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CALIFORNIA ENERGY COMMISSION

In the Matter of:

Lithium Recovery from)
Geothermal Brine)
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LEAD COMMISSIONER WORKSHOP

CALIFORNIA ENERGY COMMISSION

FIRST FLOOR

ART ROSENFELD HEARING ROOM

SACRAMENTO, CALIFORNIA

THURSDAY, NOVEMBER 15, 2018

1:00 P.M.

Reported by:

Peter Petty

APPEARANCES

COMMISSIONER

David Hochschild, Lead Commissioner

STAFF

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Gina Barkalow

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PRESENTERS

Logan Goldie-Scot, Bloomberg NEF

Eric Besseling, BHE Renewables

PANELISTS

Derek Benson, EnergySource Minerals

Trelynd Bowles, Governor's Office of Planning and Research

Tyson Eckerle, GO-Biz

Eduardo Garcia, California State Assembly

David Ginley, NREL

Andy Horne, Imperial County

Randy Keller, MGX Minerals, Inc.

Danny Kennedy, California Clean Energy Fund

Josh Mengers, U.S. Department of Energy

Phil Rosentrater, Salton Sea Authority

Susanna Ventura, SRI International

Anna Wall, Capstone Headwaters

Jonathan Weisgall, Berkshire Hathaway Energy

Bruce Wilcox, Salton Sea Policy

PUBLIC COMMENT

Stephen Harrison, All American Lithium

Fred Aminzadeh (via WebEx), University of Southern California Center for Geothermal Studies

Jeff Harris, Ellison, Schneider, Harris & Donlan

Barbara Heydorn, SRI International

Tom Currin, Southwest Technologies

AGENDA

P R O C E E D I N G S

1:02 P.M.

SACRAMENTO, CALIFORNIA

THURSDAY, NOVEMBER 15, 2018

MS. DE JONG: Good afternoon everyone and thank you for joining us today for the Lead Commissioner Workshop on Lithium Recovery from Geothermal Brine.

Special thanks to everyone who has prepared for and helped us make this workshop possible. I would like to particularly thank our panelists, who have taken the time to be a part of this workshop.

A few housekeeping items before we begin.

The workshop is going to be recorded.

For those of you unfamiliar with this building, the closest restrooms are located in the atrium just outside these doors.

There are vending machines on the second floor.

Lastly, in the event of an emergency and the building is being evacuated, please follow our employees to the appropriate exits. We will gather at Roosevelt Park located diagonally

across the street. Please proceed calmly and quickly, again, following the employees who are here with you in this meeting, to safely exit the building.

We have copies of the agenda questions, workshop notice and presentations near the entrance, if you do not already have a copy.

After the opening comments and presentations, we will be having two panel discussions with a short break in between the panels. Public comments can be made after each of the panels. Please fill out and hand in a blue card to Gina if you wish to speak during public comment time, and please observe a three-minute time limit per person. We will start with comments from folks in the room and then attendees on WebEx.

We encourage you to provide further written comments via our docket process. We have provided a link to that docket page on the workshop notice. Please submit items to that docket by 5:00 p.m. December 6th.

This workshop is being facilitated today with the support and under the direction of Commissioner David Hochschild, who is going to

give some opening comments. And when Assembly Member Eduardo Garcia arrives, we will ask him to come up, as well, for comments. And then followed by presentations from Bloomberg New Energy Finance and Berkshire Hathaway Energy.

It is my pleasure to introduce Commissioner David Hochschild.

COMMISSIONER HOCHSCHILD: Great. Thank you. Let's just take a minute to just thank all the staff for organizing today's gathering.

(Applause.)

COMMISSIONER HOCHSCHILD: So if you're in this room around the table, it's because you're supposed to be. We really wanted to get the top experts on this issue to dig into what I think could be a very important part of California's energy future.

And just by way of introduction, I just returned from Paris from an International Electrification Conference, sharing with a bunch of utilities and other stakeholders what we're doing here in California. And I have to say, I am very proud of what we, as a state, have accomplished in building a clean energy future with the leadership of so many of you who are

here today. I mean, we have the largest wind project in the world, is in California, the largest solar thermal trough and solar thermal tower projects in the world, largest thin film solar PV project in the world, largest geothermal power plant in the world, and our largest factory operating in the state of California today is an electric vehicle factory, the Tesla factory.

And at the same time, you know, we're also now, with these fires, suffering some of the worst impacts of climate change. I mean, this is what climate change looks like. And so as a state, we're in the unique position of having to both simultaneously fight hard to prevent climate change from getting worse and to lead the way to a clean energy future, and to adapt to the new circumstances in which we find ourselves.

I am very intrigued by the vision of lithium as the new oil in some sense. And if you look at what's happening, particularly around the vehicle fleet in California, it's not gotten a lot of attention, but we were selling 6,000 electric vehicles a month in January. We're now at about 20,000 a month.

In fact, raise your hand if you have an

EV or drive an EV. Yeah, well, a few of you, and I think more on the way. Before you leave this room, we'll make you sign a commitment to get an EV.

But, you know, that growth is taking off, along with energy storage. And I think the results of the elections at the state level, certainly, last week to me indicate we're going to see a lot more clean energy and clean transportation initiatives and I think that's a positive.

I particularly wanted to thank Danny Kennedy, who is really the genesis for this idea we were discussing, lithium extraction and the opportunity before us. So Danny runs the California Clean Energy Fund and I'm grateful to him, and to all of you, for being here. I think with any new governor's administration there's a honeymoon period early where you can lead with some big, new initiatives. And I think this question of how to make lithium extraction really work in California, we're sitting on one of the greatest reserves here, is going to be a really important one for our environment and for our environment and for our economic future.

So with that -- and we're waiting, by the way. Assemblyman Garcia, I guess, will join us in an hour or so.

So with that, let's move on to the agenda.

MS. DE JONG: So our first presentation today is going to be from Logan Goldie-Scot from Bloomberg New Energy Finance.

MR. GOLDIE-SCOT: Well, good morning, everyone, and thank you. Thank you so much for taking the time to join us for talking about such a, in the Commissioner's words, I think, is such an important topic and such a relevant topic today.

My name is Logan Goldie-Scot. I head up the Energy Storage Team at Bloomberg NEF. And one of the messages that I think we'd -- that everyone should take away from today's session is that to understand the big questions that we're talking about today, you also really need to understand multiple industries and multiple sectors in terms of what you'll hear from Eric around sectors beyond sort of stationary storage, such as electric vehicles but also, actually, beyond even the energy space. And that's

something that at Bloomberg NEF, as a sort of primary research firm, we spend a lot of time doing, so really trying to understand what drives the sectors that we look at, what influences changes in those sectors and how should we think about this over time? And I head up sort of the energy storage space here.

So what I'd like to do today is talk through why we think lithium is potentially the new oil and why we think lithium is important, what's driving that, what's happening on the supply side, just to sort of put into context some of the things that we'll talk through in the workshops, and how does that relate to or how is that impacting pricing and what should we be thinking about there?

So first off, what you can see here shows annual battery demand globally. And this is based on a number of different demand segments, but notably passenger electric vehicles which make up, in 2030, sort of 80, 85 percent of total demand there. And but then you also have electric buses, station energy storage and, naturally, consumer electronics.

And so there are two things to take away

from this chart. One is that battery demand is forecasted to grow incredibly rapidly over the coming years and that will have a sort of ripple effect on any of the components and raw materials that go into battery demand, but also that passenger electric vehicles are the market to really be aware of here.

And so to make sure that sort of once we've all signed the bits of paper committing ourselves to electric vehicles before we leave today, to make sure that there are enough batteries to do that, you will need to see a huge expansion in battery cell manufacturing capacity globally. Now this is based on a database we have where we're looking at already existing, so operational cell manufacturing capacity plants globally, and then also, what's in the pipeline?

And there are two things to pay attention to here. One is just the number in the center of these circles. So on the left-hand side you see 175 gigawatt hours of commissioned cell manufacturing capacity today, so that is a pretty big number already. But by the end of 2021, so by Jan 1st, 2022, based on announcements alone, this is not our own projection, this is based on

company announcements about when they will bring plants online, we expect that number to over triple to around 630 gigawatt hours of battery manufacturing capacity a year.

Now the other thing to be sort of conscious of here is just a geographical split. And I'm sure this is something that will come up throughout the course of the sessions where at the moment China, in terms of physical plants in China, has around two-thirds of global capacity. And although that decreases a tiny bit over the next couple of years, it really maintains a fairly dominant position. But you do see over the next few years, and we began to see this in Europe recently, is actually companies building -- companies often from Asia, so Koreans, Japanese and Chinese companies building new production facilities in Europe. So not necessarily diversification at the company level but diversification in terms of plants' location.

And the other thing to, I think, really be aware of, and this is sort of crucial to understand at a high level, even if you don't go into the details, is that within each of these demand segments, not all batteries are equal, and

that will have implications for all of the supply chain questions we talk about today. So batteries for passenger electric vehicles and the raw materials that go into that may end up having different requirements and different criteria to those that go into stationary storage in other markets. So that's just to say be aware of some of these nuances in the market.

And the way that we've illustrated this here is looking purely at lithium ion, so that sort of term that most people here will be familiar with but breaking it down by cathode chemistry. So this horrendous list of acronyms that you can see in the legend there, so nickel, manganese, cobalt, nickel, cobalt, thallium (phonetic) (indiscernible), all of these different batteries. And essentially, what we see is happening in the market is technology will continue to improve. And we believe there is a clear shift towards higher nickel content, lower cobalt content batteries within lithium ion, but the need for lithium remains relatively constant throughout. There are slight changes. But the need, depending on the chemistry, lithium is really the only critical material here.

Everything else is important but lithium is the critical one.

And this gives -- this is just another way of sort of trying to get across that same point where this shows the metal content by each of those cathode chemistries. And what you can see, if we start on the left here, so a nickel-manganese-cobalt 1-1-1 (phonetic) battery is relatively equal proportions of nickel to manganese to cobalt. And then lithium stays pretty constant throughout. But this chart, you can see as you move forward with these different technologies the other metals will change but the lithium content stays relatively consistent.

And I guess one of the reasons why we're here today is one of the things to be conscious of today is we are not alone in thinking about this industry from sort of a perspective of security of supply and from a perspective of sort of a it is a now be elevated to one of sort of national importance. You see this in countries where either there are major demand sources, so where you have an expectation of a lot of electric vehicles or electric vehicles or station energy storage to be deployed or where you have

an existing manufacturing industry.

And here, this is a quote from the chief executive of Posco, one of the Korean, sort of Korean majors here. They had previously not really been -- up until two years ago it didn't really have a presence in battery manufacturing. And over the last few months they've announced billions of dollars of investments in this space with the intention, with the explicit intention of firming up a domestic supply chain. And so we're certainly not the only ones considering how -- considering the geographical balance and imbalance there.

And then you see this beyond Korea. And I was actually in Australia last month, in Western Australia where, actually, as a territory or as a state it has a larger -- a relatively large amount of lithium resource, as well as nickel, cobalt and other sort of critical metals. And one of the questions that all of the miners and at the state level they're asking in Western Australia is how do we make sure that we are not just exporting raw materials and how do we think about this in a more strategic way?

Similar points in Europe where the

European Commission said -- I'm originally based from London. So the European Commission is trying to offer support to sort of domestic battery champions, as well.

So that's a bit of perspective on what's happening in terms of the demand. So where do we see this going? And essentially it's cheaper batteries means that we expect to see more batteries in more things.

And that then leads to a follow-up question of will the supply chain keep up and how is the supply chain positioned at the moment?

And this chart here shows our expectation of lithium supply and demand over the -- well, up until 2025. And so in the columns on the bottom you can see the different demand sources, so really building off that first chart I showed where you have passenger electric vehicles, consumer electronics and stationary storage. And then the red line is our expectation on supply.

Now there are a couple of things to sort of -- to also sort of flag here. That supply line, we have built that up, looking at all of the plants that we're aware of today, so all of the mines, all of the refining facilities, and

then essentially derating those, so taking the company announcement and then derating it based on various factors, such as financial health, free cash flow, the quality of the raw material, and the likely cost of production at that mine. And that gives us what we think is a pretty good understanding of sort of how much supply will be available in this market over time. And you can see that although the market looks relatively tight over the next few years, and even falls into deficit based on current announcements, so that's really important to note, based on current announcements by 2024, '25, that we do see enough supply in the market.

Now presenting this a few -- or a version of this a few days ago, someone made the very good point of but this demand chart doesn't look that steep, whereas if you look at the first chart we showed it really sort of ends up looking like that hockey stick. And so there is this question around that near-term growth where we do see the market as being able to keep up, but this only gets harder and harder as the pace of uptake accelerates over time.

And that -- and then that, that's really

interesting because you have, basically, that investment, that -- or that production sort of uptake, the bringing on of new supply. Taking sort of -- taking supply and making sure production comes online on time requires a lot of money. And what we've seen over the last couple of months is actually investors, although there's broad consensus around the interest in lithium and around the growth story for batteries, investors remain relatively apprehensive on lithium stocks.

And there were a couple of -- if we look at this chart here, you can actually see, so the metric tons on the left and the performance of these initial listing on the righthand side. And what you can see is that when the market was in under-supply the listings ended up being over -- so, basically, the companies raised what they were hoping to and more, whereas in recent months -- in October there were two IPOs and both companies listed, ultimately listed at the lower end of their expectation. And so there's a bit of a disconnect that will be great to talk through around that consensus around battery demand versus sort of apprehension on behalf of

investors.

And then taking a step back from the companies and thinking more around sort of the geographical split at the moment, lithium is more diverse geographically than a metal such as cobalt which has an incredibly high concentration of resource and production in the Democratic Republic of Congo. But lithium, you still see sort of a pretty meaningful pockets of supply here. And here you can see those pockets being in Australia, in Chile, in Argentina, and then sort of a much smaller resources or production so far in the U.S. and elsewhere, although, naturally, these can change depending on sort of the outcome of any sort of local and domestic supply announcements.

COMMISSIONER HOCHSCHILD: Where in the U.S. is lithium being produced today?

MR. GOLDIE-SCOT: So you have Albermarle and Albermarle Dam where it's producing the bromine. So let me check on the plant name, but it's basically by Albermarle's operations.

COMMISSIONER HOCHSCHILD: That's what I thought I'd heard.

MR. GOLDIE-SCOT: And so you have this --

so you have a geographic concentration. And then one of the other, I think, really – one of the other things that we naturally have to pay attention to whenever we're thinking about new supply is – and when we're thinking about that supply demand balance or imbalance is the concentration at the company level. And so here you can see the 2018. On the left is mined production and on the right, it's refined production. But you end up having, currently anyway, a relatively small number of companies, and you saw some of these on that investor slide I just showed, but a relatively small number of companies who are sort of very active in this space or, rather, who control a large amount of supply. So that, again, when -- in any conversation around sort of the competitive landscape and dynamics going forward, that will be something to bear in mind.

And the final point on this front anyway is it's not just around who owns the mines and who owns the refining facility or, rather, who's operating it. What we've seen, and I find this personally remarkable when looking at it, is the sort of the web of investments across many of

these firms is also pretty tangled. And so you have a number of the larger miners who also own significant portions of the genius (phonetic), and that has been -- and then you also increasingly have overlap between some of the larger plants, as well. So again, it's just sort of something to be sort of aware of in terms of that competitive landscape and the concentration of supply at the moment in relatively few companies' hands.

And now on -- just a few things on pricing, and then I'll pass on to Eric here.

So as demand shows up, and even more importantly, as the expectation of future demand for batteries and for lithium increased or began to increase rapidly, what you can see is that the lithium from a price perspective, so in dollars per metric ton, the lithium market naturally started to react to this. So you have relatively flat pricing for a number of years, so I'm going back from sort of 2009 to 2015 or so, and then this steep increase in pricing over the last couple of years.

Now there are different dynamics or there are different -- that change in price varies,

depending on whether it's hydroxide or carbonate. It varies depending on which country you are sourcing and selling the lithium into. But essentially, you have seen that increase over the last couple of years, even if recent action in China has caused prices in the Chinese market to sort of -- to fall off a bit.

And then these are two slides that, actually, we haven't produced these ourselves. These are sort of our source of from Nemaska Lithium, so one of the lithium sort of producers here, so that's why Nemaska is highlighted. We will be producing our own throughout the course of 2019.

But the other, probably the final, thing to be taking into account when considering the competitiveness of any new supply coming online is where it would fit into one of these cost curves in terms of the cost of production. So you can see a pretty big range here between sort of, depending on the output, between $3,000 a metric ton up until around $10,000 a metric ton for hydroxide, and then for lithium a similar range between -- so for lithium carbonate, a similar range between $2,000 and sort of $5,000,

$6,000 a metric ton here. Now these are estimates from one lithium producer. These would -- these will change. And I'm sure folks in the room will have opinions on this.

But I guess the sort of the final message that I'd like to sort of end on is we see huge demand for batteries and lithium over -- and, well, actually, in the near term, extending and accelerating in the medium to long term. That has pretty significant implications for the whole -- for the supply chain, whether you're at the battery assembly, cell manufacturing components, or the mining and processing for different metals, including lithium.

At the moment the market is relatively concentrated, both in terms of the geographical concentration but also in terms of the company mix. But there clearly is -- there's an opportunity for new suppliers sort of outside of the pool, to depending on their competitiveness in terms of the cost of production, but also depending on sort of where they sit and other non-cost-related factors, there is, clearly, an opportunity for new suppliers to come in and help meet that rapidly increasing demand.

So with that, I think that basically is for me to wrap up. So thank you very much for giving me the opportunity to present. I hope you found the content interesting. And we will hear a bit more sort of context on the market shortly. And then I'm looking forward to a great discussion around what does that mean for California and what does that mean for everyone in this room?

So thanks again.

(Applause.)

MS. DE JONG: And next, we're going to hear from Eric Besseling from Berkshire Hathaway Energy Renewables. Okay.

MR. BESSELING: Hello everyone. Thank you, Logan. First a comment on Logan's presentation.

Everything that I've been reviewing and studying for the last three or four years is very consistent with what Logan showed there, so I say we're very consistent. Some of my presentation slides overlap with yours, and I'll pass through those quick because Logan has done a much better job than I could ever on those.

I'd like to take this opportunity to just

bring into perspective what this looks like or how California fits to this as far as the Salton Sea is concerned. I'm not really an expert on North America supply. I'm an expert, if you can call if that, on what we have in the Salton Sea.

So going with that, the next slide, just a little bit of background, just to let you know where I'm coming from. I'm with BHE Renewables, which is a division of Berkshire Hathaway Energy Company which is mostly owned by Berkshire Hathaway itself. Our company is a large company now. It's a $91 billion asset company as of last year which has -- most of it is this holding company of large utilities. You can see all those ink splats on this chart here, on the map, which are all the regulated utilities that we have, mostly power generation. The couple of squiggly lines is our natural gas pipelines with Kern River and Northern Natural Gas.

And then we have what I'm with, which is the BHE Renewables Group, which is our IPP, which we own a lot of wind, solar and geothermal. And that little star in the southern corner there of California is where the geothermal assets are, and we've got 350 megawatts of generation, of

geothermal generation, with expandability to go to about 1,000 megawatts. We have about 4,000 megawatts in total of wind, solar and geothermal right now. If you include our tax equity projects, we're well over 5,000.

So getting on to the geothermal. So here's a picture of our assets in the Salton Sea. Basically, you can see eight of our ten plants there. There's roughly 250 megawatts of generation on that picture there. You can see in the back corner there in the background, we've got our five plants which we call the Salton Sea Units, Salton Sea Units 1 through 5. And in the foreground you've got the three other plants, Vulcan, Del Ranch and CE Turbo, to those that care. Basically, you've got 350 megawatts spread across ten plants. To supply that with energy, we've got 23 production wells and 22 injections wells.

And basically, we're going down a mile-and-a-half deep to get the brine out of the ground. It comes up at 450-odd degrees and about 500 pounds of pressure. We take that, bring it through the facilities. We flash the steam off that. We lose about 25 percent of the fluid, of

the liquid in the brine to flash steam, which produces the 350 megawatts of power.

Once we're done with that the temperature drops down to about 230 degrees which is a key component when we start talking about the accessibility to this for our lithium extraction, but we still have about 230 degrees hot brine still at the point. And we basically put it back underground, so we go another almost two miles down to put it back into the field for future extraction for power gen.

The flow rate is key here, as well. You've got a big flow. You've got 53,000 gallons per minute of brine flowing. And later I'll show you the concentration. It's not a huge concentration but it's all about volume. So to the extent we have this much volume to process, we've got in the order of magnitude of 200 to 300 parts per million of lithium content in this brine. But with this kind of volume, it does add up pretty quick as I'll show you in further slides.

Here's another picture of the ninth plant which is our Elmore Plant, which is a 50 megawatt plant which is kind of like the right size for

getting under certain efficiencies for permitting. That plant there could support about 15,000 metric tons a year of lithium carbonate production. The footprint of this is roughly about 20 acres for the site, not including the actual field for production but the actual above-ground site.

Lithium extraction, we've been out there working with potential developers for the last year or so and the consensus is roughly about double that size for a lithium plant, just for that site for 15,000 metric. So the footprint is rather large. It's going to be double or triple the size of our operations in the geothermal side.

So just to put it into perspective what this looks like on the map, on the left-hand side, you'll see the -- that's your left, as well -- the left-hand side, you're going to see basically what was considered the Salton Sea-known geothermal resource area. This was identified decades ago. And basically, it defines where the resource is for geothermal. But within that, what's actually accessible for geothermal power gen, which is shallow enough, is

when you have the shallow anomaly which is that little kidney-shaped light blue traced. That's basically where the geothermal energy is that's acceptable for power gen to access and get out of the ground. It's relatively shallow, again, a mile-and-a-half deep, for our wells to get at.

In that well, you can see the resource. The yellow area is what -- is the area that BHE controls which is, basically, we don't own the surface, that's all subsurface rights. We have lease agreements with all the local farmers. We own portions of that surface rights, as well, for some of our operations, but most of it, of that land holdings, is all subsurface rights. We own the rights for the power generation, as well as for all the minerals. And we've been collecting these and holding these mineral rights for the last 20- to 30-odd years, waiting for this day to happen.

And there's been -- at the very beginning of this when this resource was first identified, the focus was really the minerals way back when and has never really come to fruition. This is probably the first time the plants have aligned with the values there and the opportunity and the

skill set to get it out.

On the righthand side you'll see that the four regions, those are the actually operating regions that I showed you the photos of earlier, basically, that's our existing operations. In the bottom chart, you'll see that that's worth about 350 megawatts, as I show there in the light blue. It's good for about 90,000 metric tons or 90 kilotons per annum of production. As you'll recognize in those charts that Logan showed earlier, that's a fair chunk on today's operations and equals about one-tenth of the growth that you projected there, so it's a sizeable amount of lithium production. That's just with the existing.

The greenfield, all that other yellow area in the map above there is what we've been holding for future production. I said earlier that we wanted to get to about 1,000 megawatts of production. We've tried to go at this a number of times, just the market value has never been enough there to support new construction of recent with the onslaught of solar and wind being more competitive than ourselves. So we've been holding onto this and looking for opportunities.

Hopefully, this lithium opportunity, coupled with power gen, will allow us to tap into that growth opportunity, as well, and get the extra 700 megawatts, which would also add up to another 200,000 metric tons of lithium carbonate. So all said and done, just CalEnergy or BHE's holdings alone could supply 300,000 metric tons a year of lithium carbonate, so it's a pretty sizeable amount on the world's scale. But we've got to get through the economics of that, which we'll talk about some more.

Just to footnote a few other things on this, you'll see the green area, that's controlled. That's owned by another development operation called Controlled Thermal Resources that are trying to do the same thing that we're doing, which is to develop that for power gen and lithium production. And you've also got EnergySource, as well, in the top right corner, that little red square. They have an actual operating plant, as well, that's producing 50 megawatts. And they're also pursuing lithium extraction.

In that chart there on the map on the righthand side, the little shaded dark areas are

the actual physical plants, where they sit relative to the whole field.

Here's a gradient map of the lithium concentrations. You can see the little -- the trace around each site of wells there. That is the little sites I showed you on the previous map. Each region has its own production and injection wells. They're separated by region. And you can see, the concentrations go to roughly 175 parts per million in the far left corner and going up to about 225 in the far right in the yellow. So that's the kind of concentrations that we're experiencing.

We've been testing this brine annually for the last 20 year, so we've seen these concentrations persist over the years. Nothing's changed over the years. It's very -- pretty reliable and consistent, which is very comforting for new development.

As I mentioned before, we struggled to try to get the new development for geothermal. Here's a chart that I like to present to explain what's going on and where we sit in the stack of power supply on a levelized cost of energy. You can see the green there for geothermal. Our

price, roughly speaking, is about $95.00 a megawatt hour levelized cost to get to market. And the market, as everyone's probably heard and experienced, it's in the low $50.00s now for -- and even below that for solar production.

And that's where we've struggled to get any traction on developing new green geothermal. And this is really the lifeline to bring geothermal back into competitive with those other renewable sources, a combination of that and when you bring in -- we're now going to be, probably in the future, competing with not just solar by itself or wind by itself, but it will be a combination of intermittent with battery storage which drives lithium demand, but it also makes us a little more competitive on the geothermal.

Once you move away from all the tax incentives, the ITCs and such, we figure that the value of solar plus storage is going to be around that $50.00 to $70.00 range, and which we're probably on the -- still on the little high side. Lithium production coupled with this, the value that we could gain from both, putting the two concepts together, we should be able to get our cost driven down something below $50.00.

This is -- now I'd like to talk a little bit more about the lithium reserves. This is going to, hopefully, put things in perspective. And I've always been trying to understand over the last couple of years where we really fit in the world as far as California brine. So I know there's a lot on this chart, so bear with me.

First I want to talk about those dark blue -- the dark red bars. That's what's basically, based on the U.S. Geothermal Survey, tells us is what's the reserves that are currently on the books right now. That's the total world reserves right there. Basically, it's all set mostly in Argentina, Chile, China and Australia. That adds up to 15,000 kilotons of total lithium reserves. That's proven reserves based on current technology that's economic to get out of the ground at today's markets.

The dark blue is what the U.S. Geothermal Geological Survey projects as identified resources. That includes what's viable and proven but also includes what's marginal and what's not marginal. So that's basically the total resources out there in the world, so you

can see how much growth there. And that's where you could start seeing the U.S. show up.

That light blue, I highlighted that one bar in light blue for the United States, it's -- to the extent that we can prove up the technology, basically, I can pretty much fill that bar with just Salton Sea brine. Our reserves, if we tested and proved up our technology, our -- the Salton Sea brine would fill that bar. And if proven up, we'd be the second largest resource in the world.

That puts it all in perspective. We're talking about a big volume here.

On the other side of that, though, is that do we really need that much reserves?

So if you look at the -- if we did prove up all the -- all that identified resource, now a lot of that is in Bolivia and Argentina which questionable whether it will ever be, but if you did you'd basically be looking at 300 years' worth of reserves, which is way more than we need. To compare that in one bullet there, I show for oil and natural gas markets, you've got about 90 years' worth of reserves for natural gas and 70 years' worth of reserves in oil and

there's no on panicking.

So it's almost like, again, from a layman's view, it seems like that's almost, like that's plenty. That's like the sweet spot. You have 50 to 100 years' worth of reserves. Everybody's comfortable. They're not getting any big run ups.

I remember back in the, I guess it would be the late '90s, early 2000s, when gas started to get tight and we started hearing numbers around 20, 10-years or 20-years' worth of reserves and prices skyrocketed eight bucks on MMBTU. So you can see where it gets more constrained, but everybody seems to be very comfortable at 90.

So with that said, you look at those dark red bars, basically, that adds up to 90-years' worth of proven reserves for lithium based on 2025 demand projections of roughly 950,000 tons per year.

I should actually also comment and make note that on these charts, it's based on the geographical survey units. It's just the lithium, the raw lithium is not lithium carbonate equivalent which is mostly on the market, so we

always talk about the carbonate equivalent. The lithium itself and lithium carbonate is only about 18 percent, 18.8 percent of the lithium, so that's why you see the numbers look a lot smaller but in perspective you can see the difference.

That little -- the inset there, the chart for the lithium production for last year was only 43,000 tons last year of raw lithium worldwide. So you can see how small a volume that is relative to the reserves we have.

So the final conclusion of this chart, what I'm really trying to present, is that it's not about the actual resource, it's not about having the resource, there's plenty in the world. What's really going to drive where lithium comes from in the future is basically the production costs, which Logan alluded to, the location relative to market, and thirdly, which we've a lot of, is quality. The quality is also important.

We've been working and this last year-and-a-half, as we're trying to get our development off the ground, we've had a lot of interest from battery manufacturers, from OEMs and the like, and we've heard that quality is a

big focus of theirs. That 99.5 or better quality for a quality battery is an important part of it.

I've also heard some battery manufacturers tell us that they take one to two years to prove up a source for lithium, so it's very sensitive to the quality. And they'll spend -- take a year or then some just to prove that it's going to work for their batteries. So it's a sensitive chemistry for sure for the batteries. So we need to focus on that if we're going to be a player in this market. Clearly, we have the volume of it, and hopefully we have the cost curve.

Here's another version of the supply stack that I picked up from CANACCORD. This one looks -- I've seen various versions of this. This one, to me, looks like the most realistic, from what I've heard and talked to others. And this is where I see the geothermal cost curve for our variable cost of operation. This, again, we're not in the business today. We're actually working with a lot of developers and everyone's quoting me numbers in that order of magnitude, of $4,000 to $5,000 a ton for operating costs. A lot -- some of that's driven by power costs, man

hours and such and chemicals and processing. In that would also include what we would charge to access the brine for royalty structures and so on.

So it shows that we're competitive. This chart shows us as competitive if not more competitive than the Chile brines, which made it very exciting. So to the extent we have that whole region of the Salton Sea area, I could say we could go up as high as, based on our announcement and our geologist reviews, as well as others in the area, could be as high as 600,000 metric tons a year, but that's basically the entire growth from 300 today to 900 by 2025-2030, we could fill all that. Now, obviously, there's a lot of hurdles and a lot of barriers to get there. But I'm just saying that the product's there, and the cost structure seems to be there too. This is all desktop right now. This is all under development. We need to get through that and prove it out and get it on the ground because there's a huge opportunity there for California.

And the U.S. Geological Survey suggests that that's for North America-wide. I have no

idea what's in that, their numbers don't give you the granularity of what regions. But I'm just looking at this and seeing that the Salton Sea area could supply and meet that demand just in itself. So I'm not sure where their numbers are coming from versus what my geologists are telling us, but definitely we have the volume in the Salton Sea in California.

This is a cost curve for -- as of 2018. They also offer a version of that, what it's going to look like in 2025 when you start getting into the volumes. In this particular forecast, they suggested the demand by 2025 is a little bit more aggressive than Logan is showing, about 920 metric tons per year of lithium carbonate. You can see that the brines are expanding, as well as also the hard rock developments to meet that demand. In both cases, you're getting that marginal cost of in the close to $10,000 a metric ton, which is more than enough relative to the cost curve, what I'm hearing and projecting for geothermal production.

And it makes sense that the geothermal has got a similar cost structure to the brines in Chile. It should be cheaper because our access

to our brines should be easier, less challenges than you have up in the high hills of Chile, so there should be some logistics there.

Part of this, too, I'll mention that in my previous chart I mentioned that the location is a big driver. We've had a huge amount of interest as we're trying to, again, put out this brine.

I should mention that BHE is a bit conflicted whether we really want to get into the mineral extraction business ourselves. Our history was we actually went after this once a long time ago. Back in the late '90s, early 2000s, we went after zinc, so we've always had in the mind to go after mineral extraction back in our more entrepreneurial days.

We've grown to be a much larger company and much more utility focused. It's questionable whether it's still in our DNA to after a new line of development like this. We definitely want to untap this value proposition and get at it. We're looking for others to do it for us and we'll just collect a royalty. We're just as happy to sit on the sidelines and collect a royalty, a low-risk royalty.

At the same time, I'm thinking that to the extent that we can't find somebody to pick it up, we may very well get it into it ourselves, at least start moving down that road and proving up and de-risk the technology. But to the extent someone else can take it on, we're more than happy to sit and just promote others to do it for themselves.

But what we have had, so we've gone through and we've spent the last year going through ARFVTP to bring some developers worldwide into this. We've had lots of interest but everyone's got some hesitation. Back to what Logan said, there's some market hesitation whether it's really needed. There's a technology concern. There's lots of uncertainty around technology. Whether it's warranted or not, I'm not sure, but there's hesitation for sure.

At the same time, we've had a lot of interest in the battery manufacturers very -- watching with a very keen eye what happens here because they do seem to have a need or an interest in a North American supply, whether it's geo-political risk or if it's just location relative to the local markets for the auto OEMs

that we have in North America that want to source it locally.

We've worked closely with Tesla. Tesla is basically who we talk to, we want to sign up. They have an interest for at least 30,000 metric tons from the Salton Sea alone, so there's clearly some pent up interest and demand for North American supply. It may otherwise be, partly, just to diversify their supply from multiple regions.

Here's a chart here, it's a little outdate, it's from a different consulting group, showing the -- a more subtle demand growth over the course of the next ten years or so, going until 2030, peaking about at about a million -- or a 100,000 -- or a million metric tons per year by 2030. I put this chart here just more to show where it's coming from, and Logan touched on it, as well, so I don't need to go into much detail, but the key here is that it's coming from the auto industry. It's definitely electric vehicles.

We like to think that energy storage is going to be a big part. Well, we're not seeing that in the projections at all. It's kind of

growing and I'd like to see it grow more. Being from the energy industry, I'd love to see us do more on that side. But at the same time, we're just not seeing the big growth demands, or at least projections of that. And, quite frankly, on the geothermal side, I'm happy to see that. That means there's a bigger role for geothermal for base load. But either way, that's going to play out.

But the big thing is as we make projections and think about what's the likelihood of this market, it's really focused on we've got to watch the auto industry.

With that, I'd like to take you to this chart. On the righthand side, that's a chart of last year's total sales of worldwide vehicles, all kinds. Look at the length of China. You're talking 30 million cars sold last year, compared to everybody else. So clearly, China is leading it. And why I've picked up this chart, that's what I'm trying to get, that's the picture I want to show, like that's really what's growing. We should be watching China closely. If China, for whatever reason, changes gears the lithium demand will fall off.

But we do have -- the U.S. has a big role to play, as well, as well as the others. And this is, obviously, in order. So this is the top 25 and you can see as you go to smaller countries, you get less demand, less auto sales in total. So that's just the market share potential is there.

On the left-hand side I show a chart of all the announcements by governments of targets and policies and what they're trying to get to, to address global warming. And you can see that I put this, I think, in somewhat order of magnitude and impact, China being the biggest with at least 20 percent of sales by 2025 is their target. That's a pretty big target when you look at the size of the volume that they sell on an annual basis, which corresponds to 7 million cars. And they have a target by 2020 of 2 million.

An interesting point, too, on these guys, that they -- for China, they have over 140,000, I think, charging stations today in China, so they're clearly setting up for this. They have a goal of 500,000 charging stations in China by the year 2020, so they're definitely setting up. They're getting ahead of the curve and getting

the infrastructure there to make it easy to convert.

India is another big one. Earlier this year they made an announcement that they were going to try to get off -- ban all petro and diesel by 2030 which was, for me, a big eyeopener. They've, since then, reduced that down to only 30 percent, but it's still sizeable, by 2030. And I think there's some back and forth in that country to try to see what the real right number is from, but they're somewhere between 30 and 100 percent by 2030.

Germany is also -- Germany, you'll see that, also, and with about by 2020 they're going to have a million cars, and they want to be off petro by 2030, also leading the charge on that.

The United States has a role to play here, as well. You have, with the California Clean Vehicle Incentives, you have the Zero Emission Program, that's really basically working out to be what they're forecasting to drive about eight percent of sales by 2025. And there's been nine other states, I think, that's followed suit with California. That adds up. That's equivalent to roughly 30 percent of all car sales

in North America. It's not anywhere near what China is doing, but it's definitely a good standing.

The European Union is making some projections. They're trying to make it easy to convert. They're looking at parking spaces. They're mandating ten percent of all buildings by 2023. And they are putting more like emission targets of 95 grams of CO2 by 2021, so they're coming at it from more of an emissions perspective.

France by 2040, not as aggressive. The Netherlands by 2030. The U.K. by 2040 with the Scottish going after more like 2032.

And then Norway is probably the most aggressive, just, unfortunately, the smallest market, they're going ban by 2025. And they've got the most conversion to date than any other country. I think they have 16 percent converted by now.

On the other side, I won't go into too much detail here, but just the response from the auto production, you've seen that the major players are all following suit. They're taking this serious, as well. BMW and Daimler Mercedes

Benz both making projections of 15 to 20 percent vehicle share by 2025. So I won't read off all these. You can read them for yourselves at a later date. But basically, you can see that both pieces, on the government policy side and the auto industry following suit, you're definitely seeing this wave.

So back to those charts that both Logan and myself showed, it seems to be real. I don't think this is going to go away or fade away. It seems like, if anything, it's going to pick up and continue to be more and more aggressive.

My last slide, I just want to show, what does this mean to us as far as potential?

So here's -- for a number of reasons, this slide here shows a couple of things. Ignoring the red box for the moment, the economic development for the Imperial County, what does this really mean?

If we were just to produce our 90,000 metric tons, which is just our existing operations which are basically flowing today and could be converted over the next three to five years, for construction alone to build out the four facilities, because we do it by region, we

can get about 230 workers on average for over four years, so that's just the workers, to build the facilities. And again, this is high-level, back-of-the-envelope estimates but we're talking roughly around 400 employees for full-time employment to operate those facilities. This compares to what we have in the -- for the power generation for these same assets, we have over 230 employees. So this would be almost double our employees and double the footprint, so it kind of fits. So that's just the job size in an area that could definitely use the jobs.

You're talking about the actual construction and expenditure of roughly -- this, again, high level -- and I'm hearing a range between $1.5 billion and $2.5 billion to -- depending on what technology and how you go at it, so roughly, peg in the middle of about $1.8 billion of investment in this region, just to go up to the 90,000 metric tons a year.

And you're talking contractor expenditures on an annual basis, if you do use outside contractors, in the order of magnitude of about $18 million a year.

Leaseholder royalties, again, this is a

model where we would actual just collect a royalty. In this case, we're looking at pegging at only five percent royalty, we'd pass on $4.5 million a year to our leaseholders.

And taxes, I'm pegging it roughly in the order of magnitude of $20 million of additional taxes going to Imperial County.

One thing I wanted to just answer, because I've heard the question come up a few times in the past on some other calls we had, is the how does this compare, how cost effective is this? Is this economic to do so? Where's the value proposition? So I did some really simple math here just to kind of put in perspective.

At $1.8 billion, your cost of capital, if you will, of the 20 percent cost of capital, about $360 million spent over 25 years. An operating cost of, like I said before, about $4,000 a ton, you're talking another 360,000 -- $360 million, sorry. So it's $720 million we're talking of total cost against a revenue opportunity at what I consider the low end of the spectrum of $10,000 a metric ton, you're talking $900 million, you still have a couple hundred million dollar flow between the two.

This little red square, it almost perplexes me why we haven't done this. I'm shocked that there isn't people all over this thing already building, although we tried last year and there's some hesitation going on. I don't know what they don't see in that red square but -- and this is a value prop that we've got to get to.

And I'll leave it at that now and sort of for future discussion. But that's basically the perspective of how we see it from -- how the Salton Sea might play into this.

(Applause.)

COMMISSIONER HOCHSCHILD: Thank you. Thank you very much.

In a minute, I wanted to invite Assemblyman Garcia to share some of his thoughts and vision on this topic as we explore lithium as the new oil, but I wanted to just make two points.

One is that, you know, you've perfectly illustrated why this is an example of our environmental and our economic visions kind of overlapping here. And it strikes me that it's very clearly a co-benefit of geothermal to be

able to help facilitate this.

And I wanted to say, secondly, that we do now have 12 electric vehicle manufacturers operating in the state of California and three of them are really at significant scale now with Tesla, BYD and Proterra. And, you know, none of that lithium is being sourced in California today and that's a real opportunity for us to be actually supplying California manufacturers with California lithium.

So with that, let me welcome Assemblyman Garcia, a real champion for this issue and for his district.

Thank you for being with us.

ASSEMBLYMAN GARCIA: Thank you, Commissioner. It's a pleasure being here. I was thinking, you know, that's my district; right? That's our home. And a lot of familiar faces here who have been working very hard on pushing the issue of more baseload energy being integrated into the overall California grid. And we've tried this way, we've tried that way, we've tried going over, under, through, right, back door, side door, and we continue to receive this conversation with a tremendous amount of

resistance.

And so today, right, we're having the conversation where we're now looking at it from a perspective that may be isn't new but certainly one that, again, aligns with our goals. What do we -- we have a quadrillion cars that we want to put on; right? Is that even a word, quadrillion? A speaker was saying the only day, the only person that can make up words and people just kind of nod their head was Senator Kevin de Leon. He's the one (indiscernible) anymore, no question.

But we have an aggressive goal to put a handful of electric vehicles on the roads by a certain date. And here we have a unique opportunity in a place in California that ranks at the highest when it comes to unemployment, health disparities, seven out of ten children suffering from respiratory disease problems. And here is a unique opportunity to address a handful of those issues by simply aligning our objectives with California's policies that are in place already. And, you know, we appreciate all of the work that's been done already to move the conversation and develop a framework for policy

to be discussed at the big house across the street.

But really for us, it's a matter now of really taking it a step further and getting overall buy-in, that this no longer be an issue simply being discussed by the legislators who represent Imperial County, but that the entire state of California see the value of this unique resource that we have out in this region. And when you hear us talk about the Salton Sea, it isn't just the issue of a drying up body of water but a place in which, you know, we could develop thousands of jobs, both on the energy side and now using these minerals to ensure that we have the necessary batteries to address the needs that we've set forward as it relates to the vehicles we want to put on the road.

And so we appreciate that this conversation is happening because it has to extend beyond, you know, Senator Hueso and Eduardo Garcia and the Salton Sea Authority and the developers out in the Imperial County. It has to resonate statewide and that the entire state of California recognize this unique and valuable opportunity that we have in what people

will refer to as kind of the most southern part of the state.

But I like to say it's the beginning of the state and it's the place in which there is undoubtedly a tremendous amount of synergy when you talk about renewable energy in California and around the world. There is no other place like Imperial County when you talk about, you know, the three, four legs to the stool, when we're talking about all of the various opportunities that we have, I mean, you know, from biofuels to now the lithium battery that comes from the development of some baseload energy to stabilize California's energy needs and grid.

So I wanted to come in and just really acknowledge the fact that this is a very important roundtable that you're having for the purpose of it spilling over to the public policy debate that will undoubtedly happen again in January. We're not going to spend our time in the legislature and not push for stronger economic development policies that intersect with good environmental policies for California, and that's exactly what we're talking about here in this small piece of the presentation that I got

to listen in to.

So I'm happy to entertain any questions. I do have to run in a few minutes back to the Air Resources Board. I was fortunate enough to be able to sneak out. There's a list of 70 public speakers time three minutes, so that's about three-and-a-half hours of public testimony that allowed me to come out for a few minutes. I think they're about midway through, discussing some very, you know, boring topic like cap and trade, you know, like cap and trade.

So happy to entertain a little dialogue, if you so choose. If not, I'll excuse myself.

COMMISSIONER HOCHSCHILD: By all means. Thank you. I'm sure you're very good at that math, of calculating the number of speakers and how much time.

Are there any questions for Assemblyman Garcia? Anyone?

So you know, the one point I would make is that, you know, the lithium we're talking about today could be used to supply energy storage which we'll need to get to SB 100, and also transportation. I think with transportation, we should bear in mind how

quickly it's possible for the transition to happen.

There's a wonderful photo of New York City, 5th Avenue in 1900, all horses and buggies and one car. And then 13 years later in 1913, same street, all cars and one horse and buggy. And I think that that kind of transition is possible with electric vehicles.

And I'd note what happened last time in Norway is very significant; right? First country in the world with a majority of passenger vehicles sold in the market were battery-electric or hybrid battery-electric vehicles. And you know, once you cross that threshold, you don't go back. And we will hit that point in California as to --we didn't talk about it in the presentations earlier, but as the energy density of lithium ion batteries improves and you get longer range, I mean, that really meets the needs and we get -- you know, the other -- the advent of these fast chargers.

So Electrify America has just gotten through UL earlier this year an EV charger that does 20 miles of charge in one minute, 200 miles in ten minutes. And that is really no different

than going to a gas station, you know? And so that's where we're headed.

I'm actually having dinner with the CEO of Electrify America tonight. And, you know, I'm optimistic we're going to see new technologies come out.

So I mean, we have to -- this conversation as applying to lithium for that growing market is really key.

So with that, let's say thank you to Assemblyman Garcia for coming and joining us.

(Applause.)

COMMISSIONER HOCHSCHILD: One thing I wanted to do before we proceed any further is just do a round of introductions. If I could ask everyone to go around and say your name, your organization and how you're looking at this issue real briefly?

Danny, let's start with you.

MR. KENNEDY: Hello. My name is Danny Kennedy. I'm the Managing Director of the California Clean Energy Fund. Amongst other programs and funds, we manage the CalSEED Fund, the Sustainable Energy Entrepreneur Development Initiative for the California Energy Commission.

That's a $25 million early stage grant program that's intended to find and fund and foster the next 100 companies California needs to meet its energy goals.

We had the good fortune of finding one such company in Oakland last year called Lilac that we backed about 18 months ago. And they sort of raised our awareness to this lithium extraction opportunity. They're a specialty lithium extraction business looking at geothermal and continental brines out of Northwestern University. They've spun out and moved to California because that's where the innovators come to do clean energy work. And you know, we think that they're one of the rising stars in our portfolio of about 46 companies now. But they've really opened our eyes to the fact that we need a whole innovation cluster and industry development around this opportunity of the Salton Sea.

MR. WILCOX: Bruce Wilcox, Assistant Secretary, California Natural Resources for Salton Sea Policy.

MR. BOWLES: Trelynd Bowles, Office of Planning and Research, and acting as a liaison to local governments for issues on renewable energy,

but also interested as someone who lived in Thermal on the north end of the Salton Sea. So I spent a lot of time there growing up, so I'm definitely interested in hearing from the folks here who are from there.

MR. ROSENTRATER: Phil Rosentrater, Executive -- pardon me -- Executive Director of the Salton Sea Authority. We're the home, as you earlier heard, the epicenter of the largest, most diverse renewable energy portfolio in America. We intend to use this for the greater good and look forward to geothermal and brines being part of that.

MR. ECKERLE: I'm Tyson Eckerle, the Deputy Director for Zero-Emission Vehicle Infrastructure at the Governor's Office of Business and Economic Development or GO-Biz. And so my job is really to make sure that all those projections come true and the infrastructure enables that.

MS. WALL: Anna Wall. I'm the Vice President of Capstone Headwaters. We're an investment bank in which I focus specifically on mining investments (indiscernible).

COURT REPORTER: Can you come up to mike,

please?

MS. WALL: Okay. So in my role, I particularly focus on -- actually, brine mineral extraction is my specialty. I've been following the industry and early-stage technologies for about four years. And my background is in geothermal, having been a geothermal chemist. So I'm particularly interested in this field.

MR. KELLER: I'm Randy Keller with -- Vice President of MGX Minerals. We've developed a rapid extraction technology to extract lithium and other elements from wastewater streams, mine tailings and natural brines.

MR. HORNE: Hi. I'm Andy Horne. I'm the Deputy CEO with the County of Imperial. This is obviously a very interesting subject for us down there in the County, so interesting that I was up at three o'clock this morning to head to San Diego to catch my flight.

And I've got to tell you, Eric, when you got to this slide here I was nodding off a little bit. But when you got to the next page about the $20 million in tax revenue, I am now wide awake.

MR. BENSON: Derek Benson, Chief Operating Officer with EnergySource Minerals. So

we are, and I refer back to Eric's slide, we are one of the other geothermal operators down on the Salton Sea currently running one project, nominally, you know, 50 megawatt unit. So we are, you know, in the geothermal power space today and looking at, you know, how to develop that in our resources.

MR. MENGERS: Josh Mengers with the Department of Energy, U.S. Department of Energy, working with the Geothermal Technologies Office. We've managed a few projects and R&D in mineral extraction, including lithium. I'm really interested in seeing what comes out of the Salton Sea. That's obviously the best opportunity. But if that's a good test case, we're interested in seeing if we can scale that to other geothermal resources across the country.

MS. VENTURA: Susanna Ventura from SRI International. I've been working over the past four years on developing materials and processes for the extraction of lithium from geothermal brines, the continental brines, other brines. And the sponsorship (indiscernible) the Department of Energy and now currently the California Energy Commission sponsorship and

focusing specifically on geothermal brines.

MS. DE JONG: I'm Elisabeth de Jong. I work on the Geothermal Grant and Loan Program here at the Energy Commission in the Renewable Energy Division.

MR. GINLEY: I'm Dave Ginley. I'm the Chief Scientist at the National Renewable Energy Lab. We are a national laboratory dedicated to renewable energy, both from the basic science level all the way up to the systems and system analysis levels. So we do analysis on these kinds of programs, as well as doing basically system development.

MR. WEISGALL: Jonathan Weisgall, Vice President for Government Relations for Berkshire Hathaway Energy. We're the holding company for a number of different companies, including Berkshire Hathaway BHE Renewables. I go back to the -- I think I was employee number 12 at what was our original company which was CalEnergy, the geothermal company. As you saw on Eric's map, we've grown quite a bit since then.

And my memory goes back to around 2000 when we put together a program to extract zinc from our minerals down at the Salton Sea. We

were pretty big loss leaders for Berkshire Hathaway that year. But I will tell you that lithium is going to be one of our top priorities for 2019 and going forward. The numbers cry out for this development. It needs a tremendous amount of capital. There's a lot of risk involved, I'm sure we'll talk about that in the rest of the afternoon. But this is something very important for our company.

MR. BESSELING: Eric Besseling with Berkshire Hathaway Energy Renewables. My responsibility, I didn't get a chance to present that when I was up, standing up, my responsibility is V.P. of Business Development. I focus on the existing assets and the ongoing marketing of the existing assets and new development, as well as monetizing the mineral extract value that we have.

MR. GOLDIE-SCOT: Logan Goldie-Scot, Bloomberg NEF. I think you've probably heard enough from me, so --

MR. GENTRY: Chuck Gentry with the Research and Development Division here at the Energy Commission. I'll be moderating the first panel discussion.

MR. SOKOL: Good afternoon. I'm Michael Sokol, Manager in the Renewable Energy Division here at the Energy Commission. And thank you, everyone, for joining us.

MR. RIDER: Ken Rider. I'm Chief of Staff to Commissioner Hochschild. And I'm already excited about what I've heard so far and look forward to the rest of the day.

COMMISSIONER HOCHSCHILD: Okay. Thanks. Take it away.

MR. GENTRY: All right. So this first panel discussion, we're going to be focusing on the technical and economic challenges. We're going to discuss the challenges that need to be overcome to expand production of lithium recovery from geothermal brines. And let's just jump right into it.

The first question is: What are the current technological limitations for lithium production from geothermal brines? And I think to start off, Susanna could you start us off?

MS. VENTURA: Sure, I'll be happy to start. And I just --

COURT REPORTER: Can you move closer to the microphone?

MS. VENTURA: A little closer?

COURT REPORTER: Yeah.

MS. VENTURA: Yeah.

COURT REPORTER: It's got to be manageable.

MS. VENTURA: Okay.

COURT REPORTER: Thanks.

MS. VENTURA: Okay. Got it.

I just want to mention that, as I said before, we, at SRI International, we have been working on developing materials and processes of the extraction of lithium from brines. I want to also mention that we are in discussion to -- with a company to commercialize this technology, a company, a private company that will license this technology. So while we -- we want to move the technology from a lab demonstration to actual field demonstration. And I think this is definitely needed. Geothermal brines in particular are very complex systems. And it is critical that we are able to make this demonstration onsite.

What I would like to mention, also, that geothermal brines are a particularly complex system because they contain a very high number of

minerals besides lithium. So I think there is an opportunity. I think it's important that we also think about extracting selectively other minerals, as we have heard before, zinc, manganese, there is a lot of manganese in the Salton Sea, and potassium, for example. So that will really help, I mean, reinforce the overall process, economics, reducing also probably the pretreatment (indiscernible), so making them more effective.

So I think those are the two points that I wanted to emphasize, a demonstration on actual -- at actual sites and co-extraction of other minerals, I think it will be important to demonstrate.

I also want to mention that the company with which we are having discussion, our target is to build a skid-mounted system next year. So we look forward to have this kind of demonstration in the field at various sites.

MR. GENTRY: Okay. Thanks.

And if anyone else has something -- someone else on the panel has something they want to say -- go ahead, David.

MR. GINLEY: Yeah. So I guess I'd like

to say that I think that, one, you have to look at the whole system when you do this because these -- all these processes take substantial energy. And so thinking about where to get that from, whether that's solar, whether it's from the geothermal plant, otherwise.

But I also think that the other thing that's critical is over the last, we'll say ten years charitably, separate technologies have changed dramatically. And what we used to use in terms of, you know, brine pools and all is obviously not useful for geothermal because you lose the water, which California can't afford to do in any case. But there are now approaches that are much, much more energy efficient and much more selective for particular ions.

So along the lines, if we know what the makeup of the brine, a particular brine is, you can actually target specific ions in that brine. And I think lithium is certainly the big win, it's the easy win, and there's going to be an immense demand. I would actually argue that maybe you're actually underselling the demand because I think, one, EV growth is going to be a little bit more rapid. But I also think there's

some models that show that EVs on the grid provide grid-based storage which helps the baseload, you know, for renewables.

But I think these separation technologies are really advancing rapidly and I think it takes a champion. And I think California is the perfect champion to begin to evaluate this because, one, you already have the production facility and, two, you have a well-known brine that we can actually do decent chemistry and separation science on.

MR. GENTRY: Thank you, David.

Yeah, I think with this topic it's --

COMMISSIONER HOCHSCHILD: I think you had one comment here.

MS. DE JONG: You had one comment.

MR. GENTRY: Oh, yeah. Anna?

MS. WALL: So, just given my background, I can kind of give a little bit more context if you all don't mind.

So one of the biggest challenges in some of these specific selection technologies is temperature. So some of these technologies have been proven on the bench shop scale but they've been at surface temperature. And dealing with

geothermal brines, especially having to deal with materials chemistries, material engineering for the kind of temperatures that you're dealing with in a geothermal system are particularly challenging.

But the only way that we're going to know, as to Susan's point, is to have a demo in place with live brines and actually showing people that this works. Obviously, you can do as much testing as you want. But the more that there can be a sample brine, some type of source, and seeing it work is going to be the best door to the process.

Secondly, to Dave's point, there is -- and also Susan's, is the complexation within the chemistry itself. And the brine creates particular problems with different types of technologies. Not one solution is going to work. Some technologies, particularly, for example, like absorbent system, they would have to selectively choose out the lithium. If there's a high level of magnesium, that can be a challenge. Certain chemistries and certain technologies have problems with other types of ions. Again, there's also the caustic behavior of the brine

itself that creates certain challenges.

So the more that I can say is that that is really currently the limitation, is not having enough testing on the actual brine itself to know what are the solutions and what is the iterative process and improvements that they need to move forward?

MR. GENTRY: Thank you.

Go ahead.

MR. MENGERS: So I'm going to echo that I agree with what has been said here. But going back to the technical challenges, doing the testing onsite is okay but the scale-up is going to be really difficult. The U.S. Department of Energy, we're right now focused on early-stage R&D, low TR, technology readiness levels. That's not really our bailiwick right now. We're not going to be able to work on the scaling up process of that and I think that's going to be probably one of the largest hurdles in getting this commercially deployed.

MR. GENTRY: Thank you.

MR. BESSELING: If I could just add to that? From our past experience, the scaling up, for sure, we experienced that with our attempt to

go after the zinc and the brine. We did it at a pilot plant level. We kind of skipped going to a demonstration plant and went right to commercial scale and we struggled with that. And we found a lot of problems as you scaled up. And at the time, it's not that the technology was completely flawed, it's just that it meant more capital to throw at it to make it work. At the time the zinc was nowhere near the value of lithium which, in that case, we abandoned the project.

So by all means, yeah, learning how to scale it up at a demonstration plant, our learnings was we definitely can't skip that step because you can save yourself a lot of money in design work by doing a demonstration plant, like a one-tenth scale, which would kind of somewhat emulate that scaling up version without putting too much money at it.

With that comes the technical/commercial challenge is that to build that kind of mini scaled-up version, you're talking in the order of magnitude of $50 million to $100 million. So it's a lot of development at-risk money before you know you've got something that can take commercial. And that's, I think, the biggest

challenge we're having trying to bring a developer to our brine to proceed with it is that it's not talking about $10 million, see where you go with it, it's spend $100 million and see where you go with it, and that's a lot of money for investors.

MR. GENTRY: Thank you, Eric.

Jonathan, go ahead.

MR. WEISGALL: Just one quick additional point in terms of that R&D. One thing we would do as a company would immediately offer up our resources for any kind of onsite development. In response to your comment, I mean, you've got to do onsite. You can't do that in a lab in Denver or somewhere else. And it would certainly be in California's interest, in our interest, as well, to make the appropriate arrangements that whatever truing up would be needed, we would certainly be willing to. And we'd have to work out those circumstances but working out where that could occur at our facilities or some of the others in the Salton Sea. It's got to be done inside, onsite.

MR. GENTRY: Derek?

MR. BENSON: Yeah. So maybe to pile on a

little bit in terms of the issue of temperature and a couple other comments to make. It may fill in the question too.

But you know, the geothermal industry is, I think, generally a little bit underserved when we talk about technologies. And so I think one comparison to make is like in the oil and gas base, we benefit from a few hand-me-down sort of technologies but ultimately those oil and gas technologies tend to break down, literally, at 400 degrees. So there's a lot of skill in the oil and gas industry that we leverage but ultimately we have to go out and find a unique solution to a well that's 16 inches in diameter and 500 degrees. Nobody else does that.

And I think when we talk about looking at minerals, you made the comment, you know, we're playing with brine that's still over 230 degrees Fahrenheit when it leaves a geothermal power plant. Most mineral technologies are, you know, hand-me-down from Salar's which are typically running at, you know, ambient air temperature.

So every step of this process is going to require some new and novel approach or leverage, a multitude of technologies. So as we look at,

and I go back to, I guess, Logan had the comment, you know, don't look at things in silos. I mean, ultimately, any mineral extraction is very dependent on geothermal. But I think it's important to not only look at lithium because, ultimately, you hear conflicting stories of whether it eventually becomes a commodity or whether it's really a product. And obviously as you go to, you know, finish grade lithium carbonate or hydroxide, it is a specialty product. But if we can look at this in terms of other products, eventually you have something that's more resilient and ultimately can help weather, you know, cycles of, you know, commodity risk ultimately.

So I guess in terms of a technology, maybe put that out there that we shouldn't be siloed because, you know, it's not just lithium that's going to ultimately need to happen to make this whole enterprise kind of hit the vision.

COMMISSIONER HOCHSCHILD: I had a question. I'm sort of ignorant but well-meaning on the science of this.

What is it exactly that requires $50 million to $100 million? Why can't a $10 million

pilot work? Can you just help illuminate that a little bit.

MR. BESSELING: One thing I always like to correct people, when they call it a pilot plant, it's more of a lab. And so it's not really a working, functioning plant that's actually taking live-stream brine and processing it. So to build a real plant that's actually producing, that's a full-size plant, the full scale commercial plant is in the order of magnitude of $300 million to $400 million, so $60 million for one-tenth. So it's just the cost of pots and pans. The cost of that, those columns in that technology, is just, it's what it costs.

MR. GENTRY: All right. Thank you.

I think we'll move on to question number two now.

COMMISSIONER HOCHSCHILD: You had a comment in the back in the white.

Sir?

MR. GENTRY: Okay. Did you want to make a public --

COMMISSIONER HOCHSCHILD: Did you have a question relative to what we're talking about?

MR. HARRISON: (Off mike.)

(Indiscernible.)

COURT REPORTER: You'll need a microphone, sir. I can't pick you up from there.

MR. HARRISON: I was formerly with a company called Simbol Materials. We had a pilot planned, both at CalEnergy and at EnergySource's facilities. We've actually run a technology through the brines. We've produced lithium carbonate and lithium hydroxide from the geothermal brine, albeit on a one-thousandth scale, so let's understand what scale we're talking about.

The biggest challenge, actually mentioned by Eric, is taking it from this scale and going to the next step. He's right, it's $60 million to $100 million to build a one-tenth scale. It's $300 million or thereabouts to build a fully commercial plant. The tendency is to say we'll skip that step because it's not economically viable to run at one-tenth scale. But that is a trough of technology that is very hard to step over. And that's the barrier here, not the actual technology because I've proven the technology.

The company I was with before, the

company I'm with now, we'd really love to go that next step. It's hard. It's hard to raise that $300 million, even with the technology that would be absolutely at the bottom end of the cost of production scale.

COMMISSIONER HOCHSCHILD: That's actual very --

MR. HARRISON: It's new technology.

COMMISSIONER HOCHSCHILD: -- that's very helpful information. I mean, just to -- so I'm understanding what you're saying, you were successful in --

MR. HARRISON: Absolutely.

COMMISSIONER HOCHSCHILD: -- doing this. It was really a financing challenge to raise the money to get --

MR. HARRISON: Yeah. And there were all sorts of management mistakes at certain points. But the reality is the technology exists. The difficulty is raising the money to get to the next step.

COMMISSIONER HOCHSCHILD: Can I just ask you and others here one more question, which is let's assume with your technology at it was, you were able to get that money and get to scale, how

were you -- what would you estimate the production cost of lithium extraction using that in the Salton Sea versus, you know, the competition in Chile or elsewhere?

MR. HARRISON: So --

COMMISSIONER HOCHSCHILD: I mean, what's the delta?

MR. HARRISON: -- so we would actually be below South America in terms of --

COMMISSIONER HOCHSCHILD: You could beat Chile's costs?

MR. HARRISON: Yeah. Between --

COMMISSIONER HOCHSCHILD: Wow.

MR. HARRISON: -- between $1,500 and $2,500 per ton, the cost of production, from a single geothermal plant source. So that's a 50 megawatt plant producing about 15,000 to 17,000 tons of lithium carbonate, which is the main commodity.

COMMISSIONER HOCHSCHILD: Okay. That's helpful. Thank you.

MR. WEISGALL: And I a related issue, David, and this is less on the technology side than the finance side but it's an important point, we put out and RFP for companies to come

on in. Who wants to do minerals extraction? And you would think the big companies would have come in because they can sense what the economics are. And the answer was California is not on the scale. We're not. They're not on the map. It's Chile. It's Argentina. It's Australia. It's China. Where are you California? Someone has to prove up that technology before we're going to come in.

So that's where a company like ours, where we -- we're a big company. We could not attract any large lithium company to come in because the technology has to be proven, which is why you can't do it with a $2 million pilot lab. Someone's got to put the money in to build the demonstration plant that then can be scaled up and --

MR. KENNEDY: I'd put it back on you a bit to ask, you know, Berkshire Hathaway has $1 billion. It has a few of those. It looks like a 25 percent gross margin opportunity to me. I know there's some risk in it but you guys take billion dollar bets on 25 percent gross margin opportunities all day long at that risk profile and worse.

You know, Eric pointed it out, this should be attracting big end-of-town (phonetic) bucks all day long. Why is Warren sitting on his dollars? What have you not done to convince him?

MR. BESSELING: I've had to answer this question many times over the last year. And the short answer is that's no longer our expertise. We're no longer in that business as far as being that entrepreneurial spirit to pursue something that's not a big, fat utility or a somewhat straightforward power gen. It really just is no longer our DNA, it's that simple.

Our focus, our organization focuses on large-scale acquisitions. We have a lot of money to place. And we're looking for more of a stay in the utility space, it's just that simple. So my mandate has been given from my senior management to go monetize it with someone else's money, so to speak.

MR. WEISGALL: Indeed, you saw that revenue stream, $900 million a year. We were looking at just a modest royalty. Let someone else go make that money. We don't do minerals. And when we tried back in 2001 with zinc, we didn't do very well. As my CEO said, we make

electrons. That's what we're good at.

MR. BESSELING: The one caveat of what we've been given, as well, to monetize that is bring in somebody that has the wherewithal to be successful. We don't want a failure on our site.

So part of the challenge we've had as we go through this, there's tons of people that want to throw ideas at you and want to say give me your brine, we'll play with it. But, no, we want to find the right person that's got the wherewithal and wants to put some skin in the game and some earnest money to prove it up.

MS. WALL: And if I can add just one more comment? So coming from the finance community and being kind of an intermediator with investors, it really is this lack of risk. Investors do not want technology risk. We don't like it. These are mining investors who have very old-school technology, a very old school way of looking at these markets. Chemical investors are just as bad. And in that realm, they don't want to touch technology risks.

So the more that a technology can be proven and shown to actually produce the lithium carbonate at the quality level that they -- that

you're asking for, that is really kind of the crux at which we need to have that, you know, demo in place. That one-tenth scale is critical to show that that's actually a reasonable sized project. And at that point, then the market really opens up in terms of using either, you know, your equity investment, whether it's private equity, or starting to get into true project finance and moving into the debt side of the market, obviously, once you have some work on the ground.

I do have to disclose, I am an advisor to MGX Minerals. I have been in this space for years and have looked various technologies. But that is one of the reasons that we're here today is that, you know, MGX and other technology players have really come so close to really getting these technologies. They just haven't moved over. They have pilots in place but it hasn't been done, clearly, on the brine itself. Once that is done, then that opportunity is really available.

COMMISSIONER HOCHSCHILD: One more -- so the gentleman from Simbol Materials, what's your name?

MR. HARRISON: Steven Harrison.

COMMISSIONER HOCHSCHILD: Steve, why don't you come up and join? Take that card down. Actually, you should be at the table for this.

One question for you, Steve, of just -- I mean, she mentioned the quality of the lithium. Could you just speak to that? Were there any issues with what you were able to produce there on a pilot scale about the purity that were -- was it potentially a problem?

MR. HARRISON: With the right chemistry, no, it's not a problem. It is a challenging thing to make and it will be a challenging thing on a commercial scale to maintain purity. But the chemical steps are well known for the most part and are achievable from the geothermal side.

COMMISSIONER HOCHSCHILD: Okay. That's helpful. Thank you.

MR. GENTRY: All right.

MR. KENNEDY: I think I'm getting to your second question, I'm sorry if I'm jumping around, but we're talking about the economics and does it make sense.

MR. GENTRY: Yeah. I think we've already gotten -- started going into this next question.

MR. KENNEDY: Well, now I've actually got one for you, given that you know the world market.

I saw recent media, and that's in Australia where you were recently, probably because of your visit, $200 million of bank debt was unloaded on half a dozen or five Western Australian mining companies to scale their lithium production. Is that because that's known technology? I mean, a bank at that scale, you're looking for $100 million to build a whole new industry in California where risk capital is plenty and abundant. Why is it that they can do it in W.A. and not here?

MR. GOLDIE-SCOT: I think it would depend on the project, rather than just see (indiscernible). You know, it would depend on the stage of development and, basically, how proven the technique and how proven the site is. But I think, naturally, the state, the broader environment is helpful there in terms of sort of a do they believe that support? Do they believe there will be demand for that product over the coming years? So it's just another way of how they think, how those lenders think about risk

and allocating risk amongst the companies.

MR. HARRISON: May I?

COMMISSIONER HOCHSCHILD: Yeah. Go ahead.

MR. HARRISON: That technology is --

COURT REPORTER: A little closer to the mike please.

MR. HARRISON: That technology is 40, 50 years old. Technology to extract from geothermal brine is ten years old, maybe a little older. That's the challenge, not the technology itself. It's the fact that it's a little -- a lot more risky to take a new technology and scale that up than it is to take an old technology and apply it in a new place.

MR. GENTRY: All right. Thanks. Okay. I think we've covered question two already.

So in the interest of time, we'll move on to question three, if that's okay with you, Commissioner?

COMMISSIONER HOCHSCHILD: Yes.

MR. GENTRY: All right. So question three is: What are the physical and economic challenges in bringing California-sourced lithium through the processing stage and ultimately to

end users?

And anybody who would like to jump in, feel free.

MR. GOLDIE-SCOT: Maybe I'll kick off that. And I think the key thing to consider is, is it's not just around like the final end product in terms of sort of a vehicle here. I think there probably needs to be more of a discussion around this table around, so, where are the batteries that are being sort of put in today's electric vehicles instead of being manufactured sort of closer to home? Where are those batteries being made, sort of the cells being made? And what are the components that are going into that being made, as well?

I think it's all well and good to -- and ultimately that big end source of demand is really helpful, but there are a few steps in between sort of the lithium and the car that you'd want to consider as part of any sort of pipeline and part of any plan.

COMMISSIONER HOCHSCHILD: Yeah. One thought, this is just brainstorming here and I'm kind of leaping to the second part of the discussion a bit, but in terms of what might

incent the necessary investment to get several hundred million dollars at the table. Every one of these 12 EV manufacturers in California has received state money in some form. We've granted to most of them. They get, obviously, the benefit of the customer rebates, et cetera.

And I'm just wondering if there, you know, would it make sense to try to assemble some commitment of these manufacturers if certain price points and quality metrics are met to procure from a facility, right, so that you could actually deliver a customer list, you know, that, you know, might give assurance too?

And I'm just thinking out loud here. I'm curious if folks have thoughts on that or maybe that's another approach?

MR. GOLDIE-SCOT: Well, I think other places are certainly trying. There are different ways that you could sort of encourage that commitment.

In Europe, for instance, we had someone from the European Commission speaking around their -- and a European investment bank speaking around their support for Northvolt, sort of a European battery manufacturer. One of the ways

in which they would -- were trying to create the conditions for that to succeed will be around lifecycle emissions and actually applying that across vehicles sold or across batteries used in vehicles sold in those countries.

And so I think that a really interesting approach because -- and it's something you're seeing elsewhere in terms of not necessarily local content requirements but what is unique around specific sort of facilities and characteristics and how do you encourage or mandate organizations to pay attention to that?

MR. BESSELING: If I can just comment on that? My past experience this past year on that, I think it wouldn't so much influence the investors, I don't think, because again, it's that technology, not that they're really concerned about

But I think you might change the dynamic of the larger-scale producers that say, oh, you're actually earmarking this market to source its lithium from North American-based, not from Chile where they're currently operating, to make them take a second look at developing some resources locally. I think that's -- because

I've reached out and have had long-drawn discussions with some of the major players and the conversation goes a little bit more of just curiosity. But when you get to the real kind of proceeding to do something with it, they all kind of shy away. And I really think they have enough resources that they have enough to work with in Chile and they have their own economics working for them, so they really don't have an incentive to branch out and take risk in other regions. They've got enough to play with.

So something like that which is going to almost create a demand locally and forcing it to stay locally to some degree might change their way of looking at that.

MR. WEISGALL: And I would add to that that there is a national aspect to this and this is something where I think, Josh, I understand your point about DOE funding now. I think one can make a very good argument to Secretary Perry and this administration when you think about their priorities that having a domestic supply of something this important going forward is very much in the U.S. national interest.

So in terms of assembling, Commissioner,

funding, because this is, look, this is right in the wheelhouse of what government does, is provide some of that funding to make something commercial, I could see a role for the state. But I can make a very argument to at the federal level, as well, for that very reason. I mean, it's an essential commodity going forward.

MR. HARRISON: There is a lot of advantages to having production in the U.S.

COURT REPORTER: A little closer to the mike please.

MR. HARRISON: Certainly. There's a lot of advantages to have production in the U.S. Security of supply is important. Even to companies in Japan in Korea, the U.S. is a much more stable area than Chile and Argentina in terms of supplying lithium.

So there is a reasonable argument for saying we have a huge advantage here. We have a great resource, it's just not been tapped.

MR. BOWLES: The advantage I want to ask about is the point that you made, Eric, in the middle of the end of your presentation about the purity of the lithium and whether the end user and the customer that has the electric vehicle or

the storage battery, whether there is a market demand to having pure lithium in its, you know, best form for the longer charge, everything like that, for kind of what you said is here.

MR. GENTRY: Go ahead.

MR. HARRISON: I can answer the question. Before being with Simbol, I actually worked for a company in Canada that made very, very high purity lithium carbonate. The quality grade is 99.5 to 99.9. This was five-ninths (phonetic) pure. That is a very niche market for that product. But the people who make the cathodes, which is where most of the lithium goes, they're not that interested in anything beyond the 99.5 to 99.9. The reason for that is the purity of the cobalt, the nickel. They'll reach those levels of purity, so they can't really use the advantage. And to make those other materials very pure is not technically impossible but is very expensive.

MR. GENTRY: Go ahead David.

MR. GINLEY: So maybe two quick comments.

One, 40 years of experience in photovoltaics has taught me that people are totally agnostic to the technology. All they

care about is how expensive the electrons are; right? It sits on their roof. They don't even know what's up there.

And in a way, lithium batteries are the same now; right? You don't know who makes it. You don't know what their performance level is. All you care about is the cost per range; right?

And so I think I can see lithium batteries evolving the same way. And that's why it's really hard to convince vehicle manufacturers to sign up for a contract because two years later the battery might be appreciably cheaper from their viewpoint. And as long as the form factor is the same it doesn't matter.

But what has seemed to work for getting technologies like this over sort of the valley of death, which is kind of what we're talking about, has been the development of the right kind of consortium that brings together the right kind of expertise. And I think one of the problems here is that lithium extraction and processing involves mining geothermal, chemical and petroleum engineering kind of people, geophysics, the whole gamut that isn't normally together. And so you might succeed very well on the

separation technology but not get the other parts right.

And so somehow to integrate that, I can see why that's very difficult for somebody like Berkshire to do; right? So maybe there's an opportunity for California to put a team together that actually looks at this with the right constituents.

MR. WEISGALL: And BHG would welcome that kind of consortium, no question. I mean, we don't have that expertise. What do we have? We've got the resource. Danny, you're right, we have the resources, certainly financial. We don't have the technology. And we do have the time because we do have a very patient, you know, CEO. This is not a two-year -- this is not a one-year process or two year. This is -- we're talking about a five-year process. You know, we can do that.

And that's what I want to see come out of today, actually, is sort of moving forward to we will need some sort of consortium. And it's not just us. There are other companies in Imperial, as well.

MS. WALL: Well, I have one more

question, actually, for Logan.

So I know that NREL had put out a study a couple years ago on actually the supply chain story within battery manufacturing. And your slide in particular to the different chemistries of batteries, to me, struck a chord because to me that indicates that no matter where your supply is, you still have to potentially ship this elsewhere to wherever the cell manufacturing site is to have this and put into a cell that is then shipped back to wherever you're putting your car into place.

So, to me, it seems like there might be a story here in which it's encouraging integrated manufacturing process that can do this within here, in California. I don't happen to know what these vehicle manufacturers are doing or what that looks like since that 2015 report. But it also kind of, to me, it indicates, because these chemistries are different, there's also a huge risk in putting up the investment money to build a plant that integrates things if chemistries in the cars of the future are going to change.

So I'd really like your comments and thoughts on that.

MR. GOLDIE-SCOT: Sure. Thank you. And I think that speaks to the point earlier on needing to understand sort of those steps between sort of the raw material and the vehicle. And at that moment, you're completely right, lithium travels a long way around the world, potentially a few times before -- well, from where it's initially sort of found to where it's ultimately used.

You do have -- Tesla has been very, very cool on its desire for more integrated operations, everything from it as sort of an early resource, actually all the way through to recycling and sort of processing that back in. So I think companies are certainly thinking about this.

At the moment, you also see in Chile, for instance, the Chilean government is trying to encourage more sort of cathode production, so sort of bringing not just any raw materials in Chile but trying to bring in that sort of component step. And it's the same conversation in Western Australia. And so you have everyone from either -- you have encroachment from either side towards sort of greater integration.

And ultimately, we think there is a strong use case for manufacturing facilities near the ultimate source of demand. You see this in general with automotive, for instance. You see it with cell manufacturing now where, as I mentioned in my talk, Chinese and Korean manufacturers are setting up shop in Germany and Poland and Hungary to do that, and that's at the cell level. So ultimately, if there's a resource availability, you'd see greater integration.

But I think, yeah, understanding that full integration is going to be absolutely key to ultimate success here.

MR. BESSELING: Just to temper that a little bit, though, as far as really just talking about shipping costs basically, and this is no quality issues, but we're really talking about, for a Tesla battery, about 1,000 kilogram battery, it's only 63 grams of lithium. So it's not a huge component on a weight shipping basis. So I don't think -- there's sort of some benefit to that. I don't think it's huge.

MR. WEISGALL: I was going to make a similar point by contrasting to wind where 20 percent of the cost of a wind turbine is

transportation. So you see a company like Vestas building a factory in Iowa because there's so much wind being deployed in Iowa. It's, really, it's the weight and the transportation.

So I just would sound a cautionary note there. It would be marvelous to see that. It would be great for Imperial County. But I think, really, the bottom line is what's the weight and what's the transportation cost? Probably not as attractive as we might think.

MR. KENNEDY: I'm catching up here. What Logan said earlier is the way the Europeans got around this is saying the lifecycle emissions of the car, which when you go back to how much the lithium has been run around the world, leads to an incentive to put the lithium cell production closer to the car supply chain; is that correct? It's a trick to get around local car tables.

MR. GOLDIE-SCOT: So I won't comment on that but it's -- I'd also say this is sort of under discussion. It's not something that's being put in place but I think you will see more -- or is increasingly coming up in conversations. The lifecycle emissions, yeah, from the raw material all the way through to

recycling or second life is going to be a criterion.

MR. GENTRY: Okay. I think we already got into question four, but I'll read over that and see if there's any more comments on that.

Is there an opportunity to localize processing treatment and end users -- end uses?

Does anyone else have anything else to say on that? We kind of touched on that.

MR. HARRISON: I think getting the lithium and probably the manganese, as well, from the brine would be a motive to make that happen. Rather than put something in there to help drive the lithium being produced, you can get the lithium and the manganese from the brine which are elements of the battery and the chemistry anyway, it will drive the cells to be produced more locally rather than the other way around.

MR. GENTRY: Okay. Let's -- did somebody else have something to say? Okay.

Let's move on to question five. What are the negative and positive impacts associated with lithium recovery from geothermal brine and related activities that should be considered?

Anybody, feel free to jump in.

COMMISSIONER HOCHSCHILD: Can I just ask a basic question? And maybe, Steven, this is for you or anyone else who's done this. But just can you walk us through the actual process of lithium recovery from brine? What is involved? What materials? How much -- how energy intensive is it? You know, how long does it take?

MR. HARRISON: Okay. There's some reservations about certain secrets but, yes.

The thing that's --

COURT REPORTER: I'm sorry. Please speak closer to the mike.

MR. HARRISON: Yeah. Sure. The thing that's most challenging about the geothermal brine is actually the presence of silica in it which will affect to a greater or lesser extent depending on the technology, how easy it is to remove lithium. That was a technology we developed and proved. Getting the lithium out of the brine after that, the technology that we use and other people know about is such that it's just perfect for this brine. It wants to be used at a high temperature at high salinity and it forces the lithium into the --

COMMISSIONER HOCHSCHILD: What is the

optimal temperature at which it works?

MR. HARRISON: Ninety-five degrees is the answer. That's where we operated, and that's in Celsius and not Fahrenheit. So about 200 degrees. Brine comes from the geothermal plant at 220. The silica management processes bring it down 22 degrees, so it's a pretty optimal place to be.

The beauty of the technology is to get the lithium from (indiscernible) we use to extract the lithium, all you need is water. So there's a need for water. Imperial Valley is actually quite well served. Even though it's in the middle of the desert, it gets a lot of water from the Colorado River via irrigation. Thank you. And from there, it's actually very traditional chemistry to take the lithium, concentrate it, take out the impurities which aren't that great, to get it to a battery-grade level.

We had a special technology that we developed which is a lot like making caustic soda and chlorine, and we used that technology. But there are others to do the conversion to carbonate. We wanted to make lithium hydroxide

preferentially because that market is growing more than any of the others at the moment. It's very, very basic processing chemistries that are used elsewhere. It does use a fair amount of energy. Making lithium carbonate, that way actually sucks CO2 out of the atmosphere because when you make lithium hydroxide, you make lithium carbonate. So you end up being CO2 neutral as a process.

MR. GENTRY: Okay. Thank you.

Does anyone have any -- anyone else on the panel have any comments for this? Okay.

Go ahead, David.

MR. GINLEY: I have just a question out of ignorance.

So as you extract lithium and minerals and then recycle the water, are there any long-term geologic or geophysical implications to that?

I know that people have looked, for example, when you talked about CO2 sequestration, that there are some mineral consequences in some environments. I don't know the geothermal environment, the down-hole environment well enough to know that if you keep extracting

lithium, do you change equilibria that actually create problems down the line or does it actually get better? I don't know.

MR. BESSELING: Yeah. We've done some really high-level reservoir analysis on that. And based on the volume and the size of the reservoir, a really simple analysis. We look at the worst case scenario is one percent degradation per year is the worst case scenario. We don't expect it to be nearly that bad but that was the worst case for a conservative estimate.

MR. HARRISON: Eric, that's one percent degradation of the lithium content, isn't it?

MR. BESSELING: Correct, of the concentration, so 220,000 parts per million.

MR. HARRISON: Okay. So that's 250 parts per million in 38 percent of salts. It's minimal.

MR. BESSELING: It is minuscule. Yeah.

MS. WALL: And just from just a geothermal perspective, the only thing that I've heard --

COURT REPORTER: Go closer to the mike please.

MS. WALL: I'm very good at being too far

away.

The only thing that I've heard that might potentially be an issue is temperature change. So the more that the fluid itself is dropped in temperature to increase extraction efficiency, again, this is a hypothetical, there's a potential that the return brine might, at a lower temperature, might affect temperature recharge. But that, again, that would have to be significant, you know, temperature drops to affect the resource in the long term. And I'm sure BHE has some very good numbers to --

MR. BESSELING: Yeah. (Indiscernible) look at that closely and there's no real concern there. There's no -- there's not much communication between our injection wells and our withdrawal wells. There's lots of time for that to regenerate the heat before it gets back to withdrawal, so we're not concerned whatsoever with that.

COMMISSIONER HOCHSCHILD: And then just one more question for Eric or Logan maybe. Just I'm assuming, and please correct me if I'm wrong, that these other areas of the world where we're recovering lithium are from mining, not brine?

Because I mean, that process is similar to copper of molybdenum or are you just -- are you going after a C (phonetic)? I don't even know. Is it in terms of the formation that's in --

MR. BESSELING: I'm not a real expert on this but I understand it's recovered from the spodumene. It's a hard rock form. Basically, a lot of it is crushed in Australia and brought to China in rock form, so there's a lot of waste of freight, of moving all the rock to China and then taking two percent of it and discarding all that rock.

COMMISSIONER HOCHSCHILD: They're literally shipping the rock, the spodumene?

MR. HARRISON: Not exactly. In Australia, they take something that's one percent lithium and take it to about six percent lithium, and then they're shipping that to China. But hard rock mining is very -- a lot less friendly to mining lithium from geothermal brine to the environment than even taking the brine lithium from salt mines.

COMMISSIONER HOCHSCHILD: So I mean, just what I'm hearing, this is just a point to note here, it does seem pretty clear that this the

most environmentally benign way to recover lithium.

MR. BESSELING: Especially when you factor in the actual power need, which is not small. For this process that Steven was speaking of, I've been given estimates for our 90,000 metric tons, it would take in order of magnitude of 100 megawatts, one-third of the power gen, to support the extraction of the lithium, but it's all green energy, as well. So, yeah, if you use inside-the-fence power gen from the geothermal, you've got a very green source of lithium for sure.

MR. HARRISON: I agree with you, I submit.

MR. KENNEDY: And just so I'm clear, with continental brines, the Chilean, et cetera, the footprint here is like one-one-thousandth or better ratio; right? Your land use requirement is much less?

MR. HARRISON: It's about the same size as a geothermal power plant, which isn't very big.

MR. BESSELING: For our sites, yeah, for the lithium extraction, about the same. I've

been given estimates, people have said we've earmarked land, site access of land use, for about 40 acres per site. Our sites for similar of one-size plants is about 20 acres, so it's almost twice as much. But it's still a relatively small footprint.

MR. KENNEDY: Whereas, the evaporation ponds in South America are thousands of acres.

MR. BESSELING: I don't have the numbers for that and I wouldn't, couldn't comment.

MR. HARRISON: About 20 for fields --

MR. BESSELING: Okay.

MR. HARRISON: -- roughly.

MS. WALL: It's approximately 23,000 acres for a single evaporation pond.

COURT REPORTER: I'm sorry. The mike?

MS. WALL: I'm sorry. I'll try to get better.

It's about approximately 23,000 acres for a single evaporation pond for typical lithium process. And generally, you might have multiple ponds on a given land.

MR. GENTRY: Okay. Commissioner, it's now three o'clock. Would you like to move to public comments?

COMMISSIONER HOCHSCHILD: Yeah. Let's go ahead and take public comment, if there's anyone in the room who'd like to --

MS. BARKALOW: Hello. If anybody has public comments, you can fill out a blue card and I will come over and bring the mike to you. And we can also check to see if there's any questions on WebEx. No.

COMMISSIONER HOCHSCHILD: There was someone, I believe, from Tesla that was going to be on the phone. I'm not sure if they're with us, if they'd like to speak to this.

MS. BARKALOW: We could check to see if there's anyone on the phone lines.

COMMISSIONER HOCHSCHILD: Yeah. I was told someone from Tesla would be --

MS. BARKALOW: Okay.

COMMISSIONER HOCHSCHILD: -- calling in but I'm not --

MS. BARKALOW: So we will --

COMMISSIONER HOCHSCHILD: -- sure if that is --

MS. BARKALOW: -- open up the phone lines. For those of you that are listening in, please mute yourselves unless you have a question

you would like to ask. Thank you.

MR. AMINZADEH: I would like to comment. Can you hear me?

COMMISSIONER HOCHSCHILD: Yes, we can hear you. Go ahead. Can you introduce yourself first please?

MR. AMINZADEH: Pardon? This is Fred Aminzadeh from University of Southern California. And an earlier question was about how different techniques can see very subtle changes in the lithium production. And (indiscernible) the changes are so subtle that a known single technique can be used to see these changes. However, somehow you can use different measurements, such as geochemical, geomechanical and geophysical. Then a combination of those things potentially can see some subtle changes before and after lithium production.

So that's one thing I was trying to comment on, that we need integration of different materials to observe these changes.

MS. BARKALOW: Thank you, sir, for your comment. Would you please repeat your name and organization?

MR. AMINZADEH: This is Fred Aminzadeh.

And I am from University of Southern California Center for Geothermal Studies.

COMMISSIONER HOCHSCHILD: Great.

MS. BARKALOW: Thank you.

COMMISSIONER HOCHSCHILD: Thank you for joining.

Any other questions or comments from folks on the phone or in the room?

MR. RIDER: Yeah. I had a question.

COMMISSIONER HOCHSCHILD: Yeah. Go ahead.

MR. RIDER: Yeah. Ken Rider, Chief Staff to Commissioner Hochschild.

A question, because in your presentation you had, you know, the possibility of expanding geothermal energy production and making it competitive using, potentially, the kind of marriage of the extraction. At the same time, I'm kind of hearing that we're already producing -- like the brine that is already being extracted is quite a fair amount of lithium potential already.

So can you describe the opportunity a little more? Because if like we're already extracting a lot, you know, when would it be or

how would it be that it would unfold the -- can you expand on the expansion prospects for additional generation?

MR. BESSELING: Yeah. So let me just revisit the numbers that I presented earlier.

The -- so right now we currently produce 350, roughly, megawatts per hour. With that production of brine, we move roughly 50-odd-thousand gallons per minute of brine with the 300 -- 250 parts per million of lithium. So that could produce 90,000 metric tons per year. That's a good chunk of lithium in the world market. But we could expand to where we have a bunch of resources that we're not using today that could generate another 700 megawatts if the economics provided for that. That's the extra 200,000 metric tons of lithium production. So in total, our current resources that BHE controls, we have the capability of going as high as 300,000 metric tons. Our existing operations could only do 90.

And where I'm looking for that additional 200 megawatts -- sorry, 200,000 metric tons of lithium production for the future, I'm hoping that will support the marriage of power gen to

bring the economics down overall.

MR. WEISGALL: And again, just to clarify the market, today the world market is about 300,000 metric tons. We can produce today 90,000 metric tons. So we can supply fully just about one-third of the world demand. If we were to ramp up we could actually get to 100 percent of the world demand but, of course, that's going to grow. But it's a pretty big number.

MR. BESSELING: I should also just clarify so it doesn't get lost, that's why CalEnergy's resource, I'd say that they're in the order of magnitude of double that for the entire region. So there's what, 600,000 metric tons of total lithium production which is almost the entire growth from 2025 to 2030.

MR. SOKOL: This is Mike Sokol with the Energy Commission.

So sort of just trying to connect some of the dots here on what we've heard, that there's -- the technology risk is one of the big inhibiting factors from the investment funding coming in. And I'm wondering if, kind of taking that a step further and defining what is the sort of successful demonstration project look like?

We heard technology readiness levels referenced but is there a specific threshold that when we cross that threshold, then that's when the investment money will comment in?

MS. WALL: If I can answer that?

In the sense of what we look at for project financial, for readiness for taking a deal to market, is the terminology that's used in investment banking, is really having a plant that has been a one-to-ten scale or at least a sufficient scale that is on the ground using the exact brine or same type of supply chemistry or similar enough to the site that you're trying to extract from. Obviously, the closer the better. The closest that it's onsite the better the likelihood your deal is going to go through.

Once that is on the ground and shows data, so it can't just be in the process of being constructed or have its permits in the way of going, it needs to actually be running and show real data, and once that brine is actually -- or the plant is showing that there is actual lithium carbonate coming out, then that is really where you would have to say that's a proven technology.

Now, obviously, you have pilot scales

which can be used, you know, and tested. But to say that that's a commercial-scale demonstration is really that goal of seeing the product.

MR. KENNEDY: But how long do you need that to be backed?

MS. WALL: Well, I mean, I would have to say it depends upon the specific investor, and also the user at the other end. So part of the project finance package or the investor package is having -- it's not just having the plant itself, it's also saying do you have a supply agreement? Have you talked to customers? What do they need? What is the -- you know, and so really matching their needs in terms of that timeframe. And the quality is a factor, as well.

So I can't technically put a number on that but certainly it's having that conversation with your end user and at least having some type of agreement that is a possibility to have a (indiscernible) makes a difference.

MR. HARRISON: I'd like to add a little bit to that.

I think it takes six to nine months of actual operation of a plant. Because you not only have to do -- produce the lithium carbonate,

you have to actually go and qualify. And it takes two years, maybe not quite that long in China, but certainly in Japan and Korea it takes up to 18 months to qualify. If you produce from your demonstration plant, you're cutting that down enormously. You still will have another qualification period but it's a lot shorter because you're using exactly the same technology.

MR. WEISGALL: And building on your very good point about having the customers and the supply -- and the contracts with customers, I think it's safe to say that Tesla currently uses at least 35,000 tons per year of lithium. So again, compare, you know, with the 90,000 that's there at least, there's one built-in customer right there which has expressed interest in this.

MR. BESSELING: Yeah. Our experience this past year going through this RFP process, we've heard from a lot of end users. And there's more than abundance of interest there that are talking three- to five-year long-term contracts. In the commodity business, that's long.

So there's a real interest in North American-based brine. So I don't think that the market size is really a concern. I really think

they'll -- you build it, they will definitely come. I'm convinced of it from what I've -- just the conversations I've had this past year. But it's just you still take that -- it's really more the technologies. You do have -- any of these battery purchasers, the end users, like Steven just mentioned, they do take a substantial amount of time to qualify that lithium for their battery. They're very sensitive and very, very particular about the lithium they design around, if you will, so they got to give them time.

And it takes us a couple of years to build a demonstration plant. This is not something that -- at least this is what they're telling me. Others may say shorter, but the estimates, the ballpark estimates I'm getting and receiving is two years to build a demonstration plant, so there's time just to build it.

MR. HARRISON: It's not different to a commercial plant, just a smaller scale.

MR. BOWLES: So it sounds like a cat and dog relationship with the utility itself and then the lab, as you described, was Simbol in the past.

I know that you had mentioned the entity

to the far north on that map that was in that little red square. I just curious, have there been any entities who have married these two processes together and have they been successful in, you know, the Aussie firm that was described in doing that already?

MR. HARRISON: I'm not sure I'm catching your question. The Simbol technology was demonstrated, again, one-one-thousandth scale at both CalEnergy's and EnergySource's site on real brine running continuously 24/7 for, I think, over three years of actual operation, not absolutely everything but over three years of operation.

MR. KENNEDY: Can I just sort of ask a question? And I'm going to ask Steven not to answer because I think he's got an opinion, having gone through this.

Is one demo plant going to crack the nut? I mean, maybe this is really for David. It's like, you know -- or Susanna. You're saying with one demo plant at $100 million, one-tenth the scale, we'd run that for six to nine months, we'd prove it out and we answer the remaining technical questions about this particular kind of

brine at these temperatures. But do we still need to run ten parallel science experiments for two years to get to that solution?

MR. GINLEY: So there's two answers to your question.

As long as the chemistries are fairly similar, one plant is probably all you need. And, in fact, if you look at the Cad telluride solar cell example and what Versolar (phonetic) did, right, they made their first plant and then they cloned the bugger again and again without changing anything, and I think that works. If the chemistries are vastly different and what you pick as your separation technology doesn't work for that alternate chemistry, you're going to need a pilot plant for each chemistry.

And so part of this may be that you want to create, and I was going to make this comment earlier, you need to create a model for the separate technology and computational modeling for these things is so much better now than it used to be, that actually will allow you to adjust. And if those models are robust enough you may not have to build multiple pilot plants. You may just be able to clone them.

MS. VENTURA: I think, you know, it's very important to know what is the composition of the brine. And depending upon the composition of the brine the pretreatment will change. So you are dealing with an oilfield brine, obviously, you're going to have to remove the organics. You're dealing with a geothermal brine, you're going to have to remove the silica. So it depends a lot on, you know, the composition of a brine, pretreatment will change. And then your knowledge about your absorbent, what works and what doesn't work?

So I -- so conditions are just slightly changed but I don't anticipate major problems going from one system to the other, except the (indiscernible) brine at the high temperature, actually. That's the feature, the unique feature, the high temperature and corrosion of the typical geothermal fluid.

MR. BESSELING: On that, just a further question, would you expect a variation just across the field of the Salton Sea or would you consider all of the Salton Sea somewhat uniform enough to do one?

MR. HARRISON: I think it's probably

uniform enough.

MR. BESSELING: That's what I would have thought too.

So to answer your question, as far as we're talking about the opportunity in the Salton Sea, one demonstration plant should do it, I would suggest.

MR. HARRISON: I think the comment that was made earlier is important, though. If the chemistry, the extraction chemistry was very, very different --

MR. BESSELING: Fair point.

MR. HARRISON: -- then you might need --

MR. BESSELING: Definitely.

MR. HARRISON: -- to change that unit out. But most of the rest of the chemistry is still going to stay the same, so it would need one with maybe interchangeable parts.

MR. BESSELING: It would, to the extent that you're planning different technologies, then I've got to believe that you'd have different demonstration plants for the different technologies. But I'm saying if you are zeroed in on one technology, you should be able to apply that one.

And also from what I've heard with -- am I okay speaking? Okay.

The other thing that I've heard from, again, the developers that did pursue this to a certain level, it really comes down to a financing and a confidence level, to the extent the financiers are saying you process hot brine for six months, that's enough evidence that this is going to be successful, you work out the rest of the bugs when you go the commercial plant. So it really gets into a confidence level. And I'm hearing over and over again, one plant will satisfy that need.

MS. WALL: And I'd just like to comment that it's really important to note here that there's no one specific technology that works. And so there are multiple technologies out there that are, honestly, near commercial. And that's just from my knowledge of the market is, you know, I'm not talking to MGX specifically, but given their state of -- you know, their pilot in produced water and having that successful for lithium recovery, there are other technologies that have other options than just sorbents.

So to the degree that Salton Sea

Authority or the Energy Commission is interested in piloting different technologies and really finding winners, I don't think this is necessarily a one solution fits everything. There's potentially multiple different technologies that can, you know, work here. And it's finding, I think the most important part, the lowest cost solution that will fit for the longest term. Because if you're putting on this amount of supply online, that is going to create the supply demand, you know, price feedback in the market. And the only projects that are going to survive long term are the ones that are lowest cost.

These supplies are going to come online and basically push out all of that hard rock supply that's online now at $5,000-plus per ton. And if you're not below those costs and you can -- to operate long term, you might as well not have bothered putting your money up in the first place. It's just not competitive to stay in business.

So I think it's really important that, if you have the opportunity to do this and do this and check the different technologies and find

your lowest cost provider, that will provide you kind of security in the market long term.

MS. DE JONG: We've reached the point on the agenda for a break, if it's okay with you, Commissioner?

So we're going to go ahead and take a break. We will reconvene the second panel at 3:30s. So thank you very much, everyone, for that first panel discussion.

(Off the record at 3:18 p.m.)

(On the record at 3:32 p.m.)

MS. DE JONG: Okay. I'm going to take just a quick moment to remind everyone, please speak directly into your microphones, both for the court reporter's sake, but also for the audience. We want to make sure that everyone is able to hear the discussions.

And so we're going to go ahead and dive right into the second panel. In this panel, we're going to be discussing the priorities for policy and financial support for the lithium recovery process and the appropriate role for the role of government.

So the first question is: What would an eco-industrial development model built around

this resource look like when done right? And what infrastructure is needed to support lithium recovery, processing and transport?

And just to make sure that everyone understands, what we mean by saying that eco-industrial development, we are looking for the holistic, closed-loop approach to development for the most environmentally-conscious plan considering from cradle to grave.

Anyone want to take the first lead on that?

MR. WILCOX: Well, I'll take a shot at it.

COURT REPORTER: Just a little closer to the mike.

MR. WILCOX: I'll take a shot at it and then others can.

One of the things that -- when we developed the Salton Sea Management Program, which has really developed from the Salton Sea Renewable Energy Initiative, which was an IID document, we needed to make sure that we didn't impact the ability to -- negatively impact the ability for geothermal or any other kind of renewable energy. And while lithium wasn't

contemplated at that point, it fits well into it.

So our charges and what I'd like to see us come up with is a plan, and we're working with some of the geothermal folks now, a plan on how best we can develop surface habitat in these areas and still allow them to develop, and even beyond that, how we can develop a permitting process through the state and federal agencies that would allow the people that are developing to just pay a fee, one fee for all of the mitigation necessary, and we would use that money toward Salton Sea restoration.

And finally, one of the interesting issues that you usually talk about, not much a footprint for the projects and that's usually a good thing, we'd love to see a large footprint on the playa from a dust control point of view. Use as much of it as you need.

MR. ROSENTRATER: Phil Rosentrater, Salton Sea Authority.

Yeah, I'd like to reiterate what Bruce Wilcox just said. The Salton Sea Authority has a Board of Directors. It's a joint powers authority comprised of two land use agencies, the County of Riverside and Imperial County, two

major water importing entities, Colorado River Water, that would be Imperial Irrigation District and Coachella Valley Water District, and then one of the major land owners, the Torres-Martinez Tribe. This is a governing body that is very concerned about the multitude of challenges, environmental challenges at the Salton Sea, at the same time looking at some of these wonderful assets we have in renewable energy, making sure we work in partnership and in consultation with the state on a plan that integrates these kinds of opportunities and these assets as part of a better solution, a more stable solution for a healthier, more prosperous sea.

We heard earlier Assemblyman Garcia mention a sound policy from the state's standpoint that -- where we embrace economic development opportunities in one of the most economically challenged areas in the state of California and at the same time, one of the most environmentally challenged areas, that's good policy.

The Salton Sea Authority Board of Directors has adopted guiding principles that call for any investment of public monies in this

area should be done in a way, in a manner that creates multiple benefits, maximum ROI. And I think we're looking at an opportunity here that fits that criteria rather well.

You know, a policy where we, at the state, local and even the federal level, where we prioritize those areas where the -- and we do the integrated work up front to make sure wherever we invest these monies we have -- we're addressing multiple challenges on a scale and a severity found nowhere else in the United States, by the way. If we can accomplish that at the Salton Sea at the local level in partnership with the state, we can then pivot to the federal government and enlist their assistance, as well, and have a much more sustainable ecosystem, a healthier, more prosperous Salton Sea. And that's, I think, what bodes well for any kind of industry and private sector folks who want to invest around the Salton Sea, as well.

MS. DE JONG: Go ahead, Andy;

MR. HORNE: Yeah. Thanks. You know, the opportunities there have been discussed as far as the potential of, you know, developing geothermal or continuing the geothermal operations and

enhancing it with this minerals extraction. And that's, of course, a very good combined use of the resources there.

Bruce made a mention of the playa and the dust control issues there. I've long advocated that, you know, that playa -- we have about 15,000 acres of solar projects now in operation in Imperial County. Most of that has displaced ag land. And we've got probably that much right now in the exposed playa that, at least theoretically, in my view, could be used for something like either a solar facility or we also have a group down there working on algae biofuel production. Exxon Mobil is involved in that. You know, if you think it's a small group, it's not. And they're spending a lot of money to look at that. So that's a possibility. And then you've got all these types of energy and renewable fuels and lithium that could be produced in that same place and help control dust and provide habitat.

And in case -- one of the other things that I noticed in the pictures that Eric showed earlier, there were a lot of green fields around those geothermal plants. And geothermal has

proven to be a compatible neighbor with our agricultural production down there which is still a bedrock of our economy. And we certainly think the lithium could -- or minerals extraction could -- should also be compatible. All of this, all of these operations are on agriculturally-zoned land in Imperial County.

And so -- and just in terms of compatibility, I don't know how many of you have ever been down there, but the U.S. Fish and Wildlife Service operates a national bird refuge right next door to the geothermal operations down there.

So I think there is a proven track record of compatibility and sustainability there that we can certainly expand on.

MS. DE JONG: Okay. So we'll go ahead and move on to the second question.

What do technology developers need at this stage?

MR. WEISGALL: I'll jump in here. At this stage and maybe in the next year or so as this gets going, first and foremost, and Commissioner Hochschild is the poster child for this, but California has got to be a cheerleader

for this issue.

COMMISSIONER HOCHSCHILD: You think I'm the poster child for a cheerleader?

(Laughter.)

MR. WEISGALL: Right. Right.

MR. GOLDIE-SCOT: Your mother would blush.

MR. WEISGALL: Your tag line of lithium is the new oil is pretty good, but it needs cheerleading. That's not dollars.

I think point two, though, is dollars. We've discussed it, but there's a need for some funding to prove up the technology and then get to the demonstration plant.

The third area, a little bit down the road but I think it's worth thinking about, California, as I'm thinking of attracting the mining companies and the producers, California has a reputation for being a tough place to do business. I could see tying into Salton Sea Authority with expedited permitting. I don't know what permitting is needed exactly but I can certainly see a tie-in there with Salton Sea Authority in terms of moving red tape quickly to get something done.

And I guess the fourth thing that came to mind listening this afternoon is, you know, Governor Brown has gone on a number of trade missions to China and elsewhere and taken California companies. I'm kind of thinking of a reverse trade mission where Governor Newsom invites companies to California to hear, as we move this down the road, again, this premature but I could see it in a year or two if this really moves forward, and says California, we're open for business.

Because in a way, this is really California versus Chile. If you looked at Eric's chart and where are the real proven resources, it's Chile. And, Steve, I would defer to you. I mean, certainly, there's some in Australia, but it's Chile and Argentina, and California is not on the map. And that's really, that is a job the state is ideal at. That's not -- there's a private sector role but this is perfect for the State of California.

So those are a couple of ideas.

COMMISSIONER HOCHSCHILD: I just want to build on that. I will say that this discussion has been really, really fruitful and illuminating

for me already, and I hope for all of you, as well. I have already heard enough to become persuaded that I think we need a formal entity to focus on this, and whether it's a California lithium initiative or a California lithium authority or something that is going to be driving, you know, doing the barrier busting needed to bring in the investment. Because what I'm hearing is it's clearly cleaner and more environmentally benign to harvest lithium this way, and potentially cheaper, as well.

And just, it's also approximate to what we anticipate is going to be a lot more demand for lithium, both for, you know, we've talked about transportation, but keep in mind, you know, the largest building in the world is now being built, and that's the Tesla Battery Factory in Sparks, Nevada. That's also going to need -- you know, so there's just a huge opportunity here.

And I do think, you know, the next step is sort of thinking about what's a sort of package of goals that a focused initiative, you know, would try to drill down on and, you know, what does that look like? That's kind of the question in my mind. And, you know, I'm just

thinking of -- and then maybe it's also doing these regular convenings with the key agencies.

But I would also point out, you know, I think we'll have, you know, a bunch of new members of congress coming in. And you know, this strikes me as there's -- you know, we should be looking for federal funding opportunities, as well, and I'd love to explore that.

But anyways, that's kind of where I'm at.

MS. DE JONG: Tre, did you have something?

MR. BOWLES: I was going to echo, yeah, the federal support. I know Congressman Ruiz has been very active in exploring this opportunity in that area. I've worked for him in a former capacity.

The second point, I wanted to ask -- I actually wanted to ask a question about permitting because Tyson knows I spend a lot of time thinking about permitting in my current position. You had mentioned on this example the Elmore facility that was 50 megawatts. What's the difference between permitting this and then one of the larger facilities and what are the headaches that exist in permitting on the local

level?

MR. WEISGALL: Well, one reason Elmore is at 49.9 megawatts is that geothermal plants up to 50 megawatts get permitted at the local level at Imperial County, so the permitting has not been difficult.

We did develop and have not built a larger geothermal plant. It was going to be 200-plus megawatts. And actually came here to the Energy Commission for that permitting, probably the first CEC permit for geothermal, Randy, I want to say 20 years or something, yeah, probably in 20 years. And you know, it took a little while but there was a very, really, high level of professionalism here and it went very well, so just on the geothermal side. Now that's for electricity.

Now geothermal for -- you know, geothermal -- and if we would be building more geothermal for minerals extraction, that's a different process. I don't think there's any -- it would be a new template. And, of course, this is all -- this would all be, you know, a new slate. But I would have to say that to the extent the Energy Commission has been involved in

permitting earlier geothermal plants, the big one, it was certainly a pretty positive experience. But again, probably, I want to say, a good two-year process which is a pretty long time for permitting.

COURT REPORTER: Please use your microphone.

MR. HORNE: Yeah. I got it. Thank you for the reminder.

The county has what they call a geothermal overlay over all of this land that's in the Salton Sea KGRA. There's known geothermal resource areas in the county, as well as the other KGRAs in the county which allows geothermal development and mineral extraction with a conditional use permit. And those conditional use permits can be applied for and obtained at the local -- through the county. We do everything there. We've got Planning and Development Services, basically a one-stop shop. You go in there. They pull the other agencies, the county and the state and the federal government together that need to be involved because there are, you know, wildlife issues and so forth that are not on the county's purview.

But we pull everybody together and do the permitting through our facilities.

In 2015, I think, we adopted or approved the Renewable Energy and Transmission Overlay. It was an update to the General Plan for our county. We're one of the few counties in California that has a renewable energy element in our General Plan. And that was designed to be -- and then there was an EIR, and Environmental Impact Report, done along with that, that was designed to be a master EIR to tier off of project-specific permits that would be applied for.

So we think we're prepared to deal with that and have done all the groundwork that we can do until a project comes through the door, and then it will be analyzed on a project-specific basis. But we think the permitting can be done in relatively short order and at a relatively low cost compared to some other process.

MR. WILCOX: I think I would agree with that, and particularly with the federal government. We've been working with them to get their approval under the same sort of agreements that Andy is talking about. The U.S. Fish and

Wildlife Service has already agreed. Army Corps of Engineers has been a little bit more reluctant but we're working with them. And we're also then using that same thing to try to leverage funding with the federal agencies which is difficult at this point and time, but we're still trying.

MS. DE JONG: Okay. Yeah, Derek?

MR. BENSON: So I'd like to weigh in, maybe as a project developer. You know, with Hudson Ranch 1, we brought that online in 2012. I kind of go back to Andy's comment where, you know, as soon as he saw the tax revenue, he sort of keyed in that slide.

I think one thing that is extremely helpful, I think, in terms of, you know, however big the buildout becomes, I mean, you do need to look at supporting infrastructure. But I think important as a developer, tax certainty is helpful because an unknown in any project financing is a real problem. So I'm not necessarily arguing, you know, what that is today but, obviously, California is a pretty high tax rate to begin with. And when you don't have certainty around it, it complicates it even further.

So obviously, in industrial development, you know, we support, you know, paying a fair rate. But when you don't really know what it is when you're going into the financing, that's a real challenge. So anything that can be done to sort of lock that formula down is extremely helpful because, you know, we saw it as a problem in power financing, it's going to be the same here.

MS. DE JONG: Tyson?

MR. ECKERLE: Yeah, just to make sure I understand because you're looking at me, maybe as a business and economic development. Yeah. Yeah. But the -- so where is the issue there in terms of the uncertainty? And when you --

MR. BENSON: No. I'm talking about -- so if -- let me back up to maybe like 30,000 feet.

When we're talking about a power facility, these are pretty long-lived assets and they have pretty long off-take agreements. So as an example, you know, it would be appropriate to finance a geothermal power project on a 25- or 30-year basis. You are not going to do that with a minerals project. And your investor is a very risk-adverse-type investor. The way minerals

play, you have to have a different investor group.

What I'm saying, though, is when we're talking about going to any financing, when you don't know what the discount rate is that's going to be applied in your tax calculation, that's ultimately a problem. It's one of many as a developer, in addition to, you know, technology risk and everything else.

But in terms of government clarity, that's always very helpful.

MR. ECKERLE: And so what would you have the state do in that case, is like we sign a deal for long-term tax rate type of thing, is that the --

MR. BENSON: I mean, my experience in other states, you have pilots, you know, payment in lieu of tax, so you negotiate a tax rate. You know, I know that's not necessarily applicable here, but something where you know what your tax bill is going to be is helpful.

MS. DE JONG: Phil?

MR. ROSENTRATER: I was going to say, on the point of certainty, knowing what you're paying and then knowing what you're getting for

that is important too.

And on that note, I have to say the local governments are now engaged at the county level in creating an enhanced infrastructure, finance infrastructure. They're exploring that, which does not change anything in terms of the tax rate. It does not create any new taxes. It simply provides a mechanism to capture increased value and redirect it for infrastructure which, potentially, could be a way to enhance the development of this enterprise, as well.

MR. KENNEDY: Can I just ask the obvious question? There's sufficient rail lines out of Imperial County? I saw some media about a moving mud pile. I just wondered whether, you know, there needs to be further rail infrastructure to get this technology to scale?

COURT REPORTER: Please use the microphone.

MR. HORNE: Sorry. The Union Pacific main line between L.A. and Houston runs about five miles away from where this is, but there's all kinds of -- in other words, you've got to have a siting. And then the UP is notorious for not -- and I hope the -- is there anybody from UP

here? -- for being a little bit difficult to deal with in terms of forming unit trains and, you know, the volume of freight and so forth, so I don't know. But there are state highways in the area that the local, and this is something that Phil was referring to and a question that was asked earlier about it was a question about infrastructure, the local road network there in that area -- and I would think that a lot of this stuff would be shipped out of there on trucks rather than rail -- is abysmal because we are a rural community that doesn't have a big tax base and, you know, we don't have a lot of traffic out on those roads.

But as this type of development occurred, then what Phil was talking about is we're looking at this EIFD concept as a way to plow some of that, so enhanced tax revenues back into infrastructure that would help. And there's other grant programs that we're looking at through the federal government to do the same thing. And so it's an issue that would have to be dealt with.

MR. WEISGALL: Bottom line, Danny, rail access to the Pacific and the Atlantic without a

problem from Imperial.

MR. BESSELING: To the extent that potash would ever become commercially viable, we definitely would need rail because the volume of potash would be huge. But right now it's not really economic.

MS. DE JONG: Okay. With that, we'll go ahead and move on to the next question.

What do marketers and end users see as the next step for sourcing sufficient lithium to meet demands?

This might be a good opportunity to talk about adoption into the market or, possibly, if anyone would like to speak on innovation that might disrupt established markets? Okay.

Well, without any answers to that, then we'll move on to the fourth question.

What is inhibiting investment into lithium extraction from geothermal brine? And what do investors and other stakeholders need to proceed with investing?

MR. BESSELING: I think I'll speak to that. It's something we've been kind of circling around and we've iterated a few times already.

But I think the main thing really is just

the de-risking the technology. Once that nut is cracked, I think it's a pretty easy flow to commercial plants. So it really is just the demonstration plant that we've been talking about to get that first hurdle satisfied and proven on the ground, flowing.

MR. HARRISON: You know I agree.

MS. WALL: I'm going to actually chime in and say that some of the permitting issues and discussions that have been going on are also some of the questions that I've been getting, as well as the certainty of what that permitting process looks like, what is that timeframe? And it sounds like there is enough information going on here that that's being resolved, but that is another form of uncertainty that is certainly going to happen when you start doing project development, particularly if you try to do commercial-scale development. And you have to get into roadway development, as well.

The other thing is something that is a little bit further down here, so I'm going to jump, if that's allowed.

There's certainly questions around mineral rights and leasing and royalties, as

well. So does -- and I'm hoping that BHE can speak to this from their experience in the zinc plant. But if that zinc plant was specific to producing zinc, that may have been a mineral right from a locatable mineral for zinc. Does lithium qualify for that if you're producing lithium from a brine and it's under the Geothermal Steam Act or this again a separate mineral right that needs be addressed? And who owns that? Is it the technology developer? You know, and how are you splitting those rights?

All of that is an uncertainty, at least from the conversations I've had. Obviously, that's something that, you know, perhaps others here have experience for, but that is certainly an unknown on the investment side and questions that we're getting, as well.

And then finally, water rights are massive, as well. Does that qualify here? Is this already understood? And to what degree is that split once you start talking about changing up the amount of water that goes back into the resource from geothermal power production to the amount of water that's being used for lithium extraction? There will be some losses and so to

what degree does that matter? And what does that cost?

MR. BESSELING: I can speak to the one question about the certainty on the mineral rights. In fact, the actual electricity that we produce or the energy that we take is considered a mineral as far as the mineral rights. So we actually have full mineral rights through our lease agreements with the landowners to the extent that they have the rights to the lease to sell them to us. So we have full mineral rights to everything, including the heat off the brine to produce electricity, as well as all -- any minerals that we can find commercially.

We have to pay royalties. There's a royalty. Each of our contracts are all unique. They're just specifically separately negotiated but they're really similar in a lot of ways. But, yeah, we have a royalty commitment to them, whatever minerals we take off that are treated differently than when we produce power. It's a different royalty structure.

MR. WEISGALL: Your third point about water is well taken. Geothermal as an energy source uses a very modest amount of water for cooling.

We would need at least the same amount of water, if not more, for the minerals, not a huge amount.

Right now there's, you may or may not know, there's a tremendous litigation battle in Imperial over water rights. And if that doesn't get resolved this can't go forward because it would stop any further development in Imperial that needs water, but that's a litigation issue.

But, yes, there is a water need and it's a modest one but it's there.

MS. DE JONG: Well, we've started into question five, I'll go ahead and just state it.

How can government support development of lithium recover at this time? And what can and should be done at the local and state levels to support development?

And then if anyone wants to continue the talks about mineral rights, water rights and land leases, please feel free to do so, as well.

Yes, go ahead, Josh.

MR. MENGERS: So I'll jump in. Obviously, as the federal role, I stated up at the top that we've been directed to work on lower TRL, technology readiness level, early stage research and development. And that's really been

proven out by and large at this point.

So with that mandate from the administration, we can't really work in this gap that we're seeing for the Salton Sea. That hasn't stopped us. And we've had two previous funding opportunities for mineral extraction, not just lithium but looking at rarer, manganese, et cetera. We had a phase one which was $4 million that awarded eight projects, one of which to SRI International. And then in 2016, we followed on with a phase two effort. Again, it was around $4 million. We awarded four projects. Those are coming to a close now.

We did some R&D on new technologies and really cutting edge stuff that maybe ten years down the road is going to lower the price point even more. But again, we're working in that early stage, not stuff that's really looking for development now.

The other part of that is we did resource assessment. We came to the conclusion that Salton Sea is really the best place to do this. There are other places that, if this proves out, we might want to look into but that's, again, further down the road.

The one opportunity we do have that's -- the funding opportunity has not yet been released but the topics are available is a collaboration that we have with the Advanced Manufacturing Office that's also the Department of Energy. And they have the Critical Materials Institute there. And we're looking at using geothermal heat or desalination and then mineral extraction from the concentrate brine on the desalination, kind of a systems approach. This could be, it's a smaller scale, but an opportunity to take a proven technology and look at a systems approach. So it's not going to get you all the way there but this might be an opportunity for small businesses working in this space to take a proven technology and work on a systems approach to scale up.

There's a lot of data that we have available and as a result of some of these funding opportunities, and that's all available on the Geothermal Data Repository. If you are interested in having access to some of that data, let me know. I'll take your card and I'll let you know how to get access to it.

MR. WEISGALL: Josh, just clarify for me for a second, you're at EERE, Energy Efficiency and Renewable

Energy Division of DOE, but you've got offices for geothermal. There's an office for advanced manufacturing. Is there also an office for electric vehicles and if so how distant would that tie be in terms of looking for funding for what we're talking about here?

MR. MENGERS: So there's not a specific office for electric vehicles.

MR. WEISGALL: Or vehicle technology?

MR. MENGERS: Vehicle technologies and they are looking at batter technologies and whatnot. And so there are certainly synergies looking at lithium, the Critical Materials Institute might be a nice umbrella that lives in the Advanced Manufacturing Office, but there are collaborations already going on with the Vehicle Technologies Office.

MR. WEISGALL: Thank you.

MS. DE JONG: Yes, Andy?

MR. HORNE: On the question of what local government could or should be doing I can say pretty conclusively, our Board of Supervisors will support these types of project to the fullest extent they can. And it was because of something that -- and I joked earlier about the tax revenues, it's really the jobs that is driving that support. Because of Assemblyman Garcia mentioned we have a historically high unemployment rate

down there, so even 50 jobs or 100, but when you talk about -- Eric talked about 400 jobs, that gets their attention. And you multiply that by the number of other projects like Energy Source and the others that are looking at doing a similar thing down there and it really starts to make an impact. And that is a big driver.

There was a discussion earlier about this infrastructure finance district and the permitting streamlining that we've tried to do, but there's one other program that I want to mention. And it's called the Community Investment, you know what I'm talking, Jonathan. The CIIP Program, Community Investment Incentive Program I think, CIIP or C-I-I-P. And it's a state law, but the counties have to adopt it. And we have an ordinance that allows qualified manufacturing facilities and an extraction of minerals from geothermal brine qualifies you as a QMF. It allows for a significant tax break on property taxes and there are very few programs that the state has that mess with that, because there are groups like the schools and stuff that rely on that revenue.

But in that case you can enter into an agreement for 20 years that reduces the property taxes significantly for a project like this. And I wanted to make mention of that, because it's something that our

board and our county and the state have made available to the projects like this.

MR. WEISGALL: And I do think our CalEnergy Company, if I'm not mistaken, Andy, is the largest taxpayer in Imperial if not the second largest.

MR. HORNE: Well, the geothermal industry as a whole is the largest industry taxpayer, by industry in the county.

MR. WEISGALL: Yeah. I won't take a dig at solar facilities here. (Laughter.)

MR. KENNEDY: That was very gracious. Can I ask a question of CEC and also maybe GO-Biz? The GO-Biz one is opportunity zone funding, which I'm not sure where you're the point on in the State of California, but this is the new flood of capital coming out of federal tax reform. I believe a lot of the Salton Sea area is an opportunity zone?

UNIDENTIFIED SPEAKER: No, it's not.

MR. KENNEDY: It is not? Oh.

MR. ECKERLE: I don't know. I mean, I can get the answer, but this is certainly not my area of expertise. But just generally speaking, I know GO-Biz would be very interested in all of the business development opportunities and the tax type of stuff. I can't certainly speak for the Newsom Administration, but

going forward I'd imagine the policies will be very similar.

MR. KENNEDY: Okay, but that's key if it's not.

MR. HORNE: I don't believe there is a limited amount of acreage that was available to go into those zones. There's rather stiff competition and a lot of it got in, in Imperial County it got concentrated in the cities, because that's where typically an investment like that would occur.

And I think those maps or those zone designations are somewhat fungible, so I mean there could be an opportunity to revisit that in the future. Especially if something this was --

MR. KENNEDY: I was going to say I mean one thought with this question of how the state could help, is that as I understand it California hasn't conformed its tax code to the federal tax code. So I think there may be some opportunity to work with it there. And the other would be simply that, again as I understand it and I don't think the IRS has fully promulgated the rules, but you could just be registered in the zone. So your business entity could be in the right place in Imperial County in the right address and attract the capital out of the opportunities and finance.

I think that could be something for us all to look at if it's a significant chunk of change, like hundreds of billions of dollars that will come.

My question for the CEC is how do we do this life cycle emissions trick? Like who applies standards to EVs and batteries in the California (indiscernible) and make sure that they are going to be consistent with our carbon goals?

COMMISSIONER HOCHSCHILD: Well, I don't think we've done a life cycle analysis for them. Someone raised that to me during the break as a possible study we could fund.

Michael, do you have any comments?

MR. SOKOL: In this area I think we've done a number of research projects. I don't know how far down the life cycle analysis avenue we've gotten. I don't think there's a central authority within the CEC that would kind of look at that. Our siting certainly for specific projects would look over the holistic impacts of a particular plant.

COMMISSIONER HOCHSCHILD: In the analysis we do for when we were doing Appliance Standards there is a cost-effectiveness test, which is for the customer of the life cycle of the appliances. Is it cost effective when

we do a new standard and we look at energy savings, but I don't -- I mean, Ken, you've done a lot of those.

MR. RIDER: Yeah, and it's all been on energy. It's never been on emissions, right? And I think we're talking about emissions here for the life cycle and some of the environmental qualities of that. And I would really say it's in the state ARB is the lead agency that is tracking all the emissions in the economy. And so I think we would look there first to see how farther along they are, they're constantly getting their arms around new spaces where emissions exist. And I'm not knowledgeable about where they are on this, but this would be the right agency.

The Energy Commission typically doesn't get that detailed on specifically emissions. On energy we do, but not -- that's more of an ARB thing.

MR. ROSENTRATER: Realizing that much of the demand for the lithium is coming from the electric vehicle market that having infrastructure installed that will reduce range anxiety, having the charging stations for EV vehicles. Riverside County has done a lot of work with the CEC to accomplish that. In fact, they have more charging stations than any other entity is Southern California at this point other than Disneyland.

But that is the kind of infrastructure that is already being invested in, but additional reinforcement of that and expansion, particularly I think it might be welcome under the incoming administration. That's the kind of thing I think builds a market and it builds a market case for lithium development.

MS. DE JONG: Okay, so we'll ahead and move on to the last question. Just to tie both of these panels together we've been talking through quite a few of the economic and technical challenges, so what are the research and funding priorities that can address these challenges?

MR. SOKOL: This is Mike. Just to elaborate on what Elisabeth said I think we've heard a lot of what can be done, but the real emphasis is on the word "priorities" here. I think the question is kind of where do we start based on all the discussion and wrapping up the discussion from the first panel as well.

DR. GINLEY: Okay, I'll say something just to get things started. By just listening to the discussion, it seems like there's already a pretty good case for the economics of the lithium you produce. It doesn't seem like there's a very complete life cycle analysis for the whole thing and what other peripheral implications might be of implementing the technology on scale.

That seems like something you'd want to do right off the bat, because I suspect it's actually quite benign compared to other things that we might do. And that would be a really good sales point. I think there's the issue of, does California want as a business proposition, to become the lithium supplier to the nation? Which I think you could actually do. I think there's significant national security implications in being able to do that, though very attractive and might sell well right now, especially if we make it a domestic market.

I think there's a -- the comments before about the fact that there are multiple technologies that could work in inversive situations. I think there's an opportunity to do a little technology sorting to see where you might want to invest your $60 million the most sensibly, that would make scalable plants. And I'll shut up.

COMMISSIONER HOCHSCHILD: I just, you know, would add one other point, which is so my background is in the solar industry before I started this job. And in federal subsidies I think we made a mistake as a country in our approach on funding solar, because most of the funding actually in the solar industry went to thin film rather than crystalline. And for much of the last 30

years thin film was 20 percent of the market and crystalline was 80 percent. We are spending most of the money on film and today film is 4 percent of the market and crystalline is 96 percent, okay? So we kind of whiffed on that.

And I just think to me lithium is the new silicone. It is the new crystalline silicone really, and you have this incredible elegant market pull of what's powering all of our cell phones and our laptops and energy storage and vehicles all combining and helping us get economies of scale in this storage technology. It really is, I think turning out to be dominant. And that has, how would I put it, a target of increasing energy density of lithium ion.

So some months ago we had the cofounder of Tesla in here, JB Straubel, who gave a presentation on Tesla's storage strategy. One of the points he made was that there's a lot of focus on the cost reduction curve for lithium ion, but what's just as significant is the energy density going up. So basically that also is another -- I mean, that's a very promising trend to me, because as energy density goes up it means -- so I drive a Chevy Bolt to a 30-mile range. A lot of that is dictated by how many cells you can fit into the car and as the energy density goes up we will end up with

probably a 400-mile range being standard. That then really tips the balance for a lot of folks who are making a decision based on range and so on.

So I guess one question I wanted a little more comment on from maybe Department of Energy and NREL. I mean, what else do you think we ought to be doing to lay the groundwork for getting more federal resources into this? I mean, if we really do believe that lithium is going to follow the path that crystalline has followed. By the way, just to be clear the single largest new capacity edition domestically in the United States last year and globally last year, was crystalline solar PV, right? It's bigger than wind, bigger than gas, bigger than coal. So that has turned out to be very fast growing.

I mean, if that's our belief with lithium what else should we be doing to help make the case for this to become a federal as well as a state focus?

MR. MENGERS: So I don't know what else we can do. I know that the Critical Materials Institute and Vehicle Technologies Office, Advanced Manufacturing Office, in the DOE you go more broadly across the federal government, Department of the Interior, USGS, a number of other agencies are looking at lithium itself.

If we're talking in the context of from geothermal brines that falls squarely on the Geothermal Technologies Office. And with the constraints on where we are, I think David had some great ideas about the technology sorting. That's something that we could certainly say is in this lower TRL range, that we could look at that as being something we could do in the next couple of years and that might be something that could then potentially scale up to the next step of doing this demonstration scale.

But a flag probably just raised, because a federal employee just said "demonstration scale." (Laughter.) You know, that's the sort of thing where that's verboten. So and under our current constraints we're not going to be able to take that leap to be able to make this enticing to investors at the federal scale.

MR. WEISGALL: So I'm going to say something that Josh can't say. There's absolutely nothing to stop this group collectively or individual stakeholders to go to the House Appropriations Committee to appropriate and make appropriations for this specific project. That's done all the time. That would be another step, and I think a very important step, and certainly where my thinking is going coming out of this.

I mean, I appreciate the limits, Josh. And then this is TRL, Technology Readiness Level. We're beyond technology readiness, I think. We're kind of -- we've got to prove that, but we're well along and this just doesn't fall into this is trying to get a square peg into a round hole and it's not going to work right now with your limitations. But I think that there's a way to overcome that in Congress especially. Well, given the political issues now I think this can be a tremendous selling point.

COMMISSIONER HOCHSCHILD: Yeah, and again the leadership both in the Majority and the Minority in the House is California, so that's a good thought.

MS. WALL: If I can just echo that. I actually came from NREL before I joined Capstone and so having worked with the DOE on and being a technical adviser there, some of the technologies that are really close to being commercial, but having had someone like Simbol that is newly commercial, there are other technologies in place. Obviously I'm kind of MGX, but there are other players in the market right now that really just they need to get over this valley of death and have a demonstration and project in place. To what degree that this Commission and the state can assist in getting that resource and providing surety that the permitting process

and the rights are available to them when they're ready to do that project. And to partner with developers in a way that makes sense for both parties, that surety and the ability to have a good business environment to me is really the only limitation for financial providers at least from our viewpoint.

MS. DE JONG: Yeah, go ahead, Tyson.

MR. ECKERLE: So I guess just for the DC idea, would it make it easier to sell that idea to have this California Lithium Initiative first or does that appropriation come and then kick off the initiative?

DR. GINLEY: So I think having some definition of an initiative in California would definitely help, I think. So obviously the environment in Washington is constantly changing. But the one thing that has remained constant is this idea of sort of critical materials and what underlies future technologies.

I think everybody, even Detroit, is willing to admit that EVs are coming en masse. And right now we all feel vulnerable with respect to the lithium supply. And not only that, other elements as well have impending criticality that may be just as bad and some of those elements actually are in geothermal brine, so you might even be able to expand the scope. But if you have an initiative as a foundation I think you can do exactly

what you said, which we're not allowed to do, but which is create a national initiative and have it funded directly out of Congress.

MR. WEISGALL: We call it a strategic (indiscernible --

MR. ROSENTRATER: In terms of chicken and egg (indiscernible) California initiative, we've run into the ABC too often, Anywhere But California, back in Washington. A national strategic minerals initiative, something along those lines I think would play really well.

MR. WEISGALL: And my answer to your question would be I'd get started sooner rather than later. I mean, you define the program, you move it, it changes, but you get the momentum going. So it's certainly -- I mean, that's one of my major takeaways from today. And you'll be hearing from me.

MS. WALL: If I can make one more comment on that theme, because I think that's really something that hasn't been brought up enough, is the timeline to bringing lithium online. This is not just a six-month process or even frankly an eighteen-month process in building a plant. You have a demonstration plant proving this out then building your whole plant and still then having to go ahead and produce a product before that

actually gets to market. So to be able to supply someone like Tesla who needs demand now, you're still seeing that if you were to start today on this you probably wouldn't be able to get them anything probably for at least three years, if I'm being conservative.

So that timeframe needs to be baked into this discussion as well, because new developments, new geothermal plants, new well developments such as any of these other resources whether it's BHE or CTR, then you have to tack on all the permitting for a typical geothermal well drilling. And proving out that resource as well, which frankly from my understanding is still a six-year process for permitting. So six plus three you're now talking about nine years before you get that lithium online.

So if you have people here today, the faster that you can move on current operations and getting this proven, it will help to set a standard that can be used going forward. But you're still not talking about this being something that happens tomorrow.

MR. KENNEDY: Sorry, could you repeat what the six-year addition to the three-year timeframe was?

MS. WALL: Oh, I apologize. So from looking at past history in geothermal projects, even though technically if everything went to plan theoretically you

should be able to put a plant online between drilling a well, proving a resource and then putting a geothermal plant online could take three-and-a-half years, maybe four. But typically permitting timelines, because of the fact that it takes time to actually get all of the information in place and then also the permit, no offense to the county people here just sometimes it's a process. It takes longer than that ideal. And that on average has taken approximately six years, sometimes ten.

I mean, even a well field in Iceland, for example, which is I'm going to use that example, because it's so great. The field itself was available, it worked. Their expansion plant took ten years to permit and put online, so and that's actually a typical timeline for historical geothermal development. If that still takes that time and just then getting a project on project risk of asking that plant to add in a lithium extraction plant, it takes more time then to bring on those partners. So the more that this Commission can make that process easy and smooth, the better it will be for business.

MR. WEISGALL: Let me try to clarify a little bit there. So I mean from our company's perspective we have ten existing geothermal wells and plants, so we're not -- but Anna's absolutely right. I mean, if we were

trying from scratch we'd be talking six years. We're not factoring in that six, seven, eight-year period, because we're ready to go with the resource. You're absolutely right in terms of what it's going to take to start producing the lithium. In fact, I think your three-year period is probably optimistic. In our own plan we're thinking closer to five years all said and done.

Now, nothing wrong with that and I think the timing there is great, especially when you look at the potential quadrupling of the lithium market in the next decade. But yes, there would certainly be challenges going forward to provide new resources.

MR. KENNEDY: In fact, a five-to-six year timeline would almost perfectly match the window of when supply (indiscernible) --

MR. WEISGALL: Exactly.

MR. KENNEDY: And the new Governor's first term in office, so. (Laughter.)

MR. BESSELING: I'd just make a comment that I don't think you're going to see the project-on-project risks like build a geothermal then lithium production. I've got to believe that the future will be one plant doing both, I really do.

MS. WALL: I hope so and frankly from a technologies perspective this right now without having a

known technology either is -- there could be an option and technology could work upfront, you know? But prior to a geothermal plant or you can put it on the backend of a geothermal turbine, but this is an optimization problem. Are you optimizing your plant to produce geothermal power or are you optimizing it for lithium production? And that would be to me what a new product development would have to look like.

If you're trying to optimize how much lithium you get out of the plant you're going to change that design to fit that and then absolutely it's a single project. But if your thought is you're going to supply geothermal energy and maybe down the road you're going to keep an option to put lithium on at the end that's two separate projects.

MR. BESSELING: Yeah, just so two thoughts on that or two comments. First of all, geothermal will not get built, I'm convinced of it, without lithium. So it has to be part of the package, so it's a one-plant design. The other thing is if you look at the revenue stream you're looking at 5-to-1 on the lithium, so the answer is lithium will be the optimizing element for sure.

MS. DE JONG: Okay. Well, now seems like the perfect time to move over to our public comments and

we're going to go ahead and start with folks in the room. And Gina's going to bring a microphone.

MR. HARRIS: Good afternoon, Jeff Harris at the law firm of Ellison, Schneider, Harris & Donlan here in Sacramento. I'm making public comments on behalf, and not on behalf, of any particular client. I want to come back to this issue of permitting, because I think that's an important issue. It's something that we do a lot of permitting here at the Energy Commission. You're correct, geothermal permitting is complex enough as it is, but I think there's an opportunity and instead of just complaining, Commissioner, I'll basically get to a recommendation.

But I do want to set out how complex this is. You've got the well fields on the front end, which could be permitted locally. You've got a 50-megawatt power plant or grader, which is going to be going through the Energy Commission's jurisdiction. You have the injection wells, which are federal arguably although they may be administered by the Regional Board or somebody else. So there's a very complex permitting path, which I like.

And just as all the developers today were very coy about their technologies and their combination of proprietary technologies I'm not going to give you the key to how I think you get through process. But I do

think that the Commission ought to look at this issue. And I think maybe having the General Counsel's Office or someone in Chief Counsel's Office sort of put together a white paper on how this might work would be really good.

I'm a little loath to say that, because in the past the Commission has suggested the problem with siting was that developers needed manuals. They don't, but an understanding of how you all see the path is good. And like I said I think I have the answer, but being right is just a good start. And what you think is more important than what I think and so I would highly encourage you to ask the General Counsel's Office to put together some sort of white paper or view of how the permitting works and tying together all the alphabet soup of CARB and DOG and DOGGR and the APCD and all those other entities.

Once you have that my next suggestion would be to put together an MOU, a state and federal MOU on how this permitting process would work. There was a process put together for some of the ARRA projects, anyway I won't try to recreate the acronym, but you know what I'm talking about. That's going to be very important for some certainty to know how these agencies are going to deal with this. How they view the state and federal overlap. How they're going to coordinate their efforts. How we're going to avoid extra environmental review.

And so once I think you have your house in order in terms of how you think it works, I think putting together a program with the federal government, the state and federal partnership on this would be I think really critical.

And then, I guess finally at the end of the day I think once that permitting path is set you are going to have to recognize that ag land in Imperial County is not Joshua Tree. And one of my great fears for permitting certainty, for mitigation costs and for time of getting these projects online is that people will take the lessons learned in the DRECP process and try to apply them where they're not applicable. So having some kind of understanding about the state of the habitat down there, combining that with the state's current obligations under the Salton Sea Restoration, it just seems like a non brainer.

But I think you have a little bit of time now to try to put together a state and federal effort that can streamline these processes. There are going to be projects that will potentially add 50 megawatts to existing facilities or more than 50 megawatts to make them scalable. And so I think it's really critical for this Commission to clearly articulate their view of how

that permitting path lays out and how you can streamline it, so.

COMMISSIONER HOCHSCHILD: Can I ask before we leave Jeff, Stephen, can you just comment on what permits did you pull to do lithium extraction, even a pilot level?

MR. HARRISON: Well, I'll answer two questions, because we actually applied for a permit to operate in a commercial facility as well and we got that. And that was at --

COMMISSIONER HOCHSCHILD: Who granted that permit?

MR. HARRISON: At the county level.

COMMISSIONER HOCHSCHILD: The county, yeah. Right.

MR. HARRISON: It wasn't that onerous as --

COMMISSIONER HOCHSCHILD: Was not that onerous?

MR. HARRISON: But time has changed and that was over a few years ago. If we're talking about something where the plant is integrated with lithium extraction that is a lot more challenging; the permits to operate a pilot plant, that was trivial frankly.

COMMISSIONER HOCHSCHILD: That's good feedback. I mean, just so you know I am not interested in expanding the Energy Commission's scope of authority here for the

purpose of doing that. I really would like to see what is going to benefit the market the most. And if there's not a problem, if it ain't broke don't fix it, is kind of my thinking.

MR. HARRISON: But tying in lithium production in a very big geothermal plant that is challenging and complicated, which is leading here. Is it a geothermal power project or is it a mineral extraction and what does that mean?

MS. DE JONG: We have one more --

MS. BESSELING: I was just going to say the key there is a new plant versus existing, so leveraging off of an existing facility and it's all pretty much the big part is the brining: getting the brine out of the ground, putting it back in the ground, those extra regulations and permits that go with that is a big challenge. And we went through that with our Black Rock Development, which was a roughly 200-megawatt facility. And it was a four-year process. If we had to bring into that the complication of lithium extraction all under one house I think it would be five, six years to permitting.

MS. DE JONG: We have one more comment in the room.

MS. HEYDORN: Yeah, hi. This is Barb Heydorn from SRI International. This isn't so much a comment as

a question for the people here in the room. I'm just wondering if there's an analog between this industry and carbon capture. I know a lot of our researchers have been struggling with how to bring these technologies to scale. And something that was built was the National Carbon Capture Center, which was a common resource that a variety of people could come and test their technologies. And I'm just wondering if that's something that would be appropriate for California to consider as a way to get some of these lithium recovery technologies demonstrated at sufficient scale?

MR. WEISGALL: I'm going to give a stab at that, at an answer for you. Certainly from our company's perspective, Berkshire Hathaway Energy, as you may have heard earlier the reason we're not throwing $60 million right now to build a demonstration plant is we're not in the minerals business; we're in the electricity business.

Having said that I see no reason why we would not work with anyone with any technology. Anna has correctly stated that there are different technologies out there. It is certainly in our company's interest to find the most effective and the most cost effective and I see no reason why we would not work with anyone to provide the resource, the geothermal brine, to test anything out.

I mean, I say that I'm painting with a broad brush there. Obviously, the devil's in the detail, but it certainly would be in our company's interests to do that and I think in the overall interests to make this work. We can't be that protective moving forward, there's a need as David, you talked earlier about the need for some kind of consortium on the R&D side as well. And I think that's also part of it, so I hope that addresses your question.

MR. BESSELING: It does come with one commercial caveat though, and that is it's a two-way street. It's a transparent process and that technology's available back for us to take advantage of as well, so it's an open process. If it's just for parties to come in under a shielded guard to develop their technologies and then go try to peddle and hold it hostage that's not what we're up for. We're up for just open transparency to get the technology to the market.

MS. DE JONG: So we're going to public comments from Tom Currin on the phone.

MR. CURRIN: My name is Tom Currin. Yes, my name is Tom Currin. I tried to call in earlier, I apologize. I'm an independent lithium processing expert, 40 years of experience in lithium processing. I spent

the last ten years involved in demonstration plants in Canada, Chile and Mexico and six months in the Valley.

The reason that lithium hydroxide production in the Salton Sea has not moved forward, in my opinion, is because a package of technologies has not been demonstrated. To be successful in the Salton Sea we must demonstrate four-unit operations: pretreatment, lithium selectivity, lithium concentration and lithium production.

I support the comments that were made about the need for a demonstration innovation center. Building confidence in the process is critical for investors. Where I would offer a different perspective is in a milestone-based demonstration plant that can be established for much lower costs than $50 million. The major issue is the continuous process where spill up and the issue is scale, issues can be evaluated. I believe this can be done for less than $10 million and the reason being is that it is a modular plant that can be expanded modularly to the tenth scale and the technology de-risks as you move forward. My reasoning is based on using modular systems that scale up very similar to membrane de-cell (phonetic) systems.

All of the above-process units I described can be modularized. With FUD (phonetic) I also disagree or

have a different opinion with funding and the right implementation partner, the first stage of demonstrating the viability of the process can be implemented in less than a year with flowing brine.

Thank you very much.

MS. DE JONG: Thank you very much.

And I'm going to go ahead and read a question that we had over WebEx. We may have lost this person's connection, but the question is from Kyle Boynton. And the question is, "From an investment point of view are there other minerals contained within the brine that have been looked into further for extraction and production of some end product?"

MR. HARRISON: Yes, zinc was mentioned previously. Manganese has been looked into as has potassium. The CEC funded a project on potassium with Simbol, unfortunately not completed due to the company's financial difficulties. But there are also other elements of a much lower concentration that could be exploited from this brine: cesium and rubidium for example.

MS. DE JONG: Okay.

MR. MENGERS: I'll also mention from the Department of Energy that rare earth elements have certainly been looked at as well as precious metals.

MS. DE JONG: Okay, do we have any other public comments in the room?

MS. WALL: I'd actually like to comment on the gentleman, Tom Currin? So I wanted to just reiterate that so we've been talking about demonstration plants, but to his points this is not just lithium extraction, because that includes steps. I mean, most geothermal plants frankly, already today, have pretreatment in some shape or form to remove silica, particularly in the Salton Sea. But a demonstration plant is not just the lithium extraction itself. It's a combination of multiple processes that will have to go on and they're multiple different technologies.

Not to pick on Stephen, but I believe in Simbol's process there's at least four different technologies just to sequentially extract the silica, the manganese as well as other materials. And then finally the lithium, I believe as the last step. But that is a process step in this extraction. It's not just one technology necessarily. And obviously that differs for different technology providers, but there's still some pretreatment in that.

Secondly, most of these systems are modular anyway. They're not necessarily going to be built at full scale. These are systems that would be built at --

you know, essentially could be built at a specific plant and then multiple systems are built for the entire well field of a geothermal system. That's already taken care of by all of these technology providers that I've seen so far today.

And then secondly, in terms of the phasing, the proven technology, I think that just frankly reiterates that there's still a construction timeframe within all of this. So yes, absolutely you could get milestone-based funding. That's certainly not a question. That's been done in potash. So if we look at potash for example, as soon as you hit certain milestones for permitting in your demonstration plant, that same investor might invest that additional amount of money for your commercial plant. That is all investor-based and their own risk perspective in this. But those are all opportunities that are currently available through either the mining side or are currently in the process, in the works for these technologies, at least from my understanding of the market today.

MS. DE JONG: Okay. Thank you.

And just be sure that we get everyone on WebEx we're going to go ahead and unmute the lines. If you don't wish to speak please mute your own volume, but

we're going to go ahead and unmute. If you want to speak, go ahead.

(No audible response.)

MS. DE JONG: Okay, not hearing any comments on the phones I would just like to take one more second here to encourage everyone to take advantage of the docketing process. The notes for how to do that are in that workshop notice in the handouts that we've provided. Please feel free to docket any further questions or information that you would like to share with this group. And I'd like to thank you guys for your participation, both on the panels and in the audience.

I'm going to go ahead and turn over to Commissioner David Hochschild for closing comments.

COMMISSIONER HOCHSCHILD: Well, first let me thank you Elisabeth and the all the rest of the staff who made today's meeting possible; a very, very fruitful discussion from my perspective. I did one question, as I mentioned I am persuaded we have enough evidence here this is a legitimate goal to actually formalize this effort. And then how that happens, whether it's an executive order or some other measure.

For example, we did form a year-and-a-half ago an offshore wind taskforce. We got all the agencies that are engaged in that issue, Coast Guard maybe, all the

Lance Commission and so forth that we've been meeting regularly, that's really helped smooth out the permitting pathway for that. And something similar, I think is needed for this.

But just a question for folks here, who is not represented here that you think ought to be in this conversation? And I'm just thinking aloud. One sector we didn't talk very much about, there's all these other two-wheeled electric vehicles. You know, Uber has bought JUMP bikes, which are all over Sacramento. There are electric scooters in cities and so on. And Silicone Valley Leadership, for example, represents many of the companies doing innovation in that space. I think they would be a conservative partner in a conversation like this, but is there anyone else who comes to mind as a stakeholder that's not here, but should be? And if you can't think of anyone but think of someone later, let us know.

Yeah, Danny?

MR. KENNEDY: There are a number of small battery component manufacturers and battery manufacturers in California that, you know, aren't the Tesla Gigafactory scale, but specialists for the Department of Defense down in San Diego; SimpliPhi out of Ojai, California, various others.

And I feel like it's not a cottage industry, but it's a small pie value industry that California has some of. And they're currently buying the raw materials for their products and the cells into their battery packs out of Asia largely and getting them under the table as they (indiscernible) run through this.

And similarly, I think we talked a bit about the incoming industrial opportunity on the shores of the Salton Sea itself. But there's really a closed loop here, if you've got the biggest single buyer being Tesla when you build your first plant to take the 90,000 tons, and then some of these smaller cats and dogs buying the rest of the lithium carbonate you produce. You have the EV production here at the Fremont facility: the EV buses, the bikes of GenZE and Fremont also, etcetera.

And there's a recycling opportunity, which NREL was actually modeled with a company called Resourcer (phonetic) out Michigan, I believe, who do 95 percent already of upcycling of the lithium back into batteries, better quality than the lithium that went in.

So, you know, California could have a cost or an industry development strategy, which is far greater than just the raw material extraction although that would be great since that's at the beginning of the slate as

Assembly Member Garcia said earlier. We could involve the whole depth and breadth of this thing.

COMMISSIONER HOCHSCHILD: True, let's hope.

Yeah, anyone else?

DR. GINLEY: So I was just going to say that the end-user community probably should get involved and that's the micro-electronics community. It's the EV community. It's the growing electrified bicycle community. You know, with these companies putting bikes all over that are electrified power there'd be a lot of lithium batteries out there.

Then, I think the other area, which actually California is already the lead, is in the autonomous flight vehicles. And if you read the Uber Position Paper this is going to be a huge thing coming up and they're going to use as many, if not more lithium batteries than in EV to keep those things in flight. So I think that if you engage that community early on they'll be your strongest supporters.

COMMISSIONER HOCHSCHILD: Yeah, and by the way you think about Apple right, the most valuable company in the world. A California company, they don't manufacture here, but they have made enormous environmental commitments, 100 percent renewables not just for -- their goal is enough renewables to power every single Apple

device and all of the Apple manufacturing. And I think that's another opportunity.

MR. KENNEDY: Sorry, one more thought on that. I mean, they were the biggest battery consumer until last year, in the world. Apple, because of all your iPhones, advanced lithium batteries. But City of Los Angeles, I don't know how Imperial County and L.A. get on, but they're driving this mobility transition by the Olympics in 2028. They're going to be the biggest demand center of lithium in America in the next decade. They could have a partnership here to see it get done.

MR. HORNE: It's interesting yeah, because the Los Angeles Department of Water and Power, which is part of the city owns some property down there right along the Salton Sea. But the other person I was going to say, and somebody for IID was here earlier, but the Imperial Irrigation District is the largest landowner in that area. They are also, if a question comes up about water rights, they are the holder of water rights there and in charge of allocating water to the users, to agricultural and industrial users.

And I don't, Elisabeth, if they were invited to participate, but they probably should be at the table in the future.

COMMISSIONER HOCHSCHILD: Yeah.

MS. DE JONG: I'm sorry, just a comment on that. Yes, they were invited to participate. They ended up having just a member that was able to come for the audience.

COMMISSIONER HOCHSCHILD: Well look, let me just thank everybody again. I just want to close by saying I think we should all have really an expansive sense of possibility about how quickly our energy system can transform. And I would point out that Tesla, which was founded exactly 15 years ago, is more valuable than Ford, which was founded 115 years ago. And we're seeing transformation take place at a pace that's unprecedented. And, you know, the journey of a thousand miles begins with a single step and I think this is really an important piece of this energy journey. So I really want to express my gratitude to everybody for making the time to come here and get up at 3:00 in the morning to get yourself here, very, very grateful, so thank you all.

Yeah?

MR. WEISGALL: Just to follow up and maybe you already do this, Elisabeth, it would really be nice if you could circulate to the folks here just email contacts for everyone? I mean, there's just a lot of synergy has developed here. If you could do that, that'd be great.

MS. DE JONG: Yeah, I'd be happy to facilitate that after the workshop, sure.

COMMISSIONER HOCHSCHILD: Okay. Well let's thank staff again for organization this. Thank you, guys.

(Applause.)

And please do mind the smoke outside. It's really hazardous, so try not to be out there more than you have to.

(Whereupon, the Lead Commissioner Workshop was adjourned at 4:50 p.m.)

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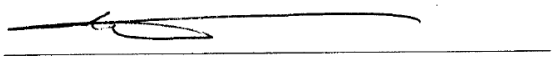
REPORTER'S CERTIFICATE

I do hereby certify that the testimony in the foregoing hearing was taken at the time and place therein stated; that the testimony of said witnesses were reported by me, a certified electronic court reporter and a disinterested person, and was under my supervision thereafter transcribed into typewriting.

And I further certify that I am not of counsel or attorney for either or any of the parties to said hearing nor in any way interested in the outcome of the cause named in said caption.

IN WITNESS WHEREOF, I have hereunto set my hand this 11th day of December, 2018.



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I certify that the foregoing is a correct transcript, to the best of my ability, from the electronic sound recording of the proceedings in the above-entitled matter.

December 11, 2018

MARTHA L. NELSON, CERT**367