for us to try and bound our conversation.

But that witness to value exchange is very important because I think it sort of reflects really the American ideal is that individual efforts are recognized and appreciated and compensated for in our society as we contribute to our communities and our nation as a whole. I think that that should be something that is considered there. And really if it can be measured, it can be valued.

If it cannot be measured, yes, we have workarounds but that is not exactly the domain we are pursuing here.

Getting back into it, in the early days of net metering, the technology in place was an electromechanical meter. Really not that far off from a grandfather clock. And the method of data collection was manual, in-person meter reads. Obviously, you can see how that can constrain a policy what even the most visionary policymaker would want to do at that customer-to-grid interface.

Today's electricity meters can sense multiple events, measure multiple characteristics at multiple resolutions. They can send and receive data through communication networks and they have a healthy bit of processing power on board. This changes what it means to be a witness to value at this interface and I think is worthy of consideration by the committee.

At this point, I do want to go through the description and the charge that was made because Kevin, Michele, myself, and multiple other colleagues within the department, we worked quite hard to try to portray our interests as accurately as possible and to faithfully execute the charge given to us by Congress. Know that the charge that is formulated here is the product of actually weeks of work. There are lots that you will probably will

not enjoy about it or shades of meaning that we have not chosen to illuminate. But it is the product of work and consensus in our own way.

I think that as we go through the discussion, it is not just a policy tool. Once you have decided on a policy of net metering, you have to understand how it can be operated, how it can function. What are the business models and the architectures that will make that happen and the rates that you may or may not be able to apply because of the systems that you have in place?

I think the other thing is that also back when net metering was conceived of, it was perhaps a lonely place and that the contributions of any net metered asset were admirably and yet trivial in nature. The world has changed and the tail can certainly wag the dog. With the growth of distributed energy resources, with the growth of transport electrification, we very much urgently need your consideration of what is possible at this because the distribution of power and I mean from a human context is different and that the grid is capable of relying on customer contributions to the system. And with that comes the need to recognize the value associated with that and compensated appropriately.

As we are moving through this space, it is not

just a technology discussion. It is not a policy discussion. Does everybody at the end of the day make enough money to make it worth their while to be in this space at all? There has to be viable business models at the end of the day because if there are not the new have increasing burdens to try to legislate a solution to a system that perhaps we could have thought about better in the first place.

I have already talked a little bit about the new technologies, the new distributed resources that are coming into existence. I think I also just wanted to lay out that we need to be able to respect the ownership boundaries that are inherent in our system. When we work with each other, we try to respect individual boundaries and behave accordingly. And just because our machines are interacting instead of people, it does not mean that we are allowed to abuse that boundary anymore or less than we do if there were a person there. Being able to faithfully be that arbiter of value in the system I think is an important dimension in the process. There are so very many new technologies at the grid edge and on the grid itself that we will need to be coping for.

I think some of the interesting debates that we have seen is that if it were merely a solar panel on the

other side of the meter then anything, any energy pushed back onto the grid is clearly from the solar panel. It sure as heck is not the refrigerator making energy. However, you add storage to that system and you cannot tell anymore the flavor of electrons coming off of it. Perhaps it was from the solar panel. Perhaps it was simply borrowed from the grid and given back. It blurs the ability of a sensor to measure that exchange of value at the system.

Now, bring into the fact is that we can easily see a future and we are directly funding the future where generation green, clean generation, storage, and electric vehicles will all be a present at a single premise. I can assure you have three separate meters to measure three separate interchanges with the grid is a horrible idea and it is unscalable. We are really looking to place more burdens at that customer-to-grid interface rather than fewer in this domain.

With that, I think I will bring my comments to a close. I do not have the agenda sitting parked right in front of me. But I want my friend and colleague, Kevin and Michele, to have a chance to represent their mission interest through the charge that we have to the committee as well. With that, I will conclude my remarks. Brent, the show is back to you.

DR. HEARD: Thank you so much, Chris. I really appreciate it. With that in mind, I will turn it over to Kevin and Michele very shortly. But any clarifying questions related to what Chris said? Otherwise, we will hear from Kevin and Michele and then have a broader Q&A.

With that being said, Kevin and Michele, we will turn it over to you.

Agenda Item: Perspective from DOE's Office of Energy Efficiency & Renewable Energy

DR. LYNN: Thanks, Brent. Maybe I will say a few things and then I will turn it over to Michele. Chris gave some really good comments. I will try to be short and sweet with the ones that I have.

It is funny. Just 15 minutes ago before I was coming in, I was thinking about net metering. I just realized 20 years ago basically this month, I put in a 2.4-kilowatt PV system in my house and signed my first net metering agreement back then 20 years ago. That was basically 2.4 kilowatt rotating electrical meter, 75-watt 10 percent efficient module. I just think about how much has changed in those 20 years. I am trying to think about how much will change in the next 10 or 20 years. If you think about where DER is going to go in the next ten years, we really expect the growth to be pretty substantial and

the impact to go with it pretty substantial. That really points to this committee and the importance of the work that you are doing here to make sure that we can provide the guidance or you can provide the guidance that is required by states and others to really think through it and make the right decisions as the proliferation of DER really increases. It is going to be put in the best way possible.

As I think through, and I think Chris and I and Michele and others really have thought through some of those principles quite a bit and Chris alluded to these. As you think through, there is such smart – we were looking at the list of folks on the blue ribbon panel, as Chris mentioned. So many smart people, so many intelligent people are on this panel. Some of the ideas you are going to have I know are going to be brilliant and going to be pulling it all together.

As you think through these ideas, one of the things that we all agree to is make sure there are things the states can use. At the end of the day, all these great ideas are going to come around but somebody is going to have to take those ideas and do something with them. Really, as you think through and you are working on this particular really important task, think about who is it

that is going to take these ideas and what are they going to do with them and how are they going to make these next ten years as beneficial for the customer as possible. I think that is really important.

I think second and Chris mentioned this one too. Develop these results that are applicable across the entire United States. Chris mentioned this. Regions are really important in thinking about different regions in the country and everyone is going to be a little bit different and every utility thinks they are different from every other utility and they are. But also think the context for DOE and for this committee is national. Really think through what is something that everybody can use across the entire country because I think it is going to be necessary there.

I think the third thing we had talked about was make sure and I know you will actively analyze the equity impacts. DER has always been a bit of a hot button about who is the adopter, who is it benefiting, who is it not benefiting. We have been talking about that for a long time at least since I have been involved with some of this.

As we move into the future, that is going to get more complicated and there are going to be more options and more ability to do things differently. There is going to be

more opportunity but there may be more challenges. Really think about that equity challenge as you think through the next ten years.

And the last thing I wanted to make sure that you think about is net metering is just one piece of a broad spectrum of things that are the policy changes and technology changes that are going to happen in the next 10, 15, 20 years. Please do not consider this as a net metering in a vacuum I think is what we were talking about. There are all sorts of other things that are happening. This is one piece of it. Make sure that you think about net metering as it relates to the broad set of other grid modernization activities that are going on so it not just – it fits as part of the broad puzzle piece of grid modernization writ large.

I think I will just stop there and turn it over to Michele for her comments.

DR. BOYD: Thanks, Kevin. I am the last one so there is not a lot left to say. But I really appreciate both Chris and Kevin's comment. I do want to just emphasize a couple of things. One is I really appreciated both Chris and Kevin pointed to the fact that DERs are growing. I like to make the point that they are not growing evenly everywhere. We have places where there is almost no DERs

and very little policy requirements to grow them. And then we have areas where we have 100 percent renewable goals and very large percentage of the electricity is already coming from DERs. I think just understanding that – everyone does understand that but including that in your thinking is really important because that means that where a location is now, not physically, but within the context of growing DERs is really important as to what the decisions they make in terms of net metering or other regulatory decisions. That is a huge piece of the puzzle, I think.

And then I would also like to emphasize the equity comments that Kevin raised. That is often -- when people talk about equity in energy, it is often pointed towards cost shifting, which is certainly an issue. But I would also really like to stress a few other areas and I might be missing additional areas that – this committee please do explore. The other two areas that I was thinking about are fairness so who gets the benefits and just as an example, DERs are becoming more affordable so lower income, not just the highest income people have access. Other people who are joining in this still receiving benefits. What kind of benefits? Is that fair? Questions like that need to be analyzed.

And then access. Who actually has access to these

DERs? Has that access changed with the regulatory structure? I just urge you to think about – and, again, I might be missing other aspects of equity. But I really urge the committee to think about and analyze that word and think about all its aspects.

I think with that, I will stop ad open it up to questions.

Agenda Item: Q&A for Academies Committee and Staff

DR. HEARD: Fantastic. Thank you so much, Kevin and Michele. Committee members, please raise your hands, which is available under the reactions button at the bottom of your screen. I will then call on you. We can begin the Q&A period here.

DR. BORENSTEIN: Thanks to all three of our colleagues from DOE. I wanted to ask a question. I asked Brent but I am hearing a somewhat different tone from you. My thinking about behind the meter's solar is that there are two separate issues. One is what is the role of behind the meter solar going forward. And the other is once that has been determined, how do we pay for it? I thought that the charge of this committee was narrowly the second question. But all three of your comments were mainly about the first question. Can you give us some guidance on how we

should partition our thinking about this and if you think that this is in fact that we need to do a larger study about the future role of behind the meter resources generally. Though I think this will be mostly about solar.

DR. IRWIN: Solar certainly will be growing in the environment. But I think that Congress was quite specific. There is distributed renewable resources in general. But it is the growth of DER that I think is relevant here too because it is no longer a clean measurement surface as to whether that contribution was renewable or not.

DR. BORENSTEIN: I agree with that. There are these two separate, in my mind, questions, one about let us forget about solar, the role of DERs or I will call it behind the meter resources because I think our distributed resources that are not behind the meter and the role of net metering. I think it is possible to just examine the second without going into the much bigger issue of the first. But would that be a satisfactory study or would that not address the concerns?

DR. LYNN: Can I jump in on that? I think a couple of things are here. I would agree with Chris that this is not going to be just a solar study in my mind especially if you think out the next ten years and we are thinking the expansion of electric vehicles particularly in California.

DERs behind the meter is going to be extremely huge and it is going to be broader than solar.

As to the first question, the question of the role of DER versus net metering or how we pay for it I think is what you said the first time. I think the question is inherent into those two questions, one has to do with value and then one has to do with how you pay for it. What are the values that come from the DRE themselves and then how do you think – what value does it play and then – I guess that bifurcation is a little strong for me at first blush. Maybe I need to think about it a little bit more. I think the value are inherent into both of those together.

DR. BORENSTEIN: I actually have somewhat the opposite view, which is we are not in a position even the smartest people on this committee to predict what the value of DERs are going to be five or ten years from now. My understanding was that the charge was to analyze net metering and how effectively it could address value.

DR. IRWIN: I am going to say is that this – the committee will not fulfill the intent that we have if you focus only on solar. It is like going back –

DR. BORENSTEIN: Drop solar. I am sorry. I never said solar. Let me just – I apologize. All resources. The question I am trying to raise is distributed resources

behind the meter. Are we expected to analyze actually what value they create or just to focus on can net metering, which was the title of this, adequately address the value that they represent?

DR. IRWIN: Putting a price on it is the value. Being able to recognize the exchange of value is I think the more operative term here. If we can witness it through that customer grid interface, then somebody else can decide the compensation that is associated with that. The ability to measure the contribution from one party or the other at that I think is going to be an operative discussion. I see a lot of hands. Perhaps you can ask me the exact same question in 15 minutes and we will hit it again.

DR. BOYD: This is Michele. I just want to say I am not – I definitely do not think we are asking the committee to come up with a number for the values. But I do not know how you have a conversation about how net metering can address the values without identifying what types of values you are talking about. I hope that helps answer that question.

DR. IRWIN: Brent, you are in charge of picking the hands.

DR. HEARD: Sue is up next.

DR. TIERNEY: Thank you. Great instructions, you

guys, and informative insights. I have two questions that go to the statemen of task. There are a couple of places in the statement that indicate net metering and alternative policies. That phrase comes up quite a few times. I can think of a really wide scope of alternative policies. I would love to hear how you have thought about bounding that exercise.

And then the second question is I have seen references to customer-owned distributed energy resources and rooftop and behind the meter and community solar. I think there are some community solar that really are not behind the meter literally. How would you like us to think about that where those maybe looking more like a PURPA project in some sense? That was not meant to be value laden or anything else. I am just poking at how you guys would like us to think about those.

DR. IRWIN: All good points, Sue. And I forgotten half of them already. I think just starting with your last point is that when we talk about the players in the game is that you have – really it is the ability to recognize individual contributions back and forth at that interface. But community solar is sort of an advocate and an aggregator of the contributions of community members. I think that in that case, we are not saying that we are

talking about grid side assets being treated in the same way. But there are new entities, either profit or nonprofit who are playing in this mix. We were really more interested in opening the fronts up than determining the limitations of them for a little bit. We may have problems with our ambition there. I think that applies to your first term as well.

When we talk about alternative policies is to a certain extent, net metering is really just the scale. It goes this way and it goes this way and it ends at that point. To a certain extent, an alternative policy is bidirectional metering where you measure the energy delivered and the energy received on two separate channels and there is no net measurement. You actually have two quantities upon which to base a policy. It can be as simply interpreted as net metering is not just the mathematical equation but it is the data that you are using to measure things exchanged at that interface. Does that help?

DR. TIERNEY: Yes. With one follow-up question. You did not mean to imply that the committee should look at other alternative policies for advancing distributed energy resources.

DR. IRWIN: Correct. And that gets to what Kevin was talking about earlier is that net metering and that

domain will be bracketed by other systems and other policies and things like that. The committee is permitted to bound itself in those areas.

DR. BOYD: I was just going to add. I agree with what Chris said. Net metering is not one thing. I think we were trying to – states had net metering 2.0 and 3.0 and trying to incorporate all of those variations into this discussion. And then in terms of community solar, I think we were thinking of virtual net metering. Just kind of putting all of that on the table but maybe not explicitly as we should have.

DR. TIERNEY: Perfect. The thing that keeps running through my mind is were you talking about – do you want us to talk about tax credits for customers, adoption of stuff? It sounds like the answer is no. That is helpful.

DR. HEARD: Great. We will then move to Tom followed by Janet.

DR. STANTON: Chris, you mentioned about respecting the boundaries. I think I understood you to be talking about the existing industry structures and the boundaries between utilities and customers and solar developers. Maybe I misunderstood. But my concern that it raises is what if the new distributed technologies are going to push us in a direction where the 125-year-old

regulatory compact has to change ad we already have multiple flavors of it in different states with some still vertically integrated and some restructured and among the restructured states, different kinds of restructuring. I am in Michigan where we had the investor-owned utilities spin off all their transmission. We have separate transmission and separate distribution and same companies owning generation and distribution.

I just want to make sure that you are not suggesting or maybe you are suggesting, are we going to be boxed in to thinking about the industry that way it is structured today or are we free to investigate how alternative structures might lead to alternative policies.

DR. IRWIN: In my emphasis of the boundary, it really is advocating for customer sovereignty. The customer's domicile is theirs. The assets they purchase are theirs first and foremost. And that anybody who wishes to borrow that functionality should have the respect to request it rather than demand it. It really is that customer grid interface where I believe a sovereignty must be respected. If you say, is it permeable where the utility can own the toaster and the coffee maker and refrigerator back 100 years ago, no, that is not permitted. Other business structures and other players is more fluid at

least in my mind.

DR. LYNN: In a similar way, I think I would just say – I think we are looking – things that are going through a pretty good transformation right now. We see some pretty expansive – and maybe I heard the question slightly differently. But I personally am hoping – I do not want the utility to own the toaster as Chris said. But I also want us to be open to different thoughts and ideas about what makes sense as an expansion DER comes about. What I do not want this to be is we are all under the same – this is an incredibly smart group of people here and we should be using your brain power to think about what is possible with in mind that at some point, you do have to make recommendations to folks on how to implement. I would prefer for people to think on the innovative side as opposed to being too constricted and how you think about what the future looks like.

DR. STANTON: I would like to note that we already do have places in the country where utility ownership of distributed rooftop solar is already taking place. I think this boundary is going to be more permeable than maybe we immediately think.

DR. LYNN: Green Mountain Power.

DR. HEARD: Great points. We will then move on to

Janet.

DR. BESSER: Thanks, Brent and thank you very much, Chris and Kevin and Michele for being here today to answer our questions. I have three questions. I think you may have answered a couple of them. But the first question is about we are looking beyond solar at all sorts of new DER technologies. I think Chris has been really clear about that and I see him nodding his head. I think that was a question that had come up.

I think we have touched on this but when people talk about net energy metering, a lot of the conversation has been about net metering being an exchange at the retail rate. It sounds though that our purview is to go beyond that and to really look at the variety of compensation levels as it were for that exchange between the customer and the grid and just looking for confirmation that that is correct.

DR. IRWIN: Confirmed.

DR. BESSER: Okay. Great. And then the third area is one that – because of some of the language used in the statement of task and in the congressional language, I think – when I think about the role of net metering and the evolving electricity system, there is a set of economic and business questions and there is a set of engineering

questions. The study is clearly meant to address the economic questions, the business models. And my question goes to – to what degree should we be looking at some of the engineering implications of increasing amounts of DER and what that might mean for grid modernization, the need for investment to manage, visualize, control, whatever word you want to use, the variety of DER as we think about the question of the role of net metering? Or should our focus primarily be on the economic side? Those are my words, economic versus engineering. I realize that may not be –

DR. IRWIN: I think I mentioned that in my opening thing is to a certain extent the technology determines the possible policies that exist, and the technology is quite different. If you can sense it, if you can measure it, then you can assign a value to it. To a certain extent, I think that the engineering possibilities – I do not think the committee should be required to imagine all the possible implications of a high DER future on the system. However, the evolution of the customer-to-grid interface and I know you have Mohammad, you have Anu, you have some other people who understand some of the dimensions upon which the exchange of value can be measured and predicated. That would certainly be in play. It is not purely an economic discussion.

DR. BESSER: Great. Thank you very much.

DR. HEARD: We will then move on to Galen.

DR. BARBOSE: Thanks, Brent. My question really has to do with the scope of the term net metering kind of how broadly should we be interpreting that terminology. Often, it is sort of used as a catch-all stand in for how distributed resources are compensated and how a customer with distributed resources generate savings on its utility bill. But I think of net metering as being much more narrowly about how do you compensate the customers specifically for the electricity that gets exported to the grid as opposed to their own consumption that they displace in real time.

I guess my question for you is within the scope of this study, are we solely concerned with the treatment of electricity that gets exported, it goes out through the meter, or are we also concerned about with the method for compensating displaced consumption.

DR. IRWIN: Kevin, I am going to defer to you on the start of the answer.

DR. LYNN: I have been doing this a long time. I kind of think of it as a pretty early stage and net metering to me is sort of equated back to the actual mechanical meter itself where the meter defined the reason

for net metering to begin with because it rotated one way and rotated the other way depending on which way it goes and no one wanted to put new meters in so that is the way it went.

I would say obviously, not obviously, but I think there is certainly – the impacts on exported electricity are more of – I would say more of a concern. I am brainstorming here. I do not necessarily have the answer – are more of a concern than the energy that is being used at the location in my opinion. Obviously, the energy use of the location offsets what the utility would be – that has impact as well. But it does seem like the exported utility, exported energy has more implications in terms of value and in terms of challenges to the distribution system than those that are being consumed online. That is my first thought.

To me, when I think about the charge, most of the charge has been – the narrative in my head is back in 2002 when I put my system on, there were so few systems that nobody cared and nobody wanted to deal with. Just leave the meter on and let it spin whichever way it does. We do not have to worry about the accounting of it. Now we are in a new place and the value is so small and the impact was so small it did not really matter. Now, we are getting to a

place where the impact matters big time and it is going to get higher and higher impact. What is the appropriate way to value the DER that goes on the system? To me, that is the appropriate sort of how do we think about and how does policymakers think about DERs that get put on a system now that the system has changed so dramatically from when we first started putting solar on a system all those years ago. To me, that is the fundamental question as opposed to the delineation between this piece or that piece.

That is the kind of question the policymaker needs to be answering. People are putting on DER. What is the appropriate way? What is the value it is providing? What is the appropriate way to value that? How do I think about what was net metering back then and how do we think about it – what policymakers need to provide to the consumer, using this distributed energy technology moving forward? Hopefully, that helps to answer the question.

DR. IRWIN: I think the committee may have to struggle with this a little bit is that it is not a five-year mission. I think that you will think about your scope, think about the charge and then think about the human dimensions of what can we accomplish in the time given us. We will go back and forth on the victory line there a little bit.

DR. BOYD: I would just add two thoughts. One is DERs are growing but in some places, there is almost none. We still have places where there is almost nothing. It is not the same everywhere. I really want to stress that again.

And then I would say, Galen, to look at both because you are talking about equity in terms of who gets the benefits. Just throwing this out as an example, restrict homeowners that they cannot sell into or provide electricity into the grid. Then there maybe a value loss that their neighbors had at some point. Just thinking about that in terms of – I do not think you can parse those two apart without thinking about the equity question. I hope that is clear. You can nod your head or shake your nod, either one, Galen. But I think it is all tied up into that. I think trying to parse those two things apart is really hard.

DR. BARBOSE: It sounds like we will have stuff to think about as a committee here. I certainly see a much larger scope if we were to extend the inquiry to also thinking about just rate design broadly and offsetting self-consumption, but something for us to ponder. Thank you.

DR. HEARD: Also note, this is not the last time

you as a committee you get to talk with our DOE sponsors. As issues arise, we will get the chance to check in and get further clarification and thoughts.

With that, Terry, you are next.

DR. SURLES: Actually, a number of my questions have more or less been answered. More of a comment going back to one of Kevin's early lead ins and thinking about this as a system. I think we are going to end up – this is a discussion we have already had. What are the boundary conditions of this study?

And picking up on another thought, the new technologies. Again, it is so different from what it originally was as just the old kind of meters. Now, look at narrowly defining it for things we are doing and why. A lot of the early just putting excess electricity into the grid created some issues for the grid. But now with things like legislatively mandated retirement of the coal fire utility there are – can we have behind the meter solar plus storage actually help to stabilize the grid? That is a question.

And then finally and tis was already just brought up by the previous speaker. One of the things we have talked about both in California and Hawaii is equity that we have rich people get to put the solar on and poor people have to pay who cannot put solar on because they cannot

afford it and have to pay more for managing the grid. Just a couple of comments. But, again, a lot of this has already been discussed.

DR. IRWIN: Certainly in play, Terry.

DR. HEARD: Unless we have further responses from our – colleagues, we will move to Marilyn.

DR. BROWN: Good discussion. Covered a lot of territory. I was so pleased to hear that the study is not just about net metering of rooftop solar. That is a big problem and deserves a study of its own. But it is so much more exciting to hear that it is really about all distributed energy resources, and it is a much bigger enterprise than I had expected. I am very glad to hear that.

In many states such as the State of Georgia, the biggest distributed energy resource is combined heat and power cogeneration. And there are a lot of issues I hope we might be able to at least consider with respect to that. Its potential for growth is enormous. As you know, the industrial sector is likely to be responsible for the biggest growth in emissions over the next half century unless we do something different about how we manufacture our goods and how heavy industry becomes more efficient with the recovery of its waste and the potential for

generating electricity from those processes. Where is the edge that we are talking about? Is this edge potentially inside a big manufacturing plant that in itself is a small power plant that it owns and it can sell to other – back to the utility or maybe back to a Marine Corps establishment? This just comes to mind of one of the bigger plants and newer plants in Georgia.

I hope we can try to extend with the principles we develop what could be potentially valuable to a cogeneration, which can provide a platform for renewable energy resources in industry. I am not talking about the old natural gas fired plants that capture their (indiscernible) but it can be a lot of hydrogen there too, renewable green gas. Anyway, excited about that.

And then speaking of where is this edge, it might be simple. But when I served on the electricity advisory committee with Sue Tierney as our chair, we undertook a study. And we asked every member of the committee a couple of questions about – really, we were focusing on V2G. Is V2G going to be alive and well at some point? There, it sort of broadens out to I think a very bigger question, which is peer-to-peer exchanges of services, energy services. They may not involve the utility meter.

Galen mentioned the comment on loss of demand or

behind the meter. These exchanges, these peer-to-peer exchanges can be quite valuable and can be very complicated and could grow over time if allowed, if the business models were to grow and the regulations were to be more supportive. But then of course how do you maintain – how does the utility get the fixed charges to maintain the backup that we all need in the utility system?

Two things there. One is do we expand to cogen? And the other is can we expand to peer-to-peer exchanges?

DR. IRWIN: Our advocacy or sort of our mission space is for the national infrastructure and the grid. It is really networked resources. And to the extent that – I think the peer-to-peer question is very interesting. I have a large body of research and transactive energy, which occasionally invokes peer to peer. But in general, until the customer supplies their own wires, it is never a peer-to-peer exchange. It is a peer to utility to peer. There is always the postage stamp shipping and handling invoked in those kinds of transactions.

To the extent that the network resources are invoked in a peer-to-peer exchange, then I think that that – obviously, I think everybody can feel the scope expanding. We do not have any contractions just yet. I really think that you kind of have to struggle with this a

little bit on it. And the cogen – I am kind of –

DR. BROWN: If my neighbor comes over and charges their car in my garage, there is no need for a new wire there – transactions too that do not require wires.

DR. IRWIN: There is a responsible party in the same way that if the neighbor comes over and uses my restroom, if there is a problem at the end of the day, I am probably going to be paying for it. I see the analogy. But I do not see where the metering is invoked where that grid-to-customer interface is activated.

DR. LYNN: Maybe to try to answer both questions in some form or fashion. I think we have a pretty considerable scope and we are talking a lot about a lot of different things here. I think this committee need to think about where the priority lies for the people that were – in my opinion, who we are trying to help which is the state policymakers and others to try to think about how they apply what is the next step in that net energy metering. If this committee thinks that peer-to-peer is the priority, that is something to think about. If they think that cogen is the priority, that is something to think about. But I think there is a lot on the plate here. I think it is up for this committee to really think about where the priorities lie for what you need to accomplish and be most

effective.

DR. HEARD: Great discussion. Thank you, all. Next is Josh.

DR. PEARCE: Hi everybody. I have a question about equity. I believe that we are moving towards a period where the levelized cost of electricity for DERs will be lower than the retail rate of electricity for consumers. If this is retail rate of normal what is considered net metering and I can produce electricity here, I am incentivized to leave the grid, which increases the cost for everyone. When you say equity, do you want an equitable value for each electron for kilowatt hour or what would be best for the poor people that are forced to use the grid in the future when all the wealthy have left it?

DR. BOYD: That is a pretty loaded question there, Josh. We are actually interested in what are the impacts on communities that are disadvantaged. As you know, this is a huge priority for the administration. Your scenario is one possible scenario, which is all the wealthy people leave the grid to – the disadvantaged communities have to pay for the grid or low-income households.

But that is not the only scenario out there. And I think that that is a very limiting scenario to look at. It is probably not realistic either because there are other

constraints that prevent people from choosing to use DERs in their home. I think that question needs to be broadened to make sure that we are not just saying everyone is exiting and we need to prevent that from happening. That is too narrow of a scenario.

DR. PEARCE: I guess what I was asking is do you want an equitable value for each kilowatt hour or do you want an equitable end solution for –

DR. IRWIN: The White House is not articulating equity goals for electrons. It is for human beings. It would be the human experience of equity.

DR. HEARD: Thank you. It looks like our last hand here is Mohit.

DR. TIERNEY: By the way, I just have to crack a joke because this is a public meeting and I just love that Chris has had that the White House is not looking for equity for electrons. That is a headliner.

DR. CHHABRA: Good afternoon. Net metering in many regions either a special rate or net meter customers are assigned to an existing or new type of rate. I hope that talking about what types of rate design enables accurate net metering is within this group's purview.

DR. IRWIN: It is. And I think we actually mention rate designs in part of the charge there that it is

certainly in play because it is like the – you have the measurement capabilities and then how it is formulated into something that a regulator can insist on. I think that is certainly in play.

DR. LYNN: And rate design in the context of the changing system to pull it all together.

DR. CHHABRA: That could go some ways towards answering the excellent questions that Galen brought up a little while ago.

DR. IRWIN: True. And in under the wire, Anu.

DR. ANNASWAMY: Not really a question for you, Chris, but more a comment to follow up in what – I think it was Mohit who said that that is exactly where technology will intersect where it is about designing the rates that not only addresses the issue of what is the value of net metering, but also as you start to scale up the net metering. Kevin mentioned what happened 20 years ago is not what is happening now and certainly not will happen over the next 20 years.

As everybody starts to proliferate on these DERs, it is really going to be more complex not just from the point of view of equity or the compensation to the customers, but also from the point of view of grid reliability. That is, I think, where appropriate interfaces

have to be designed and the technological considerations have to be addressed.

DR. IRWIN: Brent, I think we owe you a public comment period.

Agenda Item: Public Comment Period

DR. HEARD: Yes. Thank you for this excellent discussion. I have two public comments which have come in that I will share with the committee sponsors and all those watching. The first one actually dovetails excellently into what Janet put into the chat in terms of Joshua's comments, suggesting that we may need to define what we mean by equity up in the front. We did receive one comment, which is about in the commenter's words, fairness, saying that everybody regardless of monetary class benefits from a better climate. Even if the very wealthy were to receive a financial reward, if the climate measurably improves, even those in poverty would be receiving a real benefit. That was a comment more than a question, but something to consider.

The second question we received is how should we address the change for prosumers and cooperation with them without network operators.

DR. IRWIN: I wonder if that invokes the peer-to-peer question again. I am not 100 percent sure. A prosumer

of course is someone who can produce and consume electricity. To the extent that they can do it all themselves then the network is no longer relevant. They can live their lives as they see fit. Two prosumers cannot exchange anything without a network. I am not so sure that I can imagine. If we can imagine a grid without a grid then I am sure I – I might ask for a little follow up, I suppose.

DR. HEARD: That is fair. Thanks for giving that a shot. Terry, I see that your hand is raised. Do you want to weigh in on this?

DR. SURLES: I apologize for not being able to resist a response to the one comment. Let us put it this way. I come from a very modest background. I am sensitive to some of these things. Frankly, the idea that poor people benefit in some nebulous way from carbon emissions is just an elitist response.

One of the things you have to wrestle with right now that is a big issue and certainly in California that we uncovered in the Stanford study is not so much worrying about carbon emissions, but other carbon emissions like soot and local emissions. I think that the equity issues are important. But I would have to quite bluntly reject that comment as being elitist. Sorry for being blunt but I

had to say that.

DR. IRWIN: Thanks, Terry.

DR. HEARD: Thank you indeed. With that, we will wrap this session and our committee will resume its closed session at 4 on the previous Zoom link you were using. Sincere thank you to Chris, to Kevin, and to Michele for coming and briefing us. This is not the last time we will get to speak with each other. But I think this was really helpful and clarifying the committee's approach to its statement of task and queuing up important things for them to think about.

Thank you for your time and thank you to the audience, which joined us for your time and participation with this study. We look forward to seeing you all in the near future. Take care and thank you all.

(Meeting Ended)