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STATE OF CALIFORNIA

CALIFORNIA ENERGY COMMISSION

In the Matter of: 2021 Integrated Energy Policy Report (2021 IEPR)	Docket No. 21-IEPR-05 Re: Renewable Natural Gas

IEPR COMMISSIONER WORKHSOP ON RENEWABLE NATURAL GAS

REMOTE VIA ZOOM

TUESDAY, AUGUST 31, 2021

Session 1 of 2 – RNG Supply, Availability, and Price in California, 10:00 A.M.

Reported by: Elise Hicks

APPEARANCES

COMMISSIONERS PRESENT:

Commissioner J. Andrew McAllister, 2021 IEPR Lead, California Energy Commission (CEC)
Commissioner Siva Gunda, CEC
Commissioner Karen Douglas, CEC
Commissioner Patty Monahan, CEC
Commissioner Cliff Rechtschaffen, California Public Utilities Commission (CPUC)
Commissioner Houck, CPUC

CEC STAFF PRESENT:

Heather Raitt, CEC

OVERVIEW ON WORKSHOP PURPOSE AND RENEWABLE GAS ISSUES

Melissa Jones, CEC

THE RNG MARKET IN CALIFORNIA

Stephan Barsun, Verdant Associates

RNG PERSPECTIVES

John Mathias, CEC
Rizaldo Aldas, CEC
Francois-Xavier Rongere, Pacific Gas and Electric (PG&E)
Daryl Maas, Mass Energy
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P R O C E E D I N G S

August 31, 2021 10:01 A.M.

MS. RAITT: All right. Well, good morning everybody. Welcome to today's 2021 IEPR Commissioner Workshop on Renewable Natural Gas. I'm Heather Raitt, the Program Manager for the Integrated Energy Policy Report, which we refer as the IEPR.

This workshop is being held remotely consistent with Executive Order N-08-21 to continue to help California respond to, recover from, and mitigate the impacts of the COVID-19 pandemic.

The public can participate in the workshop consistent with the direction in the Executive Order.

Today's workshop has a morning and an afternoon session with separate logins for each. To follow along the schedule and slide decks have been docketed and are posted on the Energy Commission's website.

All IEPR workshops are recorded and the recording will be linked to the CEC's website shortly following today and a written transcript will be available in about a month.

Attendees have the opportunity to participate today in a few different ways. For those joining through the online Zoom platform, the Q&A feature is available for you to submit questions. You may also upload a question submitted by someone else. To do so, click the thumbs up icon. And questions with the most uploads are moved to the top of the queue. We'll also reserve a few minutes near the end of the panel to take questions but will likely not have time to address all questions submitted.

Alternatively, attendees may submit comments during the public comment period at the end of the morning and the afternoon session or the afternoon session. Written comments are also welcome and instructions for doing so are in the workshop notice. Written comments are due on September 14.

With that, I turn it over to Commissioner Andrew McAllister who is the lead for the 2021 IEPR.

Thank you.

COMMISSIONER MCALLISTER: Great. Thank you, Heather. Welcome, everyone. Looks like we have good participation here. We're at 100 people which is terrific. And this is a little bit of a redux of or a complement to yesterday's forecasting workshop and also has some overlap with the previous workshop around hydrogen.

We're really trying to get all of these related issues kind of stressed out and the pieces lined up on the playing field in a way that makes sense. And so that's overall what we're trying to do here in the IEPR this year. And it's a very kind of vibrant and ever-changing landscape it seems and obviously driven to look for solutions by the urgency of climate change and just the incredible shifts we're seeing in energy -- across the energy landscape and the climate landscape.

We're all thinking about all the communities around Lake Tahoe right now that are just under amazing -- under just incredible threat. Evacuation orders, lots of structures being burned down, and we can link that directly back to climate change. And so we really just have to figure out a way to decarbonize our economy, our energy systems, in particular our gas system.

And so renewable natural gas can be -- must play really in this -- in this game and it's got to be a part of the solution and, you know, along with all the other complementary topics, trying to figure out how much of a part of the solution. But for the gas system itself, you know, it -- as it relates to transportation and other sectors of the economy, industrial, etc.

So renewable natural gas is something that really warrants delving into. We have incredible staff on this. I want to just thank Heather and her team, Raquel and the whole team on the IEPR side who again are just organizing wonderful workshops that help us build the record in a positive direction. So thanks again for that Heather and team.

And then also we have the natural gas crew in the Assessments Division led by Melissa here, who'll you'll see present in a little bit. Aleecia Gutierrez, the Deputy over the Assessments Division, and you'll see a number of staff throughout the course of the day. And Jennifer Campagna, ably moderating our Q&A sessions.

So I want to just thank again everyone for being here. I'm joined on the dais by Commissioner Karen Douglas. I think, Heather if I'm not mistaken, she's the only Commissioner with us at the moment? But certainly --

MS. RAITT: -- (Indiscernible) --

COMMISSIONER MCALLISTER: -- would invite -- invite Commissioner Douglas to --

MS. RAITT: Yes, it is (indiscernible.)

COMMISSIONER MCALLISTER: -- (indiscernible) --

MS. RAITT: Commissioner Gunda is also -- yeah.

COMMISSIONER MCALLISTER: Oh, I'm sorry. He's not appearing on my list. Okay. I'm sorry. Sorry about that, Commissioner Gunda.

COMMISSIONER GUNDA: (Indiscernible.)

COMMISSIONER MCALLISTER: I would pass it off first. Oh, there he is. Well, I'll pass it off first to you and then to Commissioner Douglas.

COMMISSIONER GUNDA: Absolutely. Thank you, Commissioner McAllister. I'm going to say it's a joy, as always, to be on the dais with you --

COMMISSIONER MCALLISTER: And you, likewise.

COMMISSIONER GUNDA: -- and Commissioner Douglas and for this important conversation.

I did want to just kind of set the context and then kind of expand on what Commissioner McAllister mentioned just in a couple items that are important to me as we go into this workshop. Before we jump into that again, I'll restart with a sense of gratitude to the incredible staff that we have at CEC that come in day in and day out and work on this important topic and to the betterment of the state, our nation, and more broadly the planet. So just incredibly grateful for our colleagues and staff across the Energy Commission and particularly on days like this where we have our IEPR workshops.

Special kudos to Heather and the IEPR team for, you know, the tireless work that they do in bringing these workshops and doing them in an extremely collaborative and meaningful way. So. And thoughtful ways. So thank you, Heather, and your team.

So I think in terms of the context, I just want to share a couple things. You know, in the CEC as we -- as we've been through workshop after workshop this year, we try to talk about this and reiterate this important point and I think it's meaningful today to talk about, which is that CEC has an extremely important role in helping facilitate robust data driven conversations and ideate on important policy options in ensuring a kind of a safe, reliable, clean, and affordable energy system to serve all Californians.

I think this role is unique to CEC and the kind of the structure of CEC allows for this dialogue to happen in a collaborative fashion and brainstorming to happen in a collaborative fashion that other venues might not lend themselves to easily because of the regulatory regime and such that they have.

So I just want to kind of call that important -- important in CEC’s role in facilitating these conversations.

I think as we continue our transition towards this clean energy system, obviously there are two things that we are hyper focused on. And -- and thinking through the transition of the electricity system and the goals of SB100 and all the work that, you know, we’re doing as a Commission along with the sister agencies collaborative near the CARB, CPUC as well as CAISO.

I want to call attention to Commissioner Douglas’s work on offshore wind infrastructure, land use, planning, and such, in really thinking through how do we transition out of electricity system to a clean system, both from a planning perspective, but also thinking through the constraints of that is.

I think the other side of the important piece here is the gas transition. We talked about the gas transition, we -- we all watched a bunch of workshops this year. The 3232 workshop, the building decarbonization workshop. It's an all the leadership that Commissioner McAllister has been, kind of, leading these topics on building decarb as a whole and -- and the importance of, you know, the transition of these different sectors.

So it becomes then important, how do we think about the gas transition in a meaningful way and how do we ensure that transition is again equitable as well as ensure its reliability and safety for all of Californians?

This workshop will give you the state of the RNG market in California, the status of RNG projects and research in California, and policies and incentives that affect RNG. I think this is an important conversation to build the record on this important stream of work.

As Commissioner McAllister mentioned from a gaseous fuel and energy carrier's perspective, we have at least two important critical elements to think through which is the RNG and hydrogen. And many others but these two become an important element to think through as we talk about gas transition.

There is a wide consensus established today by idea of research that significant reduction in carbon emissions is feasible in a large group of sectors across the economy. But that leaves some niche and some hard to decarbonize elements through electrification which then, you know, require a necessitate other -- other fuel options.

So I'm looking forward to this conversation. It's important to set the stage. I'm thinking through the broader elements of how do we move towards more cleaner and a fuel -- and a gaseous fuel options and energy carriers.

So with that, I'm thankful again to all the staff. Melissa, Jennifer, and then the entire gas team in the Assessments Division and the management team that I will pass the mic to Commissioner Douglas.

COMMISSIONER DOUGLAS: All right. Well thank you, Commissioner Gunda, Commissioner McAllister. I'll just keep my comments brief but I join in the appreciation of the work and the analysis that's gone into this and very much look forward to learning from this workshop and from the questions and comments that we hear from it.

So thanks.

COMMISSIONER GUNDA: Thank you, Commissioner Douglas.

Heather, I'm just checking with you. Is Commissioner Rechtschaffen online ready?

MS. RAITT: Sorry, no, he's -- he's trying to join so he will be joining us shortly, I think.

COMMISSIONER GUNDA: Okay. With that, Heather, I'll pass it back to you to kick off the workshop.

MS. RAITT: Great. Thank you so much.

So first, we have a presentation from Melissa Jones who's the Senior Policy Analyst at the Energy Commission and is a frequent flyer with the IEPR workshop.

So thank you, Melissa. Go ahead and you should be able to start your video now.

Thanks, Melissa.

MS. JONES: Thanks. Good morning, I am Melissa Jones. I'm a Senior Energy Policy Specialist at the Energy Commission, a principal on electricity and natural gas issues. I welcome everyone to the workshop today.

I'm going to give a very short overview because I'm going to leave it to the experts to talk about renewable gas.

Next slide, please.

So the goal for this workshop -- there are two areas of focus that were identified in the scoping order that relate to gas, natural gas, renewable gas, alternatives to it. And the Warren Alquist Act does asks us to analyze all aspects of natural gas including forecasting and assessments, of demands to apply price infrastructure, market, and related topics. We're also intended to identify emerging issues and problems and identify solutions.

The IEPR does serve as the analytical foundation for policy development, and so we're -- we've done a series of workshops. Today we are focused on renewable gas. In the gas track, there's two items, the situational awareness of emerging topics in natural gas system planning and refinement and development of critical analytical products necessary for gas planning. We talk a lot about those refinements and development of new products yesterday at our workshop.

Today we will be seeing presentations on RNG supply, availability, and price. We'll also see presentations on policy approaches for renewable gas.

Just to mention, we've already had three workshops related to gas issues or specifically on gas issues. We had a gas infrastructure workshop back in May. We had a workshop on gas electric interdependences in July. And then yesterday, our market and price forecast workshop.

We do anticipate at least two more workshops related to natural gas. One on long-term demand scenarios and then another one when the staff has its gas demands forecast and electricity forecasts available.

Next slide, please.

So RNG is methane, renewable gas is methane produced in a sustain -- sustainable or renewable way. It's a byproduct of other processes such as waste disposal. Sources are dairies, landfills, wastewater treatment plants, agricultural waste. There are end use opportunities for renewable gas and an electricity generation, space and water heating, transportation fuel, and also as an industrial fuel in feedstocks.

Most of California's RNG is being used in the transportation sector and that's largely due to the Low Carbon Fuel Standard which provides an incentive that's driving it into that market.

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Let's talk just a minute about renewable gas and GHG admissions. This is 2019 methane admissions from ARB. Methane is a more potent climate forcing molecules than carbon dioxide which is why it's of concern. Methane admissions in agriculture including dairy and (indiscernible) fermentation and manure, nondairy livestock and rice cultivation account for about 80 percent of the total methane admissions in the state. You'll also see that pipelines account for about 12 percent.

Converting waste to RNG has important societal benefits of the pollution to waste disposal. We are looking at use in trucks and heavy-duty vehicles that have climate benefits compared to diesel which is what they're running on today and we're looking at the prospects to inject RNG into gas pipelines and we do recognize that there is leakage in the pipeline and so part of the ARB's short-lived climate pollution reduction strategy is to -- to develop renewable gas as a productive way of using it.

We've -- I would like to mention that California regulators have approved a new approach to methane leaks from natural gas production requiring utilities to prioritize repairs on lines that leak, even if the lines don't pose a physical threat. This is to make sure that we capture and prevent leakage from the system and that pipeline leakage prevention is a key utility program.

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And with that, I'm going to turn it over to the experts. So thank you for listening to me this morning.

COMMISSIONER GUNDA: Thank you, Melissa.

Before we jump into the experts, I wanted to recognize that Commissioner Rechtschaffen is with us now. And Commissioner Rechtschaffen, if you want to provide any comments before we go into the subsistent presentations.

COMMISSIONER RECHTSCHAFFEN: No, I thought that I was welcome at the Energy Commission workshop but I didn't get the special password to be on the dais this morning so I guess I've fallen out of favor since yesterday.

I'm delighted to be here. Thank you for holding this workshop. It's another example of our close collaboration. We of course have ongoing proceedings dealing with whether or not to establish a renewable gas procurement mandate and this is extremely relevant to that proceeding as well as the other work we're doing on biomethane at the PUC.

So I very much appreciate being able to participate and look forward to the discussion today.

COMMISSIONER GUNDA: Thank you so much, Commissioner. It's always a pleasure having you. And thank you for your continued leadership and would put on the policy fronts but also the statewide collaboration in moving these topics forward.

With that, I'll pass it back to Heather.

MS. RAITT: Great. Thank you, Commissioner.

So our first presentation is from Stephan Barsun who will give us an overview on the RNG market in California. Stephan is a founding partner of Verdant Associates where he leads the engineering and building decarbonization practice areas. He has over 20 years of experience in mechanical and energy engineering serving in design, analysis, and leadership roles. And prior to cofounding Verdant, he was a senior principal consultant in Itron's consulting and analysis practice. And so Stephan is a registered professional engineer.

So thank you for being here and go ahead.

MR. BARSUN: Thank you. So hopefully everyone can hear me. And as Heather mentioned or -- sorry one -- we'll be -- I'll be talking a little bit about the renewable gas market and natural gas market, some of the sources of that, some of the potential for those sources, and then finally close out with some estimate of cost.

Next slide, please.

So before I dive into this, a tiny bit more background on Verdant. Is as in the introduction, I was previously with Itron along with the rest of my cofounders. And, you know, during that time at Itron and then the transition from -- the consulting -- part of the consulting business, we were able to take some of those contracts with us. And one of those that we've been working on for some time is this -- evaluating the self-generation incentive program.

And the one -- where this becomes very relevant to the renewable natural gas market is that currently the generation part of the self-generation incentive program must be renewably fuel. And what that means is, you know, primarily a little bit of small wind and potentially a good deal of biogas or biomethane fueled generation.

So getting into some terms, you know, I'm mentioning biogas. So that's methane that's from a renewable source but, you know, might have some other components in it. It's not as clean. Biomethane is when that becomes more processed and then also renewable natural gas is when, you know, some -- some use that interchangeably with biomethane but that's when you've cleaned up, processed, and injected the gas into a pipeline.

And the sources of that I think were already mentioned the -- that's primarily animal waste, wastewater treatment plants, landfills, and then potentially forest, you know, more and more forestry and crop race. And finally, you know, potentially it's from crops grown specially for this purpose. But in California, that's not qualified as renewables.

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So I think a number of you were on the workshop yesterday and I don't want to go too far into the forecast for natural gas because they got it better covered yesterday. But this is just pulled from, you know, the source cited there. And the point I'm -- want to make about this is currently, outside of power tech plants, California is using a little bit over 12 million therms a year. This should say annual, I missed that on the slide.

The other thing that's cited is that the efforts in building decarbonization should really start to reduce that usage down into the bottom two blocks, the residential and commercial buildings. So the takeaway here is currently a little over 12 million therms. And that's our natural gas use that may be changing.

Next slide.

So how much renewable natural gas is available? And like many things with potential studies, this really depends on who you ask. So on the left where it says technical, those are what are called technical potentials. That's how much gas could nat -- or renewable natural gas could potentially be supplied by different sources. And, you know, there's a broad range. And remember, you know, framing this with that over 12 million therms that are currently being used in California but, you know, I think electrification you'll probably be looking at least, you know, reducing half of that as if those efforts, you know, get to spanning the market.

And then additionally on the other side, transportation may consume a little bit more. But one of the takeaways from this is that you can see when you have those sources differentiated on both the technical -- on the technical side. Landfills can provide a significant hunk of that. Animal waste, another bit. And then the top two bars are when you're looking at municipal solid waste, all the comp -- you know, potential compost, lawn clippings, and food that we throw out. And then also agriculture and forest waste.

So a significant amount potential from those but how much of that we can realize, I guess, that's what we start to see on the right side of the graph. Because that's where based on some assumptions about basically the current market or incentives, what may actually be feasible and potentially cost effective. Again, the number –- the precise numbers here may not be super valuable but, you know, depending on your potential -- your range, you could be looking at replacing almost half of our natural gas use or about one-tenth. And probably the more realistic figures are the ones on the right.

Next slide, please.

So walking through the process of how you get renewable natural gas or biogas. And this is when it's being processed through what's call a anaerobic digester. And what that is is basically you take the waste -- the animal waste or from a wastewater treatment plant, put it in a large container that it has a few certain parameters in it and make sure that the right bacteria is there to break that down. An anaerobic being basically without oxygen, so it's covered and sealed.

After that process, you're left with digested material which is the ones on the left that you can use for a variety of purposes. And you also have gas, and that gas is primarily methane. Then one of the keys is is that with wastewater treatment plants, most of that methane crop is required to be destroyed. So basically rather than releasing that methane into the atmosphere, it needs to be burned or destroyed in some manner. Simplest of that is what's called a flare. So without many of the wastewater treatment plants out there are already using a digester to basically help clean up some of their waste and then also going through that flare process.

If you want to make better use of that methane, you need to remove -- you go through the -- remove some substances especially siloxanes which are formed by the decomposition of plastics or sulfur, both of which can cause a variety of not desirable effects when you try to burn those or use those in equipment. And then need to compress that gas and that's where you get to the biogas stage. So this is gas -- methane that can be used for fuel. It tends to have a lower heating content than renewable natural gas and that's not at the same pressure that natural gas is needed.

That biogas can be used on sites to produce heat either for, you know, heating a building or a lot of times for some process heat or to turn a generator, and that's what a number of sites are doing.

And then the final option would be you remove -- you basically upgrade that gas so that's removing some of that CO_2 so you have a higher heat content. Further compression and then it's -- that gas is virtually identical to natural gas and it can be injected into a pipeline.

One important note is that with farms and dairies, there's swine farms, that -- in the absence of a digester, what would be standard practice is those large farms would collect that waste and then just let it degrade, expose the atmosphere. That releases that methane directly into the atmosphere, which I think was mentioned earlier, you have a significantly higher global warming potential than the releasing just a ton of CO_2 if you burned it.

So this is sort of the process for dairies and wastewater treatment plants. Let's talk about how many of those are out there and what they're being used for.

So next slide.

So some sources put dairy -- you know, the number of dairies with over 500 cows in California close to 1,000. That's the line the EPA has used as where it becomes potentially cost effective to install a digester. Others in industry think that number's a little bit higher and that may be more accurate given some higher costs in California.

So if you look at the bottom chart, the dark gray bars, the number of larger dairies in California. And then the next bar are those that are actually using biogas currently. And that can be for onsite generation, onsite fueling, or pipeline injection. And then that final much small bar is the approximate number of those -- they started injecting basically upgrading and injecting that renewable natural gas into the pipeline.

Something to note, and I think one of the other presenters will talk about it is that there are already over 100 of these more in construction today. So those numbers are going to grow. But the few things I want to emphasize here is that there's a lot more potential for these just by the numbers and also this is a very potent reduction point because if you're not using a digester at a large farm, chances are that methane would be vented directly to the atmosphere.

So next slide, please.

Another large potential source of RNG are wastewater treatment plants. One big difference between wastewater treatment plants and dairies is that in these cases most of these, not all, but many are already required to flare or again destroy that methane by burning it and producing CO_2 and water. Those with anaerobic digesters tend to be the larger wastewater treatment plants. Again, very similar to, you know, dichotomies of scale make a difference.

And if you look at the bottom chart, again, the first bar is approximate and these numbers are all approximate. Depending on your source, the numbers vary a little bit. So, you know, take, you know, the range is the more important thing to focus on.

So a little bit over 200 of these in California. Over 150 are already have an anaerobic digester. And then a smaller fraction, that 112 bar, the lighter green bar, are the numbers that are known to be using that biogas for onsite generation or pipeline injection. And then you get down, you know, much smaller percentage are using that, you know, refining that biogas further to inject it into a natural gas pipeline. And again, these tend to be, you know, those with anaerobic digesters tend to be the larger facilities.

And then on the right you see, you know, the geographic dispersion which follows, you know, population. And those with green circle are those that are basically -- that have an anaerobic digester. And those with the red circle are those that, you know, may not -- may be a smaller facility further from population centers and may not already have that anaerobic digester.

So there's an additional potential with those smaller sites. And then depending on state goals, those that already have that digester are producing biogas and then what we want to do with that I think is where a policy does definitely have some influence.

Another thing to note that will I think be talked about a little bit more this afternoon is one of the recent policies, I believe it's SB 1383, which is going to drive us to reduce our waste from food and other, you know, substances that decompose. Is this is -- these wastewater treatment plants, many of these have excess capacity and could, you know, basically make use of an existing anaerobic digester to help process that waste for uses renewable natural gas or onsite generation, whatever the most valuable use would be.

Next slide.

The other and I think, you know, the current larger source of renewable natural gas, you know, in the states and I think even throughout the nation are from landfills. And you can think of as a landfill as basically a very large anaerobic digester in that once that waste is covered, it's effectively sealed in place mostly away from air but it still breaks down and produces methane. The larger landfills already required to collect and destroy that methane to help reduce that -- that global warming potential. That's why, you know, the introductory slides, even though, you know, landfills tend to be larger, their slice of the methane and global warming contribution is the entire pie because they're already collecting and destroying -- the larger ones are already collecting and destroying this methane.

Once this methane is produced, it can be basically cleaned up enough. So you remove some water from it, do some filtering to remove the large components, then, you know, again, destroy it through a flaring process which is again just burning it. The larger ones, again, are already required to do that. So in absence of any incentives or changes, that's what the larger landfills are already required to do.

To make use of that, you know, either in generation or other uses, some additional processing is needed. So, again, you know, very similar to what we saw with the anaerobic digesters is you need to purify that, remove additional water. And then with landfills, one of the big ones that needs to be removed are those siloxanes I mentioned previously. Those are, I believe, formed when plastic decomposes and can cause many undesirable impacts on either generation equipment or even burners and fouling flame centers, all kinds of undesirable things that you don't want a customer or gas company to deal with.

Once those and also any sulfur -- sulfides are removed, it can again decompress and then use onsite like discussed previously. And -- or alternatively to process it into renewable natural gas a very similar process with, you know, some additional removal steps to again refine that and compress it for use -- injection into a pipeline.

So next slide, please.

So again pulling some data from the EPA is, you know, how many landfills are out there? How much more renewable natural gas might we be able to get from those? So there are, you know -- and this neighborhood of 300 land -- distinct landfills within California, of those for the EPA's guidelines, approximately 80 are good candidates for basically biomethane or renewable natural gas. And, you know, again the criteria on those are that those are slightly larger, you know, up to a million tons of waste in place as opposed to requirement line of 450,000 tons and are either active or have not been closed for more than five years. I think the assumption being that if it’s been closed that long, chances are it’s going -- there are just a number of hurdles to get there from here.

So of those 80, almost 60 of those are making some use of that biogas. And that, again, is primarily going to be generation or, you know, there are a one -- or, you know, and there are many more throughout the nation that are using that to for either pipeline injection or for use in transportation fuel. And then the lowest potential slides or the sites tend to be closed, older, smaller sites.

But again the, you know, a large number of these candidate sites already collecting the biogas but not many are using it, you know, further refining it to be used as renewable natural gas.

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And the last big category would be what we would call biomass. And this is largely from forest waste, agricultural waste, other components. To refine this, it’s a different proc -- often a different process if not through an anaerobic digester but you still need to convert this waste into either a gas or some burnable fuel that you can use elsewhere.

And, you know, right now, again, this afternoon I think we’ll talk about some of the incentives in programs such as that biomass feed-in tariff and then also SB 1440 which may be driving towards more pipeline injection. And I think we'll hear more about that today.

The current plants are, you know, very much in the northern part of the state where we have a lot of forests and then through the -- down through the Central Valley.

Next slide, please.

Oh, actually go back. I'm sorry.

The one thing to note is that these facilities may provide, you know, maybe one of their great potentials because we're not currently collecting much RNG from these facilities unless the increasingly urgent need to reduce fuel for forest fires. Potentially there's a significant -- significant potential here and obviously that was not the best sentence.

Next slide, please.

So I've alluded to this but basically where we, you know, right now getting, not just by numbers but by volume. So if we use the low carbon fuel standard as its source, you know, that -- for renewable natural gas over the history of the program, the gross majority of that is from landfill gas, and then some small components from food waste and dairy digesters.

And if you go to the next slide.

All of that landfill gas again, using the LCFS as a proxy, by site that bar on the far left we see that, you know, less than 10 percent of the landfill gas that we're getting right now for the transportation program is coming from in state, the majority is from out of state, similar trend for swine and dairy manure. And somewhat similar trends for wastewater.

As you saw previously, you know, a lot of the landfills and wastewater plants in California are already making use of that biogas so they're not providing that, you know, not -- a lot of them are providing to pipelines. And then the other subs -- the other ones -- you have a very small sample size so, you know, basically there's one.

But again, takeaways from these two slides is the majority of renewable natural gas available in California today is from landfills and most of that is coming from out of state.

If you go to the next slide, please.

Another part -- and part of the reason for that is how much does it cost or how much is expected to be produced? And, you know, what this shows is bars based on a report by the American Gas Foundation but the median -- the average of those prices shown but as mentioned it is -- those first two bars are landfills and wastewater treatment plants. For the most part, those facilities are one, already collecting the methane; and two, would otherwise be flaring that methane or destroying that methane if they weren't turning it into biogas for their onsite use or injection into a pipeline.

As we move to the right where you see dairies and municipal solid waste, those tend to be a little bit more expensive and again that's because you have to either gather that waste -- in the case of the municipal solid waste or process it and create and build that dairy digester.

Next slide, please.

In addition to what it might cost to generate that RNG, the source is very important for what your impact on carbon is. So again, pulling from the LCFS program that calculates a carbon intensity to a what, you know. Well, you know, we don't have the wheel or cradle to grave lifecycle estimate of how much carbon that RNG embodies.

And one of the interesting ones is with manure or animal waste with, again, that vented baseline that -- that methane would otherwise be vented to the atmosphere, that has a very significant, negative carbon intensity. It's actually removing carbon from the environment. The others you -- you're not removing the carbon from the environment because otherwise it would've been burned.

And let's go to the next slide.

So the -- that big, negative carbon intensity and the way that the LCFS prices things to remove carbon is that you're -- so this is, again, you know, the green bars on this are the costs based on production and then that gray bar is approximately what somebody could expect to get with the LCFS and the federal RFS program.

As you see with dairies, there's a significant difference. You know, part of that may be that -- that statewide -- that nationwide estimate for dairies is low but there, you know, the major driver right now is that LCFS transportation program, because it's helping to reduce -- it's based on that carbon intensity.

Both of these tend to be, you know, variable, they change, so the other option is that a producer could enter a long-term contract with a utility. So the -- a green tariff or carbon pricing where the utility purchases that green -- that renewable natural gas and then sells that as a product to their customers. And, you know, one estimate places that at $18 per MMBtu and it probably varies up from there.

The other two things to note are that this is just the commodity portion. So if you're comparing this to what a -- the commodity price of gas is, I think you're talking more like 3 to $4 MMBtu or maybe five as opposed to when we're talking 20 or, you know, up to even $100 MMBtu for renewable natural gas.

And then, last slide. Next slide, please.

So summing this up, you know, I've already mentioned a few times is that with dairies, you have a good number more of those in the state and, you know, using and collecting that renewable natural gas has a great carbon potential -- a great carbon reduction potential. Wastewater plants and landfills already producing a significant amount of methane that's mostly being used onsite. As mentioned, with SB 1383, that may drive up the available renewable natural gas or biogas from those sources. And then again, biomass, there are only 60 or so known plants in California that are all being used for generation. There might be significant ability to add to that and this is where policies can really make a difference.

And that is it. And sorry, it was like a minute or two over. And questions?

COMMISSIONER GUNDA: Yeah. Thank you so much for that overview. I mean, I've always kind of struggled to get a comprehensive view of the biogas and what RNG in general and I really appreciated just learning from your deck.

MR. BARSUN: Thank you.

COMMISSIONER GUNDA: So that was extremely helpful.

There's a couple of places I just wanted to make sure I ask you some clarifying questions.

One on just the process. And I want to understand, you know, for example, if we go to your Slide Number 8 which is the landfill gas to biogas with RNG, I just want to understand this from a technical perspective. So once you have the landfill gas, you know, the secondary treatment to biogas, kind of like my understanding is that could be used for electricity but then we have the advanced treatment where we're going to put it in the pipeline.

I just want to make sure that I -- that I'm crystal clear on both the biogas and the RNG stages for the secondary and advanced treatment, both can be equalized today in power generation?

MR. BARSUN: Correct. The biogas is more, you know, it's -- basically you can use that onsite to turn a generator to get to the point that you would be able to use that in a pipeline to be able to deliver it to a power plant. There are pipeline standards, in some cases, are a little bit more stringent than what a generator standard would be for different, you know, especially siloxanes and to a lesser degree, the sulfites.

COMMISSIONER GUNDA: Great. So the -- the second question just for you as you kind of mentioned earlier in your deck, that there's a wide range of kind of a forecast that is commencing right now for RNG and biogas.

MR. BARSUN: Uh-huh.

COMMISSIONER GUNDA: I mean, maybe there was a conversation that's more nuanced but at a high level, you know, as we think through the -- the policy making and then kind of future scenarios for decarbonization and such, what do you propose from your vantage point on the best way to think about the availability of this are -- are just going to consider about ideas, scenarios, and then -- then think it through. Any insight of how to improve or have better estimates would be greatly appreciated.

MR. BARSUN: So -- so it's -- it's really, as I mentioned, the amount that you can get is going to be really dependent on what your incentives, policy, and market are going to be driven by. And, you know, not trying to completely evade the question but I think as I mentioned with dairies, right now the major driver on that is with that LCFS program. A lot of that is already, you know, there's a driver there. There are still some barriers to get that to go.

So I think, you know, with dairies, it's -- I think some of the studies out there are already like that, U.C. Davis study I mentioned already looks at, you know, some of the incentives for looking at LCFS and RFS incentives. So, you know, that, you know, going, you know, doing a little bit more potential, you know, secondary research is a step but the answer is going to be more highly nuanced with what your incentives are at.

And, you know, again, you know, it takes the dairy sector and then the biomass sector are the two that have -- I think there are already a few efforts in place to working at refining those but those are the places potentially add --

you know, look at better incentives if, you know, we want to be doing something other than using dairy biogas for transportation.

COMMISSIONER GUNDA: Thank you so much. I just want to see if any other Commissioners on the dais have a question at this point.

Yeah, go ahead, Commissioner Rechtschaffen, please.

COMMISSIONER RECHTSCHAFFEN: I just was hoping you could clarify something on your slide about wastewater treatment plants.

MR. BARSUN: Uh-huh.

COMMISSIONER RECHTSCHAFFEN: And you may have said this already and I didn't follow it. So, 154 have digesters and we -- we think most are the -- the use that they're making is generationally five are injecting into the pipelines. So what else would they be using --

MR. BARSUN: The primary --

COMMISSIONER RECHTSCHAFFEN: -- the biogas for?

MR BARSUN: Yes. So, sorry. The primary other use would be to just turn an onsite generator. So you -- instead of -- that saves you the step of getting it further processed and then injected to the pipeline. And I don't have this in front of me but there are, I think, a handful more they are using that for process heat, either onsite to help heat their own equipment to, you know, aid the digestion process. Or, you know, if there's a facility nearby that needs basically water (indiscernible) heat. But again, I believe the majority and I can follow up with more exact numbers on this are using that for generation onsite.

COMMISSIONER RECHTSCHAFFEN: Their own electricity needs.

MR. BARSUN: Correct.

COMMISSIONER RECHTSCHAFFEN: Yeah. Okay. thank you.

COMMISSIONER DOUGLAS: (Indiscernible.)

COMMISSIONER GUNDA: (Indiscernible) Commissioner --

Go ahead, Commissioner Douglas. I was just going to pass it to you.

COMMISSIONER DOUGLAS: Great. I mean, that was actually my question too. So I think you mostly answered it. But I'd love to get a little more detail on which landfills or how many landfills are doing onsite generation and what the additional potential, if any, might be for that.

MR. BARSUN: I have that. I don't have that in front of me right now.

COMMISSIONER DOUGLAS: Okay.

MR. BARSUN: But I can follow up with, you know, some additional data on that.

COMMISSIONER DOUGLAS: Great. Thank you.

COMMISSIONER GUNDA: Great. Commissioner McAllister, I don't know if you have any questions. I don't see any.

I want to recognize that we have Commissioner Houck joined from CPUC as well. Commissioner Houck, would you -- do you have questions from your end?

COMMISSIONER HOUCK: No, I don't have any questions at this time, but thank you. And I'm happy to be here, so I look forward to the presentation.

COMMISSIONER GUNDA: Thank you, Commissioner --

COMMISSIONER MCALLISTER: (Indiscernible.)

COMMISSIONER GUNDA: -- McAllister, it looks like you have -- yes.

COMMISSIONER MCALLISTER: I just wanted to say thanks to both of our colleagues from the PUC for joining us. It was a really important conversation and the background info is super helpful. I'm -- I will say I did -- let me think -- I'm probably not the only one but, you know, we do have a number of dairy digesters, biogas digesters that the CEC has funded through the EPIC program that, you know, do have options for where they send that biogas.

And I think even the ones that have PPA's that they sort of put in place early in the game are kind of seeing that the landscape has shifted and I think that as the speaker said the L -- the LCFS seems to be the sort of -- the center of gravity for much of the market.

And so, you know, what does that mean for the rest of the gas grid? You know, is this a plausible, you know, fairly, you know, plausible source at fairly significant volume or -- or, you know, will it current kind of cost paucity of incentive to inject it into the broader gas grid (indiscernible).

So I think that's maybe a policy question that we need to talk about with ARB and others but maybe some insight on that question.

MR. BARSUN: Are you, you know, looking for my input or --

COMMISSIONER MCALLISTER: Yeah. I mean, I just --

MR. BARSUN: -- (indiscernible.)

COMMISSIONER MCALLISTER: -- maybe I'm inviting you to speculate but maybe just to (indiscernible.)

MR. BARSUN: (Indiscernible.) Need more coffee, I guess.

So I think the -- it's a -- I think there is more potential out there. I think as hopefully Daryl Maas, you know, will be able to join us later on, he's got, you know, very much the boots on the ground experience -- oh, great, he is here. He's very much more the -- the boots on the ground guy that, you know, has experience developing these.

I think, you know, from a -- the low hanging fruit is starting to be there but, you know, as I was showing in my presentation, there are still a lot more dairies out there.

I think the real question gets into -- and I think there's already been some work on this, is how close are those to pipelines? And, you know, that drives, you know, basically if you're miles and miles away from pipelines trying to get an interconnection to, you know, pump that elsewhere is probably going to be cost prohibitive.

So I think that's where the incentives, you know, I think a lot of the potential may be with using that for generation because it's a lot easier to move an electron than it is to move, you know, thousands of therms or cubics -- thousands or millions of cubic feet of natural gas.

COMMISSIONER GUNDA: Thank you, Stephan.

So I know we have a couple more minutes here and I -- you know, there's a bunch of questions coming through. We don't have kind of a public Q&A right now at this point, but we'll take a few Q&A later moderated by Jennifer after the next panel. But given that we have a couple minutes, Stephan, I just want to ask one question that keeps coming in the chat.

Just at a high level, based on the numbers you provided, I think that there's a -- there's a kind of a commission that it's not on the natural cost effective compared to fossil gas. But to the extent that you can comment on what makes this competitive for the other attributes that we don't consider today that doesn't make this comparative however you want to frame that. I think it might be helpful from some of the participants to hear.

MR. BARSUN: Great. Yeah. So it's like many things where it's renewable natural gas, you know, as we're looking at decarbonizing things, the answer can get very complicated and nuanced very quickly.

I think one of the, you know, things that we need to keep in mind is, you know, looking the, you know, how -- what price are we putting on carbon? Or, you know, carbon equivalency? Is, you know, as we, you know, showed is that, you know, especially with dairies, you know, taking carbon out of, you know, not taking the actual carbon but taking the carbon effectiveness of that very much out of the equation.

So, you know, and then even with the other sources, they're still significantly lower carbon intensities than natural gas.

So one thing to, you know, keep in mind is, you know, and -- is how we are valuing carbon, you know, has a significant impact on, you know, if you're trying to run a cost effectiveness, you know, they're going to get way into the technical lead, but if you're trying to run a cost effectiveness test, the major impact, you know, swing around that is, you know, how much are you pricing carbon? Are you pricing carbon at the point that, you know, how much it costs just to avoid the next more -- less expensive approach? Are you pricing it on, you know, how much it impacts society?

And that -- and then when you're comparing this to other efforts like building electrification or other things the, you know, again, the primary driver on that is how we are valuing that carbon, and then what's your, you know, your baseline?

So, but, I think, you know, when you're comparing this to again, you know, building electrification, you know, what your source is has, you know, pretty significant impact on what your carbon is and that again is what, you know -- and that and then what you can price this to buy this commodity at.

COMMISSIONER GUNDA: Thank you so much. That's really helpful.

Commissioners on the dais, I want to just make another pass if any of you have any additional questions. We have a couple more minutes before -- okay. I don't see any.

So with that I'm going to pass it back to Heather.

Stephan, thank you so much for your presentation.

MR. BARSUN: Thank you.

COMMISSIONER GUNDA: Personally, for me, you know, I just loved learning about the broader context. Thank you.

MR. BARSUN: Welcome. Appreciate the time.

MS. RAITT: Okay. Thank you, Commissioner.

Thank you, Stephan, that was really helpful. So we'll move on to our first panel, RNG perspective. And John

Mathias is going to be moderating it and he's Electric Generation Specialist at the Energy Commission.

Go ahead, John. Thank you.

MR. MATHIAS: Thanks, Heather. Yes, I'm John Mathias with the natural gas unit in the Energy Assessments Division.

And we have a very interesting panel this morning. First, we'll hear from Rizaldo Aldas from the Energy Commission's Research and Development Division. After Rizaldo, we'll hear from Francois Rongere who will discuss PG&E's work on RNG research and development and innovation. And after that, we'll hear from Daryl Maas, the CEO of Maas Energy.

All right. We'll hold questions and discussions till the conclusion of these three presentations.

So first up, Rizaldo Aldas is the program lead for the Renewable Energy and Advanced Research Generation Research and Development Program for the Energy Commission's Energy and Research Development Division.

Previously, he was a supervisor to two RNG programs in the Energy Research and Development Division and an Energy Specialist providing technical leadership on biomass energy and natural gas fuel advance distributed -- distribution generation systems.

So, I'm going to turn it over to Rizaldo.

MR. ALDAS: Hi, good morning. Thank you, John, I hope you can hear me okay.

So as John mentioned, my name is Rizaldo Aldas, I am with the Energy Generation Research Office of the CEC. And today I will share some I would say lessons learned as well as the all of your considerations impact in future role of renewable natural gas. And all from the standpoint of R&D projects funded by the CEC under the EPIC and the natural gas program.

Next slide, please.

Great. So I will go over the first few slides. Great. Those are addressed extensively by Stephan in his presentation. But I will provide examples of actual biogas facilities funded by CEC and then will divert a little bit on the -- from the technical topic to look at some statewide scale and how RNG might play out in the future looking at the resources and some key takeaways from the E3 study. And then I will come back and introduce some of the lessons learned and considerations for some future work.

Next slide.

Okay. So this is not to divert from the definitions that have been presented in the past two presentations. But I will just point out that for a few sectors conventionally the word RNG could include renewable hydrogen also aside from biomethane and as in the case of the future study that I will cite later on where they refer to RNG from an umbrella term meaning biomethane, synthetic natural gas and renewable hydrogen. But for purposes of our discussions today, I will refer to RNG as primarily biomethane which is a different form of biogas.

And I will also cite the recent AB 3163 which was signed by the Governor in September of last year that expanded the definition of biomethane. And first to note, of course, is their requirement that it has to meet certain standards for injection to the common carrier pipeline. And the definition also now includes not just biomethane from anaerobic decomposition that described earlier but also methane from noncombustion thermal conversation of process. And the bill also specifies some types of qualifying feedstock when separated from other waste.

Next slide.

Okay. So Stephan talked extensively about the process for converting waste or organic feedstock to renewable natural gas. And the only thing I will point out here is that there are other routes, it was alluded to also in the previous presentation either aside from the bio type of conversion that is the thermal type of conversion which is now qualified under the new bill, there are different feedstocks that can be used for conversions. Some are this are shown here for this process. I call this the most common process for renewable natural gas. That because of the --

they are more -- they're commercialized, there are common feedstock that are available now. I would call it pretty much every day organic waste.

And a few things to note, key steps include gas cleanup, gas upgrading, and to tie it with a question a while ago, there are options for using that biomethane either by electricity, onsite use, pipeline injection, or compressed -- as compressed natural gas for transportation applications.

In the next slides, I will give you example of actual facilities for different feedstocks, one on the food waste and green waste, then wastewater, and then dairy manure facilities.

Next slide.

Okay. So on with our first example funded under the EPIC program. So this is a standalone or dedicated bioenergy facility for converting food waste and green waste collected from San Luis Obispo County. The facility constructed, designed, and operated by a company called HZIU Kompogas is using an enormity -- type of digester called the horizontal plug flow. And they are a big digester that process high solid feedstock so that essentially a dry feedstock if you think about or compare it with manure and wastewater, the facility is scaled to process organic waste from the county with the capacity of 36,500 tons per year. And converting that food waste and green waste to renewable electricity which they sell to PG&E under a power purchase agreement. And then they also create a valuable co-product in the form of solid and liquid fertilizer.

Next slide.

Okay. So this is just to show you the picture of the completed facility. The cylindrical shape part you can see at the lower section is the plug-flow digester and the structure on left is where the new generator system is. This was one of the first facilities that benefited from the BioMAT program. I think they are actually second in terms of the contract execution but are now fully operational and selling electricity to PG&E.

And just to illustrate some of the milestone achieved during the end-of-year agreement term with the Energy Commission which ended late 2019, that they were able to fully demonstrate the system, generate electricity exporting over 2 million of renewable electricity and for using co-products like over 77,000 tons of solid fertilizer and over 1.5 million gallons of liquid fertilizer.

Now there were obviously operational challenges and challenges even from the start during -- during design and construction. And we heard about adjusting there because the design come from outside of the U.S. And they have to do a lot of adjustment for California requirement. But some of the notable lessons learned are not related to the gas quality but more on say the upstream of the digester. So their operation challenges will be getting a better quality of feedstock. They found out that they get a lot of contamination, meaning those that should have been separated from the green waste. There were at the time lower food waste percentages obviously affected the biogas yields of the facility. But overall, the system worked and they are continuing in the operation from that point on.

Next slide.

Now moving from the high solids organic waste that I showed you a while ago, we'll now look at an example of facility processing wastewater or also known as municipal sewage sludge into biogas energy. This project is funded under the natural gas R&D program. And I would say coming from a relatively small wastewater treatment plant called the Las Gallinas Sanitary District. This facility is located in San Rafael. They serve about 32,000 customers and manages average dry weather flow of about 2.2 million gallons a day. So for this particular project, they constructed or established a biogas energy recovery system to use 100 percent of biogas produced by the existing digester. And that biogas is used to provide electricity, heat, and transportation fuel. So to do that, they installed a biogas cleanup skid. They changed their older internal combustion engine and changed that with microturbines.

And then they also installed CNG refueling station and replaced of their -- the diesel-fueled, the vehicles. So the picture on the lower left is showing you the portion of the gasoline digester and microturbines and the diagrams describing the simplified, the schematic of the new process that they have for the whole system starting from the digester gas to the cleanup processes and then the applications.

So they -- they have microturbines for electricity. They have boiler for producing hot water and for heating applications. Some of them will return to the digester to maintain the heat. And then some of the gas are compressed for, again, for fueling.

Next slide.

So, again, the project successfully demonstrated the benefits of recovering biogas or energy application. And at the time of the -- by the end of the project and they were able to conduct a 12-month operation and presented some of the benefits for doing that. For instance, some of the numbers shown here include the biogas production and (indiscernible).

For immediate, some of the -- the RNG production, volume of the conditioned gas, and amount of generated renewable electricity, generated by the facility’s microturbine system. But there are also some lessons learned that they kind of encountered during the process. Some of those are mentioned here.

They find it valuable to have a better or more accurate biogas study. These are the basis for the design and construction and future operation of the facility. Verifying quantity and quality of digester gas is important as that they use a -- an important equal parameter also in their operation. In their experience what they found is that the -- what they are actually getting at the beginning of the operation is kind of slightly different from the design and quality that are used in the study that they prepared for in the design and operation.

And then obviously learned a lot from having a good knowledge of the -- for the construction and equipment and the way of selecting those equipment. And overall given that they are a small wastewater treatment facility, I think that they demonstrated wider possibilities that larger scale facility mean those that are the handling significantly larger volume of waste water and producing greater amount of biogas in their facility. And as we seen in a previous presentation, there are now wastewater treatment facilities larger than Las Gallinas that actually have digester and using the gas for their onsite use of power generation or pipeline injection.

Next slide.

Okay. So my last example here is of existing facilities on processing dairy manure for biogas energy. I would say that one of our speakers Daryl from Maas Energy will be discussing more extensively this particular topic. And I will also mention that the R&D program have funded dairy digester projects in the past even prior to the EPIC program and one of those is the (indiscernible) dairy digester built by Daryl's company under the ARA program. But this particular example that I have today is from a, I'll say competing company called CalBio and this will be, I would say, one of the first dairy digester projects that were funded under the EPIC program and the CDFA's dairy digester program. And that also, in a way, helped and stimulated the deployment of a number of dairy digester facilities in the central valley.

And the project is focusing more on electricity generation being by the EPIC program. And the project is -- all of them are using covered lagoon digesters and they are demonstrating three different strategies of biogas storage project. These are project -- this is a project that's producing and storing biogas for generating electricity and be able to respond at times, so for peak demand. The concept of hub-and-spoke was explored in one of the projects where one central hub dairy could serve nearby dairies to process and clean the biogas and use that for electricity generation.

And then the other strategy is improving the efficiency of the whole process by capturing the waste heat from power generation system and using that for the subsistence process, for instance, running an absorption chiller to process the milk.

Next slide.

This is just to share with you some of the estimated impacts of each of those digester projects over the 12-month operation. All of the three projects, digester projects I have here have a PPA with beginning and exporting renewable electricity with an estimate of about 7 to 8 million Kilowatt hour over 12 months. And the other numbers here include the reductions in CO_2. We emphasize the value important of cleaning the gas. Like, for instance, reducing the amount of hydrogen sulfide to help prolong the equipment, the engine generator. And also cited some numbers in jobs and net income.

Some of the key lessons and development needs are already something that we got from team include, I would say, it’s kind of a breakthrough model, there’s the dairy bioenergy operation in that the dairy owners pretty much not involved in the business for operation of the bioenergy facilities. And to quote one of the operators, we seldom need -- we provide them the manure and, you know, they generate. So it’s really a separate business.

There are technology improvements and we're able to show that it can result in increased biogas production. It has consequence on electricity generation. They have contract with the utility and there are needs to improve some of the components.

Next slide.

Okay. So just very quickly mention that upgrading is a critical component of the technology. And just want to mention that one of the companies that we funded, developed, a technology called Metal Organic Framework for upgrading biogas into solid state. Scrubbing technology, they had some success in demonstrating that and what they're finding from there, they are actually looking at expanding, bringing it closer to the market.

Next slide.

So I just want to mention here that we are also exploring the potentials of woody biomass to RNG and these are outside projects that are halfway through so don't have results yet. But I'm including it here because of significant potentials when you think about the volume of woody biomass that are available out there, and potentials for converting to RNG.

And then next slide, please.

This is just divert a little bit from technology discussion and to mention that there are different estimates out there in terms of their resources and the previous -- speaker also talked about it extensively. I just want to mention that their estimates on the model we can have for the entire state. And the table that I included here is from a study funded under the EPIC program -- or funded through the environmental program and it shows a different estimate that we have in the future 2040 and 2050. And then -- and then just looking at some of the resources we can expect in the future we can convert for other applications. I would note that not all of these can be converted and there are other competing uses for the resources.

And in the next slide I'll just kind of put a little more focus on that particular study funded by -- under the Environmental Research Program.

Next slide, please.

That study evaluated the potential costs and energy per sector near quality, and focus on options. This is well presented in the public with a lot of input. And my intention really here is just to note that there are reconsiderations when you look at future work in developing R&D technologies in the farm facilities. And some of the key aspects that are noted here in terms of the E3. Use natural gas. There are probably some model renewable natural gas needed to meet the climate goals. There is a limitation in terms of the biomethane at recommended to be allocated to hard to electrify facilities and applications.

And with that, I'll just conclude in the next slide to go back to some of the lessons learned that I mentioned that overall there is still challenges going all the way from the feedstock management, feedstock handling, improving the components from cleanup and upgrading technologies. There's an opportunity for managing co-products, improving technologies, such as solids separations. And there are cost efficiency programs for downstream equipment.

And also noted from the other considerations, most of these are nontechnical when we talk about capital cost, (indiscernible) and in consideration of really high availability and low cost of fossil natural gas that its competing with. And then there are gas requirements for pipeline and onsite use quality.

With that, I'll conclude. And thank you.

MR. MATHIAS: Thanks very much, Rizaldo, a lot of interesting information.

So our next -- next speaker will be Francois Rongere from PG&E. Francois leads R&D and Innovation for PG&E gas operations including research efforts towards zero carbon. His team is responsible for the detection, assessment, and introduction of new technologies and all aspects of the business.

Prior to this assignment, he worked in various capacities for PG&E energy efficiency department, successively in charge of emerging technologies, customer services, and product development. Before joining PG&E in 2006, Francois worked for the R&D division of a French utility where he developed new technologies and solutions for electricity for generation and customer applications.

He’s also a lecturer at San Jose State University where he teaches engineering classes about renewable energy and biofuel.

Francois.

MR. RONGERE: Thank you very much, John.

Good morning, everyone. Can you hear me well?

MR. MATHIAS: Yes.

UNKNOWN SPEAKER: Yes.

MR. RONGERE: Okay. Perfect. I thought I was on mute. Perfect.

So. Next slide, please.

First, a few words about PG&E for people who don’t know our company. So we are a gas and electric utility for the northern California. Here is a short map, a small map showing our territory. For the gas system, we’ve been about 6,000 miles of transmission and 43,000 miles of gas distribution -- the gas distribution. So it’s a large gas system and serving about 4.6 customers for throughput of a little bit less than 900 BCF.

900 BCF is about nine million terms, to use Stephan's units. So it's difficult in the U.S. to -- manipulate a different unit. So for you to understand that's the slide of what we talk about.

So next slide, please.

So this slide is just to show you the current projects to be connected to our systems. From my knowledge, I don't think that we are any injection of biomethane in our pipelines so far. So they are -- these projects are coming and we'd be the first injection of biomethane and we are very excited to have this coming. Without being a little bit delayed, that's all because of Covid and other issues. But we are almost there. And you see that the first project would be connected in Q4 this year. It's dairy projects, wastewater treatment, and also landfill. So there's a range of sources that Stephan has mentioned at the beginning. Again, the units are, always a little bit different. So here we talk about thousands of cubic foot per day. The "N" is actually thousand. I'm European, don't ask me why we put an "N" when we should put a "K." But, so it's 3 million cubic foot per day for the first dairy. And just so for you to get a sense, a cow always about 30 -- 30 cubic foot per day. So the first project is about 100,000 cows. It's not to just one dairy, it's actually a clusters of dairies. And it could be done in different point of injections. Our vision of projects are company coming to us with a plan for injecting biomethane in a pipeline, but it could be in several points.

So they are fairly large projects, what I would say here, and the total is about 35 million cubic feet per day which represents -- so it depends because that's the maximum. That's -- the plate number but of course there's a capacity factor if you want that price. Electricity and the production is not under the maximum over the year so we take in this number, we present about 12 BCF of biomethane per -- per year. If we take a capacity factor of 50 percent, that's about 5 BCF per year of production. So that give you a sense of the size of it.

To refer what Melissa mentioned at the beginning, the emission of methane in California is about 80 billion cubic foot. So here we are talking about six -- 6 cubic billion cubic foot compared to this 80 billion cubic foot knowing that SB 1383 has a goal of a reduction of 40 percent by 2030. So that would give us a goal of about 30, 35 billion cubic foot of biomethane to inject in our pipeline. So we are here at six, a good start more will come in the future.

So as the utility what we want to do is to facilitate the interconnection. And one of the aspect is interconnection cost and reducing interconnection cost. One of the things we -- my team, as in R&D, is working on is reduction of the cost of interconnection points by (indiscernible) of it and using the best technology to measure what we need to measure, you know, that you optimize the cost of this interconnection. But still only one aspect that we are focusing on now.

Another aspect is gas study measurements. Again, finding the best measurement technique at the best price. You know, that to measure what we need to measure but reducing the cost as much as we can.

Another aspect of biomethane injection is as we mentioned before, I think Rizaldo you mentioned it briefly, that one of the challenges is injection and the connection to the large pipeline system. Often the production is close to distribution system but the consumption for the distribution system is not large enough to absorb all the time the production by the biomethane user. And, by the way, we have a limitation of that -- on that. One aspect we are looking at is to our ability to actually bring this gas back to the transmission system. I will show an example on my next slide.

Before I go to the next slide, I just wanted to mention the link I put on this one. It’s our R&D roadmap for RNG and hydrogen at PG&E. It’s our view of what we need to accomplish in the next few years. And I encourage you to check about it and we are more than happy to discuss about what we are trying to accomplish in corroboration with many other players across the U.S. and international.

So next slide, please.

So this slide wanted to be an animation on PowerPoint. So throughout I want to you to stay with me with the story here. So on this slide, you see the green lines are the distribution system limited to 60 psi and the blue lines are part of the transmission system that feed the distribution system. In a traditional way, the utilities operating, the gas flows from the transmission large, very large pipeline of transmission at typically 900 psi to what we call here the local transmission pipeline that are perhaps 250, 300 psi. And then down to the distribution system at 60 psi.

And here just as a description of that is if we have a biomethane injection project as -- so lower right corner of my slide you see that we need, theoretically, to install transmission pipeline from that point to the closest blue line extremity in order to be able to transport the biomethane into transmission system because the distribution system at that location doesn't have the capacity to absorb pools of biomethane, especially in the summer. Such a transmission pipeline here perhaps 3 (indiscernible).

And so what we tried to do in order to reduce the cost of interconnection is to do -- replace the transmission pipeline by actually back compressing or reverse compressing the gas back from the distribution system to -- into the transmission system. And that's what the compressor here shows. So my slide -- well, is a little bit confusing - the orange line is the transmission pipeline that we would build, that's one option. But the only option is to build a compressor but not building a transmission pipeline.

We continue to use the distribution pipeline to transfer the gas but in order to absorb the quality when we need to absorb it especially in the summer, we would transfer the gas back to the transmission system. So that's one of the solutions we are developing in order to help the injection of biomethane in our system.

Next slide, please.

Looking forward for a longer term and I wanted to show just a longer term vision of that is how we can actually improve the injection of methane by increasing the quality of methane we can -- we are, this is available to be injected in our pipeline. During the process of upgrading, talk a little bit about it, we go from biogas to biomethane. Biogas is typically 40 percent CO_2, so 50, 40, 50 percent CO_2 and 50, 60 percent of methane. So we have to separate the CO_2 from the methane. And the CO_2 is generally released in the atmosphere. What we purpose to do here, what we are exploring here is the opportunity to have actually this CO_2 which is fairly concentrated because it has been separated from biogas and can be merged with here water and electricity, sort of electrolysis, in order to generate methane and oxygen that could be released.

We are working with two organization today. One is Opus 12 which is a startup company in Berkeley that use a chemical process, so it electrolyzes to breaks the molecule off CO_2 and merge them with a proton from water and generate methane or several protons of water to generate methane. And the other option is a biochemical pathway that is developed by the team of Professor Alfred Spormann at Stanford. And the idea is the same, just replace the catalyst which is the key for Opus 12 by bugs -- bacteria to do the same routine and produce methane.

You are perhaps aware of a company named Electrokia (phonetic) that has worked with our colleagues from SoCal Gas and DOE in the past to develop a process that takes the same thing to CO_2 but hydrogen and produce methane. Here we try to accelerate this process by directly doing the electrolysis on the CO_2 and producing methane without -- to produce hydrogen into meal. But this potentially can increase the production of biomethane from anaerobic digestion by rules factor of two. So a way to increase the throughput of biomethane but also to avoid to release CO_2in the atmosphere where we can actually use it for methane and for energy.

So that's one of the more exploratory project that we have, you know, in order to help in improving and optimizing the injection of biomethane in our pipeline.

Next slide, please.

We talk about an anaerobic digestion and or so Rizaldo and Stephan mentions that there is also another pathway which is thermal chemical pathway for woody biomass. The (indiscernible) is not very easy to digest by bacteria so it's difficult to use anaerobic digester for wood residues in general. Even if we are also looking at a co-digester so where we can put some woody biomass with other waste in the process of biogas production in order to increase the volume of biomethane which is -- oh, I see I'm at the end of my time. So sorry. And here just -- oops, yeah. Here is just a quick description of it. And I just wanted to mention a study we have done with SoCal Gas and SMUD, and also (indiscernible) as well a few years ago in 2019 or '18. And you see the report on the right and give us a sense of how we can actually repurpose electricity generation from biomass to the production of RNG and here are some numbers of the -- the cost, for example, here is 13 to 15 dollar per MMBtu which is to be compared to what Stephan providing which was about 23 so the same range as to what was proposed before.

Thank you very much for your time. I think I've gone over by five minutes so my apologies for that and I'm happy to take any questions.

MR. MATHIAS: Thank you, Francois. I think we're going to hold questions to after the next talk. That was very interesting information.

So the next -- next speaker is Daryl Maas. Daryl Maas is the CEO of Maas Energy. After finishing up a career in the U.S. Air Force in 2007, he returned to his hometown in a dairy community in northwest Washington where he learned that many of his friends in dairy families were interested in deploying digester technology to capture energy from animal waste. He developed his -- developed and commissioned his first biogas facility in 2009. And since then, his company has grown to be a leading developer, owner, and operator of dairy digesters in North America with over 40 completed projects serving over 50 dairies. And the company is currently active in over a dozen states.

So I'll turn it over to Daryl.

MR. MAAS: Wonderful. Thank you very much, John, and everyone else.

I've been asked to -- the previous presenters have told you a lot about RNG, the market, the regulations, and so I'm going to scale down a little bit and talk more directly just about dairy digesters themselves. Try to finish up with some time remaining and I know there's a lot of folks with questions. So thanks very much and let's go to the next slide.

So our company was founded in 2010. Came from Washington on that date and realized that California had a lot of opportunities for dairy biogas. First of all, we have the most cows of any state. And second of all, we have the most progressive energy policies that are trying to target decarbonization renewable power. And so we began building in the Central Valley.

This map shows -- it’s a little bit out of date -- but this map shows our projects which essentially are between Bakersfield and Sacramento with some retrofits we also did out in Marin County as well. This has become pretty big. We’re one of several companies in California, there’s another one about the same size of ours and then there’s many more entering. So the industry is certainly growing to try to accommodate those.

I’ll talk a little bit more in the future about the locations of those projects. But as you can see, we are placed in the Central Valley primarily.

Let’s go to the next slide.

Just a couple of more statistics. As I said, about 30 to 40 digesters in operations, depending on which state and which region. Our company’s actually grown to be over 80 employees, thanks in large part to a lot of the support that California has provided for digesters that us and others are really scaling up. Just those digesters you saw it the previous screen, those are funded by some of the Low Carbon Fuels Production Program from the Energy Commission, the Alternative and Renewable Fuels Program from the Energy Commission, the PUC's pilot project program. All of those are programs that have really enabled us to scale up where as a company we've gone from building one or two digesters a year to more like 15 a year at our current rate. And that's responding to a market demand. I think we're operating five biomethane injection facilities right now, each one of those serving multiple dairies.

As you can see across the top, and it is important to our market, is that we and many others like us are active in other states where there's an effort to produce RNG and bring the gas back to California because that is where the highest demand is for carbon negative gas. And as some of the other presenters have described, dairy digester gas is highly carbon negative and runs about a negative 300 CI score on the average and so that gas makes its way into the California vehicle transportation fuels market.

Next slide.

So just on a very basic terms, dairy farmers already use cow manure, this is not a new thing. Dairy farmers know that there is value in cow manure. As you can see kind of on our little org flowchart there, crops make food for the cows to eat, and cows make milk, that's the cash product for dairy farmers. Cows also make manure which is stored in lagoons. It has to be stored there because manure is a pollutant if it is spread on the fields at the wrong time of year. So you keep it in the fields, and while it -- you keep it in the lagoon. And while it sits in the lagoon, it naturally breaks down and creates methane gas. But the farmer is using that manure in the lagoon to spread on its fields. That creates a certain amount of odor and other air pollutants, but it provides an organic fertilizer for the fields which makes the crops grow which feeds the cows. And so a modern dairy farm is already a pretty self-sustaining nutrient loop, you would say. It’s good for the soil, it’s good for the production locally of crops, but it has these negative byproducts.

So what a digester project really is doing is it’s just inserting itself in the existing closed loop system at the dairy farm which is shown on the next slide.

So all we’re really doing here is we are inserting a digester between the cows and the manure storage. So whereas that manure -- manure storage used to be uncontained manure that’s breaking down in the natural environment, now we first put that manure in the digester, then it goes to lagoon, fields, crops, cows in a circle. When we do that, we create two benefits. One is the gas itself, and one is the reduction in methane emissions which has already been referred to.

Next slide.

This is a pretty simple, relatively small dairy farm. And small is important because as some other presenters mentioned earlier, the low hanging fruit is being gobbled up in the early phases of development in California and the real growth is in the medium size and smaller dairies. We have hundreds of dairy farms in California, around 1,000, and most of them are not targets for dairy digester developers because they're not large. But this one, for example, is about 1100 cows, that would make it a medium sized dairy. And this one works because of some incentives offered by SMUD and CEC which funded this one maybe 12 years ago now, it's a pretty old facility in Sacramento County. But that's a small dairy, collect the manure in the back, and we put the manure under this covered lagoon digester. You can see the gas gets captured. And in this case, the gas is used to make electricity. In fact, my first 10 or 12 digesters in California, say between the years of 2010 and '15, were all power generation digesters that were responding to the incentives as they existed at the time. They were selling under net metering, or feed-in tariffs, or eventually the biogas which were all good programs in their day. But they were fairly limited in the number of digesters we could develop because the economics required pretty unique situations where there was public funding or very large dairies.

What's been happening, of course, is that as the market begins to incentivize renewable energy, there's more and more digesters that we can build on. And so we hope to capture more and more of these types of dairies in the small to medium size range.

Next slide, please.

This is more the scale we're talking about now. This is our first -- in fact, California's first pipeline biomethane project. This is with Calgren Dairy Fuels. It was brought online about two, three years ago now. And in this case we built the gas cleanup facility in the center of an existing ethanol plant. So there's really two plants side by side. And we had to lay over 20 miles of pipeline all over Tulare County. So you can see the size of that line going in there.

Let's go to the next slide.

So this is a little hard to read but it gives you the idea of the scale. On the left-hand side of the map, that's Highway 43, south of Corcoran. That's the highspeed rail corridor. And down the center of the map, that's Highway 99 which of course is our main artery. And east to west, this is about 14 miles. And you see all those pipelines.

What we're doing is we're gathering gas from all these different dairies. That slide says 13 digesters online injecting RNG to SoCal. I think it's actually 14 or 15 now. We're going to end up at at least 25 by the time we're done. So we're at over 4 million GGE a year, or say 400,000 MMBtu's of biogas a year at our current size. It'll probably approach double that size in future.

This is just the most established one. The other presenters from PG&E, Francois talked about CalBio has one down in Kern County and some others they're working on. I'm not sure the status but they are -- they're very similar to this. This is essentially the dominant business model which is to combine groups of digesters and inject. So I know they have several at they're building. We've got three other ones for sure that this group is aware of because they've had contact with PUC under the pilot project and with the CEC. That's one in Fresno County, one in Kings County, and one in Merced County.

Two of those will inject into the PG&E line later this year as you heard a little bit later. So those will be the first two in PG&E. You'll notice that these dairies are close enough to connect. So we've done our best to build in locations where the dairies are fairly concentrated. But once you have invested in the expense of equipment and the expense of backbone pipeline, it gets easier and easier to expand and capture more dairies.

So for example, the Merced pipeline project, which is already about 18 or 19 dairies, that will be on later this year, that was funded with the pilot project funding from the CPUC. We originally built it for just 8 or 9 dairies, but it's already going to be, as I said, at least 18 or 19 and maybe more. And that's because it got pilot project funding so that we could afford to build out that initial backbone infrastructure. And now on or own, we can go out and expand it in the future.

Now it's really expensive to get these started. It takes a long time, the interconnection they're quite expensive to make sure we get all the safeties and quality controls correct. And the costs do tend to run high. For all of us that got into this industry a few years ago, we ran quite expensive when we actually had to build these and deal with CEQA and environmental litigations and unionization of all the other things which is good because it's really good that the pilot project and these other programs, the CEC low carbon fuels production program exists to help these things get off the ground. And I believe even the pilot project has a mechanism for if the costs run over and they're found to be reasonable, that those could be reimbursed which is really critical to us getting expanded to more and more dairies. So we hope to have clusters like this between us and others in the industry, at least 7 or 8 of them running in the next couple of years.

Next slide, please.

Virtual pipeline is an option. So some of the other presenters are describing that if your dairy is not near a pipeline, we have two options. You know, we can extend the pipeline which we have done and we're going to continue to do. Up in Merced, with the benefit of pilot project funding, we're actually connecting to two dairies. One of them has less than 1,000 cows which as far as I know will be the only dairy in the state that has less than 1,000 cows making RNG. And another one is just barely over 1,000. Those weren't in the original pilot project application but because the pilot project exists and we can -- we can get those costs reimbursed, we can build out to additional dairies.

But in some cases, that's not possible. So we are running a virtual pipeline from one, two, three dairies as we speak and another one or two coming online soon where we compress and clean up the gas at the dairy and then we truck that gas to the injection point. It's not quite as cost efficient but it does make sense for dairy gas, especially if you've already paid for the baseline infrastructure to connect to the utility as we have. So we'll have, let's see, both of these will be in PG&E territory in addition to the one we have in SoCal. So we'll have three different locations where we can truck in gas.

And that doesn't have to be dairy gas. We're actually in conversation with the variety of folks that have landfill gas or other wastewater gas and they don't have to (audio lost) with the pipeline. Once the operational expertise and the equipment is there, we can bring in gas that way. And it was a lot of work but with the support we've gotten, that is another viable option.

Next slide, please.

Combined heat and power is still very possible and very viable. We've got about a dozen projects that are still running gensets which we actually packaged up in Northern California and install them and maintain them here in the state. In some cases we've converted over from combined heat and power. But in other cases we try to participate in the LCFS market which there are ways to do that with power generation so that you're supplying electricity to electric vehicles.

Now the way the Air Board does the rules on that, you don't quite get as many carbon credits and you don't get a federal RIN, so it is not quite as profitable as doing RNG. But for some dairies this may be the best way to go and obviously we have to work very hard to meet air emissions. Half of that picture is our SCR catalyst for meeting emissions which continues to be a challenge but the engine can make it, it just requires a lot of know-how and a lot of upfront investment to make sure that we can meet the Central

Valley air quality requirements.

Next slide, please.

I think this is my last slide. A lot of people have talked about the market before. Obviously with dairy digesters, the gas is going to the California Transportation market. As you can see by about 2019 or 2020, nearly all of the compressed natural gas vehicles in California were being supplied with renewable natural gas. Now the next stage of that development -- the first stage, as you can see, was pushing out conventional natural gas and replacing it with renewable natural gas. Now it looks like what's going to happen is that all the renewable natural gas that is not dairy gas will eventually be pushed out for natural gas that is from dairy gas. And so that's a process that is ongoing as we speak, including from a lot of out of state gas. Because one of the issues we in the California market are up against is folks out of state can oftentimes go faster and cheaper than we can just because if they're in the middle of say west Texas, it's just easier to do.

But thankfully we have, you know, policy incentives here and we have the world's largest dairy herd so we've got other advantages to help us keep supplying gas from California dairies as well and that is where the overwhelming majority of our company's work is as well.

So thank you very much for your time and we'll look forward to participating in any panel questions.

MR. MATHIAS: Okay. Thanks very much, Daryl.

At this point I'll turn it over to the Commissioners for comments -- or questions and comments.

COMMISSIONER GUNDA: Yeah, thank you so much, John. Thanks for moderating the panel and thank you to the three presenters, that's incredible information Rizaldo, Francois, and Daryl. And some really important information for us to think through.

So I'm going to first begin with Commissioner Rechtschaffen. I believe he has a question.

COMMISSIONER RECHTSCHAFFEN: I have -- you just sort of make it up to me because you wouldn't let me on the dais at the start. I don't mind.

I have two questions. Rizaldo, could you do me a favor. Go back to your last slide where you talked about the potential. I don't know if you can bring that up but I just wanted to -- for you to remind us of the potential -- what the denominator is. You know, our current natural gas usage in California and how this potential compares to that. And maybe if you could give your best estimate of (audio lost) you think the potential since we hear a lot of varying estimates and we want to at least have a range of what we think is reasonable.

Is that a fair question to ask you?

MR. ALDAS: It is. I would say except that we don't have -- don't have that information. In the earlier presentation, there was estimate that came out of the UC Davis study. I think that's the philosophy in terms of the estimates of the RNG. What we have are some estimates of the resources. These are the biomass resource that are available at the time and projected into the future. But there are ways to convert that into potential volume of renewable natural gas. As I noted in my presentation most likely not all of these feedstock would be converted to RNG. But we have those estimated resources.

COMMISSIONER RECHTSCHAFFEN: What's the range of, you know, you hear 5 percent to 20 percent, 8 or 9 percent. What are you -- if you don't feel comfortable me putting you on the spot, that's fine. But I just wondered if you could give us your best professional judgment of what you think the most reasonable estimate is of the realizable potential compared to the, you know, our current usage in California.

And we can talk about this in the afternoon or, you know, we can --

MR. ALDAS: I could -- I could follow in that I just don't want to put out some numbers out there in terms of the range.

COMMISSIONER RECHTSCHAFFEN: Okay. Fair enough.

Commissioner Gunda, I had a question with Daryl, if I can.

COMMISSIONER GUNDA: Please, Commissioner, please go for it.

COMMISSIONER RECHTSCHAFFEN: The ones where you're trucking the gas to the pipeline, what about the emissions environmental impact of that? And how are you thinking about reducing that impact both in terms of the direct emissions and other impacts.

MR. MAAS: So the simplest thing we can do and the main thing we can do is we run the trucks on CNG itself, as opposed to go on diesel which of course cuts down on emissions pretty significantly. But there still are some and we haven't found a way to get lower until someone can get us an electric truck which perhaps is coming. So we understand it's not quite optimal, we would always prefer a pipeline.

But other than running on CNG and we also tried to, you know, we used the pressurization and the container to not have to repressurize the gas you put it in the pipeline. So we try to be as efficient as we can with power, but there certainly are tradeoffs.

COMMISSIONER RECHTSCHAFFEN: Thank you.

COMMISSIONER GUNDA: Thank you, Commissioner Rechtschaffen.

I'll go to Commissioner McAllister or Commissioner Houck, do you have a question?

COMMISSIONER MCALLISTER: No, I just -- I was thinking along the same lines as Commissioner Rechtschaffen. And maybe if there's -- I mean, I guess we have two -- two complementary problems, you know, we have the noncore and the core customers. And sort of, you know, it's substitution of RNG for fossil on one or both of those. Right? So I guess the question is kind of, are -- what portions of the marketplace, you know, is RNG going to be. Is the value proposition going to line up? Right? Is it -- is it retail, you know, core customer or is there some reason to sort of have the RNG go over to the power side?

I don't know if anybody has insight on the market aspects of that. Maybe PG&E.

MR. RONGERE: No, Commissioner. At this point I personally don't have an insight on that. I think it's a question of the market itself and the use of methane could be -- could be for different applications. Today it's driven by transportation definitely after that we will see how it goes.

COMMISSIONER GUNDA: Thank you, Commissioner McAllister.

Commissioner Houck, would -- do you have any questions?

COMMISSIONER HOUCK: Sorry, too many mute buttons. Yes, I do.

Rizaldo, would you be able to go back to Slide 12? I know you weren't able to talk through that as much because I think the time had run out and just briefly about the woody biomass to RNG and whether there may be forest management synergy there and the cost comparison with the dairy digesters.

MR. ALDAS: Sure. Yeah. As I mentioned a while ago, if it's going to be halfway through to the process, but really, it's -- one of the options that are could be or potentially be exploring in terms of by using -- use of, you know, large number of woody biomass, forest biomass resources. Obviously, one of the options now are just using that in other aspects like gasification and converting that directly to electricity potentially providing a kind of a resiliency and the micro grid application. But there are options now in terms of the processes where you get that woody biomass process through, you know, a similar gasification (indiscernible), but there are additional process where they could -- it could be combined and then processed to RNG.

It's I would say something that we're looking at. We don't have the kind of pool resource out yet but there are different organizations that are working in that, West Biofuels are working with UC Davis, UC San Diego and NREL optimizing some of their process. Not just creating RNG but potentially other -- other biochemical product from the process.

Then of course that (indiscernible) industry looking at the slightly different kind of gasification system and employing some commercially available process for biomethane.

COMMISSIONER GUNDA: Thank you, Rizaldo.

So I'm just going to make a quick request. I know this is supposed to end in another three or four minutes, this particular segment.

But, Heather, I would like to request a few extra minutes for us to take a few Q&A from public we've received in the chat. So with your permission, I'm going to extend it to 12:05, if possible.

But I do want to ask one question before I hand it off to Jennifer. I think anybody, Rizaldo, Daryl, or Francois. First of all, I can appreciate your expertise and boots on the ground knowledge of how we are transitioning this. I'm kind of still in the very learning mode at the very basic level so trying to kind of think through the policy choices that we might make as we move forward and it will take me into account, you know, that, you know, public opinion and how we -- how the analysis all come together.

So I think one broad question and I'm going to -- sorry for the long version of the question, is there an analysis or framework that we currently have and to look at pathways to maximize the economywide or local decarbonization potential of biogas. The reason I frame it that way is, you know, as we think through the comprehensiveness of the decarbonization policies, you know, as we noted early on, the biogas RNG could play a very significant role in ensuring the liability and supplying energy to certain -- certain domains particularly.

So, you know, as we think about optimizing data and minimizing investments to really think about a -- think about it comprehensively from an economywide, is there a framework, you know, a pathway analysis being done on how do we best utilize biogas given the uncertainties and the change in policies but also the uncertainties that exist on adding investments that are necessary. It's kind of a loud conversation where you need to make investments to make this happen. At the same time, making them happen could, you know, have costs in investment risks in the long run.

So just wanted to frame that question, I hope I came out kind of clearly there. Any high-level thoughts on comprehensive thinking about RNG would be great.

MR. ALDAS: I would just mention that there's probably not one framework about. The study that I cited a while ago from the E3, that's one where we did some projections, considered a lot of different scenarios.

I'm not very familiar with all the different scenarios, but this is a look at the different infrastructure, potential cost, air quality implication we want to achieve the economywide climate goals and focusing on some of the options. So look at decarbonization, I think that’s one -- one framework, one study that we can look at. And there could be others out there.

COMMISSIONER GUNDA: Anybody? Rizaldo, Francois or Daryl want to add?

MR. RONGERE: Yeah, I would -- I would give those same recommendation. There are several studies now that have been -- developed to look at different pathways for decarbonization. And then look at the integration of renewable natural gas generally with different angles. And that’s, perhaps, where you can find this information the best way. And -- but it’s -- it’s a complex question with a lot of variables, I’ll tell you. And I think that view is keeping options is important and adjusting the function of the market and the needs we see of the market is also key. So looking at the different pathway help to understand the professional drivers but clearly there are different options right in front of us. And the future would decide along way.

MR. ALDAS: I would just add that --

COMMISSIONER GUNDA: (indiscernible)

MR. ALDAS: I’m sorry. Just add to what I mentioned a while ago about that study. There are also other studies, for instance from LBNL and UC Davis. Just kind of factoring in what are some of estimates available from facility or from location. Just kind of looking at what would be best in terms of the applications or, you know, acknowledges that it's -- it's not a, let's say, holistic framework but it's a good factor in consider at looking at this overall aspects for the framework.

COMMISSIONER GUNDA: Thank you, Rizaldo. Thank you, Francois, for your answer too.

I know we have now Doug --

MS. RAITT: Commissioner, I think we lost your sound.

UNKNOWN SPEAKER: I think you muted yourself. Can somebody unmute it?

MS. RAITT: Commissioner Gunda, you were muted for the last part of what you were saying. Or maybe you're muted now.

COMMISSIONER GUNDA: Sorry. Are you ready to do the Q&A? I'm sorry. My -- my -- our car got started and then it got picked up. Sorry. Go ahead.

MS. RAITT: Sorry. All right. So --

COMMISSIONER GUNDA: Jennifer, if you want to get started on the Q&A.

MS. CAMPAGNA: Okay. Thank you. So I'm going to start with questions for Rizaldo. It's from Tom Roth. And there's two questions but I'm going to combine them because Tom had asked what is the cost produce a megawatt of energy using Example 1. And then he also asked what's the cost including return on investment to produce a megawatt of energy using Example 2 and Example 3. How much funding was provided by the CEC or money from other state sources?

So I think if we could pull up the slides that have those examples, that may be helpful.

MR. ALDAS: Sure. I can just quickly respond to that.

MS. CAMPAGNA: Okay.

MR. ALDAS: Dollars per megawatt. I will not provide a number of that but the information is probably in terms of how much this facility is, particularly the one in the compound, the one in San Luis Obispo, which Example 1 and the dairy facilities area. In terms of the power purchase agreement they have it as PG&E, they are selling at 127.7 dollars per kilowatt power for. I think that's pretty much the same for -- for the -- their facility but it should be along those lines. The one in San Luis Obispo, that's the -- that's the amount that or the part their selling back electricity.

The Example Number 2 which is on the wastewater treatment facility, that particular facility is obviously a small scale. They only have 65 kilowatt of of microturbine. And all of the electricity produced are being used onsite that will be exported. But overall, in terms of their --

their analysis and measurement of the model interest they used, they're in place of about over $50,000 savings in annual use of that electricity generation facility.

In terms of the funding the large demonstration projects, the example on food waste and green waste in Example 3 on dairy digesters, their funding level is $4 million. The dairy digesters, there are three projects there. The first project on -- are about $4 million. And the other project on combined heat and power is $3 million.

While the wastewater treatment facility project that's all close to $1 million I think in the funding.

MS. CAMPAGNA: Okay. Thank you, Rizaldo. So the other question -- another question is from Mike Federhoff (phonetic) from CEC. This is for Daryl Maas.

Daryl, you mentioned negative carbon footprints for biogas. This point is often referred to but not always well understood. Can you explain further how a negative footprint comes about?

MR. MATHIAS: I think Daryl may have had to drop off. So.

MR. BRYANT: Yeah, this is Doug, if you guys can hear me. I'm the Communications Director for Maas Energy Works. I was here to supplement in case he lost reception there.

But the negative footprint for biogas generally occurs because the methane isn't being -- it's not like extracting natural gas out of the ground where there's a resource that you're going to -- that's already polluting that you're -- or sorry, it's a resource that you're capturing. This is more as a pollutant that's already affecting the environment that we're now capturing and removing that pollution out of the air. And so that's why it's a negative carbon footprint because the little bit of carbon involved in processing it is far outweighed by the negative reductions of carbon from the environment just by removing that methane from the environment.

MS. CAMPAGNA: Okay. Thank you, Doug.

MR. BRYANT: Uh-huh.

MS. CAMPAGNA: So we have another question, Doug, that you could probably answer from Kevin Peace (phonetic).

Have you considered co-digestion of woody biomass in your existing or future RNG digestion sites?

MR. BRYANT: We have not considered it strongly as of yet. The main reason is that as soon as you start to mix other substrates or other feedstocks with dairy manure, it starts to dilute that carbon, that negative carbon intensity and therefore reduce the amount of credits generated with the gas. And so food wastes, other things like that in California and other states we haven't really considered blending the two with the dairy manure simply because it actually takes away from the revenue. It makes the projects less feasible.

MS. CAMPAGNA: Okay. Thank you, Doug.

This question is for Francois from Brent. Who is buying the gas off taker for the PG&E injection site, utility PPA or commercial customer?

MR. RONGERE: (Indiscernible) commercial customers. We are not actually directly involved. It's through the LCFS program for all the projects I mentioned before.

MS. CAMPAGNA: Okay. Thank you, Francois.

We have a clarification question for Stephan from Verdant. John Hake (phonetic), I'm sorry if I'm not saying that correctly.

For the RFS credit value, what RIN type was assumed D3 or D5?

MR. BARSUN: I believe -- I mean, I will double check but I believe that a D3 which is the predominant one that if you have cellulose you're able to use. But let me -- I have it in my afternoon slides and would be just -- if I can find it. Give me a second. Just don't want to state something that was erroneous.

Aw, yes, the majority was assumed to be D3. So it's, you know, 15 to $20 per MMBTU once you do the conversion from gasoline equivalent and run numbers.

MS. CAMPAGNA: Thank you. So another question for you, Stephan, from Kelsey Hallahan. The question came up during your presentation.

What is the main barrier preventing biogas producers from injecting that gas into the pipeline grid? Two small volumes or extensive building connection to pipelines, the lack of pricing incentive. And of course the question can be answered by others as well if they'd like to (indiscernible.)

MR. BARSUN: My -- my understanding and I think, you know, Francois or others from the gas, you know, the utilities can probably chime in and one -- Doug, probably, is it's a little bit of all those. The -- you know, the bigger the supply you have, the more you can spread out your economies of scale. So you have to have enough supplies for it to make sense.

And then during Daryl's presentation, you heard about clustering. And, you know, one of the challenges is, again, getting enough supply together close enough to a pipeline and then the other barrier is getting that gas to a quality that meets California gas pipeline standards which, you know, depending on your source, you need to do a variety of different processing techniques.

But again with wastewater and especially landfills, the siloxanes tend to be a bigger barrier than my understanding. When you're talking dairies, it then becomes more the sulfide's problem.

And others can chime in if I missed anything.

MR. RONGERE: Stephan, you summarize it very well. I think there are different aspects, one aspect has been the LCFS has been a critical catalyst in order to start the activity and by doing that solutions have been developed in order to facilitate the gathering of biogas injection in pipeline, et cetera.

So there are different components but definitely as we have seen in Europe the way to provide a driver for the market is critical in developing the industry.

MR. BRYANT: Yeah, I'll just add one more thing in that one of the big challenges you face of getting biomethane market is a lot of the bigger dairies as you were saying earlier, a lot of the low-hanging fruit are in -- are in projects or are already in the process of injecting.

As we move to smaller and smaller dairies, your inherent risk is a little bit higher. The smaller dairies are more susceptible to regulatory risks where new regulation comes out that just gets them to the point where it's just no longer viable for them to stay in business as well as a lot of the smaller dairies are older facilities and if water regulations come down, there's a lot of guys scared about that right now where they're going to be limited on water usage and have to fallow fields. Some of this it will just mean we can't -- they can't remain. And so it makes it a little bit more challenging to even bring those projects to bear simply because if you have eight dairies committed all at about 1,000 cows, each of them has a little bit more risk on are they going to be around in five years or six years and not knowing the regulatory outlook for outlook in the market.

So there's a lot more dairies in California, but the more the biogas market expands down into the smaller dairies, there's a bit more risk that investors and developers and they're going to have to be kind of okay with taking on. And unfortunately, the cost of the project doesn't scale down with smaller dairies, the costs of the projects are still fairly expensive.

COMMISSIONER GUNDA: Thank you, Doug.

I think Jennifer just kind of in interest of time maybe we want to move to public comment. So thank you, Jennifer, for moderating that.

Thank you to all the panelists for being here to answer the questions.

With that, I'll pass it on to RoseMary for public comment.

MS. AVALOS: Thank you, Commissioner Gunda.

Please allow one person per organization to make a comment, and comments are limited to three minutes per speaker. I'll go first to those raised hands on Zoom.

And the first commenter is John White. You may need to open the line on your end but you can go ahead and speak.

Please state your name, your first and last name, and your affiliation, if any. Thank you.

Go ahead, John.

MR. WHITE: Good afternoon. Thanks, again, to the Commission for another really interesting and thoughtfully prepared workshop.

I have a couple of concerns I'd like to express. First of all, I think we need to realize the need for some truth in advertising in this space. There are a lot of people using the term renewable natural gas. But to me, the out of state methane that's collected and counts under cap and trade is not a suitable definition. First of all, it undermines the actual renewable natural gas that's collected in California; and second, it creates the impression of things being greater than they are. This is particularly true with some hydrogen producers who are using the claim of renewable natural gas as their feedstock when in fact, that isn't what they're using. They're buying some credits from out of state that has no benefit.

Secondly, I think we need to be careful about creating incentives to grow the dairy industry in California. I don't know if it's in fact increasing, but what we know point apart from the renewable methane and the need to collect it from -- and I worked on AB -- SB1383.

So we don't want to expand dairies in California. We don't want more waste. These have serious local environmental impacts. And you need to at some point invite some of the folks from the Central Valley that have very, very unhappy experiences with the air pollution impacts of digesters. It's not just GHG, it's also criteria air pollutants. But similarly, the air pollution impact of combustion of this methane, particularly in reciprocating engines and other kinds of high pollution generators ought to not be encouraged.

So to me, we have a waste management problem and a methane management problem that and similarly landfills. You know, landfills, we want to collect that methane but we don't want more methane being created in the landfills which is why CalRecycle is pushing everybody to take organics out of the system. So we have to to recognize we don't want to create incentives for more landfill gas or for more dairies, what we want is the best environmental usage of those resources that we need to collect.

And I thank you for your attention and hopefully will try to provide some written comments.

Thank you.

MS. AVALOS: Thank you. Our next commenter is Julia Levin.

And for the record, spell your name and state your affiliation, if any.

Go ahead, Julia, your line is open.

Julia Levin, your line is open.

MS. LEVIN: Hi. Julia Levin with BioEnergy Association of California. Can you hear me now?

MS. AVALOS: Yes.

MS. LEVIN: Great. Thank you.

So I want to thank the Commissioners and the staff and other presenters. There was a lot of very helpful information presented.

But I wanted to start by answering the question that Commissioner Rechtschaffen raised about what is the total potential of biomethane. Because I think unfortunately the first presentation included some really out of date information and it is time for the Energy Commission to stop citing studies from six, eight, ten years ago including one from the Bioenergy Association of California that I helped to write that are really out of date.

A lot of things have changed since some of those studies, particularly the one by Dr. Amy Myers Jaffe at U.C. Davis that was based on just 100 dairy digesters, a 100 wastewater treatment projects, and a 100 landfill projects. We already have more than that in California. She never looked at biomass resources, urban wood waste, agriculture or forest waste, and she never looked at the potential for medium and smaller dairies and wastewater treatment facilities.

Her report at the time on page 1 says it was never intended to be a complete assessment of in-state biogas potential. It was intended to look at what was economically feasible at the time based on existing policies. That was before the adoption of SB1383 and the state's waste diversion laws. It was before the tree mortality crisis and SB901 and other policies that require forest fuel removal on a million acres a year, and a lot of other policy changes have occurred since then. So that study in particular is really no longer helpful to the conversation.

Similarly, the E3 study uses a population weighted average across the United States for our in-state biomass resource. That's just not good science at this point when we have actual technical assessments by Lawrence Livermore National Lab and others that look at California in particular. Things like forest waste, agricultural waste, and even urban wood waste are really not linked to population. And so population weighted averages are just -- it's not good science at this point.

The other two things I wanted to mention are I think when we're looking at the total potential, it's really important to consider the cost effectiveness of carbon reduction from biomethane. The cost of the energy is significant, as well it's an important data point. But biomethane can reduce carbon emissions more cost effectively than any other tool we have in California. That's not my opinion, that is the summary of the California Air Resources Board -- California Air Board's report to the legislature from just a couple of months ago on the state's climate investments.

And that report found unequivocally that the two most cost effective of all of the state's carbon reduction investments are investments in dairy digesters and diverted organic waste projects which are reducing carbon at the tiny cost of 9 and $10 per ton, respectively. That compares to $200 per ton under the low carbon fuel standard and even more expensive investments in other things that we're doing.

So as we're looking at the data around biomethane, it's really critical to consider the cost effectiveness because biomethane is reducing the most damaging climate pollutants and providing carbon negative emissions.

Thank you.

MS. AVALOS: Thank you. The next commenter is Mike Catone (phonetic).

Please for the record, state and spell your name and state your affiliation, if any.

Go ahead, Michael, your line is open.

Okay. We have now Michael Boccadoro.

MR. BOCCADORO: Yes, Michael Boccadoro, can you hear me?

MS. AVALOS: Yes. Go ahead, Michael.

MR. BOCCADORO: Michael Boccadoro with the Ag Energy Consumers Association.

Thank you very much for the good discussions this morning. I think as many of the Commissioners know, I've been deeply involved in the dairy methane reduction efforts in California since the beginning. And we've made tremendous progress in large part because of the commitment by the state in terms of funding for the digesters on dairies in terms of the funding for the cluster projects that Commissioner Rechtschaffen led at the Public Utilities Commission and some of the other incentives from the Energy Commission that had allowed these projects to get up and operating.

We need to continue making that progress. I think all the recent reports coming out of the U.N., the last two reports including the one two weeks ago show the importance of reducing methane. And follow up to Ms. Levin's comment, the Dairy Methane Reduction Program was funded by the climate investments portfolio is providing 29 percent of all the reductions of all the programs funded using just 2.1 percent of the available funding. And it would be a crime not to continue funding that program.

In response to the comments from John White, there's no concern about incentivizing dairies in California to where we're going to be increasing the number of cows in the state. We're actually seeing a decline overall in the dairy sector in California in terms of the number of cows. We've been seeing that decline since 2008 and all expectations are is that we're going to continue to see that decline over time even with these incentives. It's just much easier to dairy in other states. And you're going to see the increase in demand for dairy products both nationally and internationally is going to be me in others regions of the country and other regions of the U.S., not here in California for a variety of reasons.

I want to underscore the comments from Mr. Bryant at Maas Energy about the risk of these smaller dairies. That's very real. We're not going to see a lot of these smaller dairies as prime opportunities for digester development.

And that gets to the last point I want to make is most of the estimates including, you know, the estimate of maybe 900 dairy digesters that Verdant had in their slide, that's not going to happen in California. I work closely with the entire industry and our estimates are closer to maybe 300 which would be double the 140 to 150 we currently have either operating or in line to be operating in construction in the next few years. So the idea that we're going to have 900 digesters on dairies, that's just not feasible economically in the state. At least not with -- without a greatly expanded incentives to make that happen.

But we do need to continue providing incentives to these projects. That would be the interconnection incentives by the Public Utilities Commission. We may want to look into funding a couple of more cluster projects in the state and we certainly want to continue to CDFA, a dairy digester program which has shown to be the most cost effective. And we can't lose sight of the fact that it's all methane and the U.N. reports are demonstrating the need for methane reduction in the state. We need to continue these good programs.

Thank you.

MS. AVALOS: Thank you. And our next commenter is Evan Edgar.

Please state your name for the record and state your affiliation, if any.

Your line is open. You may need to unmute on your end, Edgar -- Evan.

MR. EDGAR: Hello, my name is --

MS. AVALOS: (Indiscernible.)

MR. EDGAR: Hello, my name is Evan Edgar, I'm the engineer for the California Compost Coalition. We are RNG producers, fleet operators, and compost producers throughout the state of California. And basically represent the solid waste industry, the urban sector. We have a fleet of about

15,000 vehicles out in California about half are on RNG, other half are on diesel. And we are motivated to get off diesel and produce more RNG.

We're heavily vested in the SB1383 program at CalRecycle that was mentioned. We want to reduce 75 percent on the urban waste from the landfills by 2025. We already have a billion dollar investment in California with in-state AD facilities and we need to make another $3 billion worth of an investment to fulfill that mandate to reduce short-lived climate pollutants. As you know, the one and only tools left to bend the climate curb to stop catastrophic climate change. So we're totally motivated to continue RNG development.

There was a report produced last year by GNA Associates, it's an assessment of California's in-state RNG supply for transportation from 2020 to 2024. And it's pretty on target of what's going on in the marketplace. What they're predicting is going to be 160 RNG developments underway now. We'll produce 119 million diesel gallon equivalents of RNG with a carbon intensity averaging a minus 100. And that's amazing. And that's enough fuel to fill 14,000 vehicles.

So what we have here is a perfect circular economy where we're taking the urban food waste and organics out of the landfill, putting it right back into the CNG truck platform with an RNG in-state supply. So we'd like to continue on with the RNG, continue on with 1383, and find a place for that within the IEPR. Because over at CARB, we're feeling that they're pushing electrification too fast, too soon. It's a generation away.

It doesn't have the duty cycle, it doesn't have the infrastructure for fueling, it's just not there yet. So we're pushing real hard to continue reducing criteria pollutants where there are near-zero NO_x in their CNG engine with in-state RNG that's carbon negative. And we just want to make sure that CEC is supportive of that because over at CARB, we feel that their -- their push to electrify too soon is not finding a market for RNG. They -- they would like to move RNG to another platform and we'd like to continue on with the perfect mousetrap in a circular economy at community scale to fulfill the intent of 1383, reduce short-lived climate pollutant and then the climate curve.

Thank you very much.

MS. AVALOS: Thank you. Our next commenter is Brian Biering.

And please, state your name for the record and state your affiliation, if any.

Brian, your line is open. Brian, your line is open.

MR. BIERING: Hi, this is Brian Biering on behalf of Dairy Cares. My last name is spelled, B, as in boy, i-e-r-i-n-g.

Dairy Cares represents dairy digester developers, dairies, and dairy processors. We really appreciate the Commission and the other sister agencies taking a close look at potential for renewable natural gas development in California.

As a number of the commenters expressed, the state incentives and various programs have been critical to ensuring the emission reductions are realized in this sector. And as Mr. Boccadoro and Mr. Maas and others have acknowledge, there is still considerable work to be done, particularly at the smaller dairies in California.

We don’t see this as a risk of, you know, in terms of applying more incentives, you know, leading to greater dairy production in California. What we’re really fighting for is ensuring that these smaller dairies can remain in California and not move out of state which would create a significant risk of emissions leakage which the Commission and other sister agencies are aware is a global pollutant and that is a risk to the environment.

So we really do see a need to continue the incentive programs. They’re already in place, expand those incentive programs and ensure that dairy digester developers are able to compete with other types of RNG developers for various types of programs that may not just be focused on the LCSF program. The LCSF certainly does create a price incentive to sell dairy biogas into the LCSF market, but it does not have that longer term certainty that's -- that's really needed to make some of the investments particularly in some other smaller dairies.

So ensuring that there are opportunities available to dairy digesters for developers to make their biogas available, for example, to the (indiscernible) utilities is a critical path forward ensuring that the state does meet the SB1383 emission reduction targets and the broader emission reduction targets required by SB100.

We appreciate the opportunity to be here and thank -- again, thank the agencies for taking the time to take a close look at this.

MS. AVALOS: Thank you. That concludes comments from those on Zoom. We'll move on to folks on the phone lines. And a reminder to phone users, dial star 9 to raise your hand and star 6 to mute and unmute your phone.

I'll give a few seconds to those who are on the phone if you want to raise your hand.

All right. That concludes complete public comments. I'll turn now to Commissioner Gunda.

COMMISSIONER GUNDA: Thank you, RoseMary. Thank you for moderating the public comment.

Just want to kind of begin and, you know, just thanking everybody again one more time for taking the time to provide your expertise on the panel today. And as I started my comments earlier today the importance of all the work that staff are doing in advancing this conversation, I just want to recognize the importance of the stakeholder feedback and the public comment. That really helps us think through these -- the various elements from a broad perspective.

So I just want to thank all the public commenters and really encourage you providing some written comments and then pointing to any analysis data that we should be thinking through as we develop a record for IEPR this year.

I also want to thank just Commissioner Houck and Commissioner Rechtschaffen for joining from CPUC and continuing this interagency conversation. We look forward to having you all in the afternoon, but before I go there, I want to see if any other commissioners want to provide any closing comments.

COMMISSIONER HOUCK: This is Commissioner Houck. I just wanted to thank the CEC for inviting us to participate in this workshop. I learned a lot this morning and want to thank the presenters and the public and other participants for their participation and look forward to this afternoon's session.

COMMISSIONER GUNDA: Thank you, Commissioner Houck.

COMMISSIONER MCALLISTER: And just to say thanks to all the presenters. This is really informative. And in particular Mr. Maas and just the folks who really have their boots on the ground doing projects and helping develop this market and also learning all the -- all the lessons and gaining insights that we need to really do good policy. I think that is just invaluable. That's -- that's the best of learning by doing and it really does help policy when we convene a conversation that in some ways might seem a little theoretical but really part of that process here the benefit of being here together having a discussion is to make it grounded and pragmatic in a way that we can actually make it happen. So policy can do that if we do it right.

So really appreciate everybody's contribution to that process and looking forward to the afternoon.

Thank you, Commissioner Gunda.

COMMISSIONER GUNDA: Thank you, Commissioner McAllister.

Want to see if any other commissioners we have. I believe Commissioner Rechtschaffen had to jump off. I'm sure he's going to join for the afternoon.

So again, thanks everybody for attending and participating this morning. Please join us for the afternoon session on policy approaches for RNG. It'll start at 2 p.m. I really look forward to that conversation.

With that, I'll pass it to Heather to adjourn for the morning.

MS. RAITT: All right. Sounds good. We're done. Thank you, Commissioners.

(Thereupon, the Hearing was adjourned at 12:34 p.m.)

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