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STATE OF CALIFORNIA

CALIFORNIA ENERGY COMMISSION

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	)	RE: Building Decarbonization: Embodied Carbon and Refrigerants

IEPR COMMISSIONER WORKSHOP ON BUILDING DECARBONIZATION:

EMBODIED CARBON AND REFRIGERANTS

REMOTE VIA ZOOM

THURSDAY, AUGUST 26, 2021

Session 1 of 2 - Embodied Carbon, 9:30 A.M.

Reported by:
Elise Hicks

APPEARANCES

COMMISSIONERS PRESENT

Commissioner J. Andrew McAllister, 2021 IEPR Lead

Commissioner Siva Gunda, California Energy Commission

Commissioner Cliff Rechtschaffen, California Public Utilities Commission

STAFF PRESENT

Heather Raitt, CEC

Rosemary Avalos, CEC

PRESENTERS

Rebecca Dell, ClimateWorks Foundation

PANELISTS

Harpa Birgisdottir, Danish Building Research Institute/Aalborg University

Daniel Garza, California Department of General Services

Bruce King, Ecological Building Network

Kate Simonen, Carbon Leadership Forum and the Department of Architecture at the University of Washington

Emi LaFountain, Turner Constructio

Henry Siegel, Siegel and Strain Architects/ AIA California

PUBLIC SPEAKERS

Scott Shell, EHDD Architects

Claire Warshaw

P R O C E E D I N G S

9:30 A.M

MS. RAITT: Good morning, everybody. Welcome to today's 2021 IEPR Commissioner Workshop on Building Decarbonization, Embodied Carbon and Refrigerants.

I'm Heather Raitt, the Program Manager for The Integrated Energy Policy Report, which we refer to as the IEPR. This workshop is being held remotely consistent with Executive Order N-08-21 to continue to help California respond to, recover from, and mitigate the impacts of the COVID-19 pandemic. The public can participate in the workshop consistent with the direction in the executive order.

Today's workshop has a morning and afternoon session with separate logins for each. To follow along, the schedule and slide decks have been docketed and are posted on the Energy Commission's website. All IEPR workshops are recorded and the recording will be linked to Energy Commission's website shortly following today, and a written transcript will be available in about a month.

Attendees have the opportunity to participate today in a few different ways. For those joining through the online Zoom platform, the Q&A feature is available for you to submit questions. You may also upvote a question submitted by someone else. Click the thumbs up icon to

upvote.

Questions with the most upvote are moved to the top of the queue. We'll reserve a few minutes near the end of the panel to take questions, but we'll likely not have time to address all of the questions submitted.

Alternatively, attendees can make comments during the public comment period at the end of the morning or afternoon session. Please note that we will not be responding to questions during the public comment period.

Written comments are also welcome and instructions for doing so are in the workshop notice, and written comments are due on September 9th.

With that, I'm pleased to turn it over to Commissioner Andrew McAllister, Lead Commissioner for the 2021 Integrated Energy Policy Report. Go ahead, Commissioner. Thank you.

COMMISSIONER MCALLISTER: Great. Thank you so much, Heather. So, my name is Andrew McAllister. I'm the Lead Commissioner on this year's Integrated Energy Policy Report as well as a lead commissioner on energy efficiency and our buildings related activities generally at the commission.

I'm pleased to be joined on the dais today by Commissioner Siva Gunda, who leads our work on forecasting and reliability, which obviously in this day and age is

front and center in everyone's mind, certainly in the regulatory community and the power sector as we traverse a very difficult summer with fires and heat waves, and really squarely within the new normal of the context of confronting -- not only avoiding future climate change, but actually dealing with it today in real time.

And so, the level of urgency overall for these conversations is rising. And we all believe will continue to do so for the foreseeable future.

So, there's particular urgency around our policy work to really engage on these issues directly and quickly. In this year's Integrated Energy Policy Report with both the reliability track and the building decarbonization track of which this workshop today is a part.

I want to thank Heather and the team, the IEPR team, as well as our division staff from the Efficiency Division who is in charge of our buildings-related work. That includes Building Standards and Appliance Efficiency Standards in both new and existing buildings among other topics.

And our team in the buildings work, Kristy Chew is organizing and doing a fantastic job, putting these workshops together over the course of the IEPR. And Jen Nelson, who leads our Existing Buildings Office, Mike Sokol and Christine Collopy who lead the division itself, and all

the teams who are working so hard behind the scenes.

Our workshops come off looking like they're kind of easy going and seamless, but that reflects a huge amount of work in coordination behind the scenes. And I just want to acknowledge that.

I want to thank everyone for tuning in and listening. There will be a record online. So, those who aren't able to make it can listen in. And obviously, look at all the materials submitted in the docket. We encourage written comments to come in on these issues.

So, embodied carbon, this morning -- this morning was all about embodied carbon. The afternoon will be about refrigerants. And both are topics that the commission is relatively newly engaging with. I mean, we've been aware of these issues over decades, really, but certainly, over the last few years as emerging issues in the climate sphere around buildings.

And we've been getting a lot of stakeholder suggestion that we engage on embodied carbon and it certainly is related, you know, the context is around the Building Code. And so, as we get a handle on the operational impacts of new buildings and existing buildings both, particularly in the new construction arena, the embodied carbon and the materials themselves and the construction process become more and more important

relatively as part of the overall carbon footprint of buildings.

And so, we're talking cement, steel, dry wall, glass, all the different materials that go into buildings and the embodied carbon along the whole supply chain to get them on onsite and into a building. And so, this is a global issue. It's not just California, and there are, I think, very smart people thinking about this across the globe. And we will hear from many of them in our panel here presently.

This is entering the political realm too, as the Biden administration is even thinking of putting in place the system to express, in economic terms, the embodied carbon in building materials and imported goods from other countries. And so, I think this is only going to become more front and center.

Now, it's likely that there are other agencies. We have DGS on the panel here today, but there are probably a variety of agencies in the state that will be wrestling with this issue. And also, that have some authority that affects embodied carbon.

So, the commission obviously needs to be engaged in that, but the Air Resources Board and other agencies, I think will also have keen interest in leadership positions on various aspects of this topic.

So, what we're doing here today is kind of level-setting, starting to build a record on this, and engage, try to understand how the Commission can be helpful in this discussion and guide California forward, as we have a goal to decarbonize our entire economy by 2045. So, this obviously is a core part of that. So, it's very important in that respect as well.

So, with that, I will ask my fellow commissioner, Commissioner Gunda, would you like to take a mic and make some opening comments?

COMMISSIONER GUNDA: Yeah, thank you, Commissioner McAllister. As usual, I always love the workshops that you kind of lead and conceive of. I think they're just really rooted in kind of the idea around ideating and developing the record and really thinking through systems approach. So, really appreciate your leadership on this topic as well.

And as you mentioned, this is a relatively new topic for CEC, and I think it's very new for me. So, I'm really excited to take the time today to learn from so many of the experts that we're going to have on the panel, and have this dialogue today.

I think in terms of importance that you already raised, a couple of stats that I heard in preparation for this, is that about 28% of the total lifecycle emissions

from buildings today are coming from embodied carbon. And there's also another stat, which was really impressive to me that 8 to 11% of global GHG emissions, depending on what source we use, could be embodied carbon, which is a pretty massive stat.

So, as you mentioned, as we move towards the kind of carbon neutrality efforts of the state, I think it's really essential that we think through this. I'm actually going to take a cue from your typical remarks, which is that we are approaching more and more the integrated nature of our systems thinking and it's essential that we think about this in an integrated approach.

We have continued to move, especially from a building standpoint, and are purely thinking about energy efficiency and carbon neutrality. Now, we're talking about decarbonizing buildings. But like really moving into the realm of how do we make buildings a way to really think about all touch points of policy to decarbonize the essential points of contact.

So, I think the treatment of buildings in this system of like thinking about decarbonization really provides an opportunity for us to think of it more comprehensively and from a policy point, it's really important we try the decarbonization strategies for multiple fronts.

And I think this conversation would really push those conversations forward and put the necessary fire under a few pathways that we might not be thinking on a regular basis.

And so, I finally want to thank my advisor, Sudhakar Konala for leading the demand side efforts in our office, really helping me prep for this workshop. So, with that, I'm really forward to it. Thank you to all the stakeholders for being here and for the excellent panelists and speakers lined up. And thanks, as always to have Heather and her team for pulling this together.

Right back to you, Commissioner.

COMMISSIONER MCALLISTER: Thank you very much Commissioner Gunda, and you always have wonderful comments. I really appreciate that and keeping things grounded. So, thank you for that.

And lifecycle assessment has been with us for a while, but at the policy realm and really linking it to the project level is where there hasn't been sort of that logical next step.

And so, I think there's a lot of potential to align incentives in the same way we do with the energy efficiency piece in the buildings through the Building Code, but align incentives. And it's reflective in the fact that we have … a lot of the stakeholders who have been

telling us that we should engage with this have been architects. Because I think in part, their clients are telling them they want to decrease the carbon footprint of their construction projects.

But they are the front lines in the same way that maybe a contractor, a builder are the front lines in sort of the production build environment. Well, architects play a key role in that and certainly, across the board in all construction projects.

And so, I think that's reflected in our first panel where we have a heavy presence of architects and they really are in a position to influence purchasing procurement, make recommendations to their clients about how they do things. And so, we'll hear … I won't get ahead of it.

But I want to first just thank all of our panelists this morning, but in particular, Rebecca Dell, who is a really acknowledged leader in this realm of Embodied Carbon and certainly has done a lot of groundbreaking work to assess it from a technical and a policy level.

So, really, your leadership on this Rebecca, has been tremendous. And I guess, I don't want to cut you out Heather, so I'm going to pass it back to you so you can introduce Rebecca.

MS. RAITT: Great. Thank you. So, yeah, we're excited to have Rebecca here.

So, Rebecca Dell directs the industry program for the ClimateWorks Foundation. And previously, she worked at the U.S. Department of Energy in the Obama administration, where she coordinated implementation of President Obama's Climate Action Plan, and was lead analyst and author of the U.S. Quadrennial Energy Review.

Before her federal service, Rebecca was a scientist at the Scripps Institution of Oceanography, studying the interaction between the ocean and land-based ice sheets, and Rebecca has a Ph.D. in climate science from MIT.

So, thank you so much for being here, Rebecca, go ahead.

MS. DELL: Thank you very much for that lovely introduction and for those very helpful comments Commissioner McAllister and Commissioner Gunda.

I'm not going to use any slides for my presentation. We're going to have an opportunity to see a lot of … yeah, so that's great. We'll take the slides down.

So, I'm really excited that the Energy Commission is engaging with this extremely important topic. And we have a very rich panel of experts who are going to dive

into a lot of the details of both the technical and policy aspects of this.

So, I thought I would maybe start the morning with a story, and this is a story that will likely be very familiar to many people who are attending this workshop.

It's a story about a guy named Art. And Art was minding his own business about a half a century ago, when he happened to realize that for many important home appliances like refrigerators and other pieces of equipment, there was about a factor of four difference between the most energy efficient and the least energy efficient models that were available on the market. And that energy performance was completely uncorrelated with the price of the equipment.

And so, of course, he immediately realized that there were just vast quantities of energy being wasted as a result of this. But he, I think, realized two things that were even more important than the fact that we were wasting energy.

The first is that the cost of this wasted energy was not just in megajoules or in dollars, that as the population and the economy of California grew, if we continue to use energy in this incredibly profligate manner, we would have to transform many of our landscapes. We'd have to fill our coasts with giant power plants in

order to meet the growing demand. And we would do enormous damage to California's environment.

And the second thing that he realized was that this profligacy in our energy consumption was because we weren't measuring energy performance, and so, we couldn't manage for it. And what that meant was that there in fact were lots of low cost and even no cost opportunities to dramatically improve our both energy and environmental outcomes.

And the activism that Art Rosenfeld launched into as a result of this realization was instrumental in getting the California Energy Commission founded. And as a consequence, now, decades later, California's population has increased enormously. The size of our economy has increased enormously. Our energy consumption has not. So, this is a story about which the California Energy Commission can be justly very proud.

But what if I told you that Art and the inheritance of his project had missed half the problem? And Art and his inheritors have focused exclusively on the operational energy and the environmental impacts of that operational energy for buildings and equipment around California, but have not looked at all at the impacts of the embodied emissions.

Which is to say the energy consumed, the

environmental damage created by making the physical building materials, equipment, and other pieces of our built environment. So, in exactly the same way that back in the seventies, there was this profligate use of energy from a failure to measure and manage that yielded lots of low-cost opportunities for improvement in the same way.

Since we have not been measuring, since we have not been managing for the embodied emissions since then, we are both creating a lot of waste and also, faced with a lot of opportunities for low or zero-cost interventions that can significantly improve the situation.

So, as I said, my distinguished fellow panelists are going to dive into a lot more detail around the technical, financial, and policy aspects of embodied emissions. And so, in the remainder of my talk, I'm just going to try and answer three simple questions that I hope will help us frame this discussion and our thinking on the subject going forward.

First, what is embodied carbon? Second, why is it so important that we regulate it? And third, what are the considerations and opportunities around this that are specific to California? What can California bring to the table? What does California need to account for that other places might not?

So, first, what is embodied carbon?

In short, it is the greenhouse gas emissions from the full supply chain of a building or structure. So, that is the extraction, the manufacturing, installation, maintenance, all of that, for the materials. In its fullest form, it also includes the greenhouse gas emissions that are associated with the disposal of materials at the end of the life of the building or the structure.

So, as you can probably imagine, these emissions are really front-loaded. Most of these emissions are associated with making the building in the first place. And that's really important for the climate because a ton of CO2 emitted today is a lot worse than a ton of CO2 emitted 20 years from today. Because what we care about is the cumulative emissions, and we want to keep those as low as possible for as long as possible.

But it's not exclusively associated with the initial construction of the building. Routine maintenance, replacing components, retrofits, renovations, all of these things can generate more embodied carbon over the course of the building's use.

There are kind of two basic ways that we frequently talk about it. One is at the level of an entire building or an entire structure, and the other, is at the level of a particular material. So, we can say, what is the embodied carbon in kilograms of CO2 per kilogram of

material for reinforced concrete or structural steel or plate glass, or insulation?

We can also say, what is the total embodied carbon for the entire structure? And depending on how we measure it, we're going to be focusing our attention on different types of intervention. At the material level, measurement and regulation there is really going to incentivize better manufacturing practices.

So, if you have two cement kilns and one of them uses conventional production, the other one has carbon capture and storage and is able to reduce its emissions to the atmosphere by 80%, a material level standard is going to point you in the direction of cement kiln number two.

However, it's not going to get you to ask a question like, could we maybe use timber instead of cement in this context? Those types of questions are associated with the whole building level.

As you might imagine, the embodied carbon associated with buildings varies enormously based on building type and location. Because of this, the range of estimates that you that have been done for what is the total embodied carbon compared to the greenhouse gas emissions associated with operations of buildings.

Several very prestigious and high-profile organizations have done these estimates and they've come up

with pretty different numbers. Commissioner Gunda mentioned one of them. He said 28%. Other estimates have found that it's as sort of as low as a quarter and as high as a half, depending on kind of how you count it. So, that's basically what embodied emissions are.

My second question. Why is it so important that we regulate them?

Well, the short answer is that there are so many greenhouse gas emissions associated with building materials. The International Energy Agency has estimated that actually it's about 11% of global CO2 emissions that come from manufacturing, building materials, and construction activities around the world.

And that's dominated by a small number of structural materials, particularly steel and cement. But actually, the situation here in California, for reasons I'll talk about in the final section of my talk -- mean that the ratio of embodied emissions to operational emissions in California is much higher than the global average. It's closer to a half here than to a quarter and that's over a 50-year … usually depends on the estimate of like 40 to 60 years. But usually about a 50-year assumed lifetime for a building.

The other thing is that it's not just greenhouse gases, there are also other important environmental

consequences that are associated with manufacturing building materials. And that can be ameliorated at the same time that we're reducing greenhouse gas emissions using many of the same techniques.

These are things like air pollution, particularly these industries often have high SOx emissions, so contributing to acid rain and many health impacts. Water consumption, a particular importance in a semi-arid climate like California.

And of course, all of these environmental impacts tend to fall most with the heaviest burden on communities of color, low-income communities, and other previously disadvantaged communities. So, it's very important that we start measuring and managing the embodied emissions in our buildings.

So, what does California bring to this and why is it particularly important in California?

Well, first as I said, this is an opportunity for the California Energy Commission to double the impact of its building energy codes. The reason why the embodied emissions are so much more important here in California than in many other jurisdictions, there's three reasons.

The first is that California has a relatively mild climate. So, we just don't need as much energy for heating and cooling as many other parts of the world.

The second is that we have a relatively clean electricity grid. So, one unit of electricity is associated with fewer greenhouse gas emissions than in most places.

And the third, is that we already have quite an energy efficient stock of buildings compared to a lot of places, very much because of the good work of the California Energy Commission over the last several decades.

So, all of those things are driving down our operational energy and greenhouse gas emissions, which means that the embodied emissions are even more important here in California than in other places. So, you have an opportunity, as I said, to double your impact.

Next, this is essential if we want to meet our climate goals and maintain our global climate leadership. So far, the building materials industry, like many other industries in California have been our primary policy instrument for reducing emissions associated with them, has been the cap-and-trade system. This has not proven to be a strong incentive; very little progress has been made.

And in some way, that's not surprising because as of right now, it's very, very hard to find somebody who will be willing to pay you more for low GHG building materials than for conventionally-produced high GHG building materials. We need to create structures and

incentives that make that differentiation.

And we can do that through a lot of the same tools that the Energy Commission is already using. Building codes, standards, reach codes and other types of regulatory interventions.

A couple of other reasons why this is particularly important in California. One is that many people are surprised to learn that we still have coal-burning facilities here in California. We do, we've got eight of them. They're all cement kilns. These are the only facilities left in California that still burn coal as their primary source of fuel.

And associated with that are, compared to other types of facilities, quite shockingly high emissions of conventional air pollutants, like SOx and PM2.5. And so, we need to address those issues as these facilities are some of the leading offenders in the state in terms of these emissions.

Second, is that there are some opportunities here in California to deal with critical other issues at the same time, particularly fire and forest protection. Timber, including engineered wood products and mass timber are potentially a great way to reduce embodied carbon if we can use them instead of high emissions materials like steel and concrete.

And expanding mass timber industry here in California will contribute to our manufacturing leadership and will allow us to address the primary threats to the conservation of our forest landscapes, which are fire and development. Both of those, we can ameliorate through mass timber.

And so, there are an enormous number of both benefits and opportunities for the state of California, specifically, in taking a leadership role on embodied emissions.

I am really looking forward to today's panel, and I will just leave you with one final thought, which is would you write an efficiency code that only requires half a building to be insulated? If not, maybe we shouldn't be writing Building Codes that only address half of the problem of energy consumption and environmental impact.

Thank you very much. And I look forward to the discussion.

MS. RAITT: Commissioners, do you have any questions or comments for Rebecca?

COMMISSIONER MCALLISTER: So, well, I would just thank you for that great really sort of fairly in depth framing of this question and your challenge to us to figure out how we could systematize, inclusion of this in a Building Code, an element of the Building Code.

I think we probably need sensitivity as to how we would actually do that. And so, we're going to lay the foundation for that discussion today and move forward. So, I'm excited about this opportunity to get a handle on this big source of emissions and diffuse source of emissions.

So, with that, I think I guess, Heather, do you want to introduce each speaker or Rebecca, are you going to do that?

MS. RAITT: I think Rebecca is going to do that part. Go ahead, Rebecca.

COMMISSIONER MCALLISTER: So, I don't have any questions. I mean, maybe my question implicitly to all of the speakers is sort of what models might we look to, to actually do the accounting and sort of put some rigor on this to make sure that okay, well, there are systems by which cement and different building materials, steel, can be rated by carbon content and sort of how can we be fairly rigorous and make it accountable if we were to put in a place analogous, put in a system analogous to the Building Code which does require transparency and rigor in terms of compliance?

So, just functionally, how might that work in the California context? It would be my kind of general question for you, Rebecca, and for all of the panelists here as we go forward.

Commissioner Gunda, do you want to ask any questions?

COMMISSIONER GUNDA: Yeah, Commissioner McAllister, I think I also want to acknowledge as Rebecca stated, I think that is incredibly helpful framing of the problem and kind of putting like an aspirational target on what we should be trying to achieve.

And I think as we go through this panel, it can be really helpful to hear the market-based model-based models, inventory-based models, and any local community-based models that are really trying to tackle this today, and anything that we could learn from that, that would be really helpful to hear as we go through this discussion.

I think I'm just trying to contextualize the magnitude of the problem, Commissioner McAllister, as you mentioned, it seems to be … it's both complex, I think, from a policy angle perspective on how to do this, but how do we go about it, I think is still – that's something I'm trying to grapple with. So, it would be really helpful is this discussion can shed some light on that. Thank you. Thanks Rebecca really, for framing this.

COMMISSIONER MCALLISTER: Great. So, I think with that, we can move forward with the panel. So, thanks Rebecca, again.

MS. DELL: Thank you, commissioners. And as I

said, we have a really great panel lined up. And so, I'm going to start by introducing our first speaker who is Harper Birgisdottir, who is a professor at the Department of The Built Environment at Aalborg University in Denmark.

She is the Head of the Sustainability of Buildings Research Group, and is also affiliated with the Danish Buildings Research Institute. And she's going to tell us a little bit more about the Danish experience in assessing and regulating embodied emissions.

MS. BIRGISDOTTIR: Yeah. Thank you very much for the invitation to participate today. So, yeah, I think I have been very well introduced, so I will just go straight forward … just before we go, I am working at the, like you said, at Danish Buildings Research Institute at the Aalborg University but we perform a lot of research on the behalf of the Building Authority.

So, a lot of the research we do is like commissioned by the Building Authorities. And that will be a lot of what I will present today.

So, perhaps we go to the next slide.

So, I guess it's small, but if you look at the left-hand side, the slide there, the figure there, this is the requirements and the Building Code on operational energy for the past 60 years in Denmark. So, there has been a lot of focus on strengthening the operational energy

requirements in the Building Code, and with also good results.

This is, of course, these are the requirements. When you see them starting using the buildings, of course, the result can be different. People are using more energy and so on, but there has been a lot of focus on reducing the operational energy.

And that moves us to the right-hand side, that now the focus is moving on the whole lifecycle of a building, which Rebecca so well described earlier that we are looking into the whole lifecycle, looking into the production of the materials on the building side, on the use of a building for a given period.

So, we often work with a reference study period of 50 years. We hope in Denmark that the buildings will have a lifetime that is much longer, but we calculate now for 50 years. And then we also look into the end of life of the materials and hopefully, as much as possible is reused or recycled.

So, if you go to the next slide.

Then there has been like this 10 years concentrated focus on LCA on buildings in Denmark. In 2011, Green Building Council Denmark was established and they decided to work with the German certification system, DGNB. It's similar to LEED, but what is special about DGNB

is that you are supposed to do a full LCA of the building for certification.

So, that is where we started working with LCA on buildings and develop tools for this. What happened in 2014, the governmental side, there was this political strategy on buildings where they first mentioned this vision for a voluntary system of building class in the Building Code.

And because of that, they started also the development of different things. For example, the National LCA Tools for Buildings called LCAbyg, which we have developed and built, and also several analyses and publications to help to introduce this subject to the building sector.

In 2020, the final of the Voluntary Sustainability Code of the class was launched. So, this is like voluntary, but related to the building regulation. And now, this year, the Danish government had this National strategy for sustainable construction. And here there is a requirement on the whole life carbon of a building. And I will explain that a bit later.

So, if we go to the next slide.

So, in relation to this, as I told you, we do a lot of research on behalf of the authorities, the building authorities. And in 2020, we published a report in Danish.

And we have an English version published this year, but it's the same study.

Where we did this whole life carbon assessment of 60 building cases. And the purpose of this study was to establish the sufficient data background on the climate in part of buildings in Denmark over the lifecycle.

I, of course, understand if you question yourself, 60 buildings, is that sufficient? But that is at least a big study compared to Denmark. And we are constantly working on increasing this data analysis now.

But from this study, to look into, if you could possibly develop some reference values based on this study, and they are linked to this report here.

And if you go to the next slide.

And directly to the results of the 60 buildings. So, here you see red and blue. We calculate the building whole lifecycle as we described earlier. And I know I cannot go into any details about this, but it is the whole life of a building for 50 years, including the construction of the materials and also, replacement of materials and end of life of those for 50 years.

And as you can see, the blue part of the results are the embodied carbon emissions, and the red ones are the operational energy, the carbon emissions related to operational energy for 50 years based on the requirements

as I showed you earlier for the building regulation.

We know that the consumption in the building can be larger, but this is what is included in the building regulation. But you can see here in Denmark, that the embodied part is quite large and more than 50%.

And if you go to the next slide.

Then I have one example of an office building. And this is based on 80 years reference study period, because we calculated both in the report, but it's very similar, the results.

What we can see … there are many different lessons learned from this study. But what we can see on the first one is that the embodied carbon is important for the results, the size of it is important in Danish conditions.

So, you can see that it's like 70% here in this case. And on the right-hand side and I know it’s small for you to see, but the timing of the emissions is also very, very important. And Rebecca was into that earlier.

So, maybe it's complicated, but you see the Y axis, this is the emissions of carbon and it's small, but the blue is still the embodied … and you can see, of course, we are building the building construction phase and so on. We emit 300 kilograms of CO2 per square meter.

And then because we are looking into replacements of materials and maintenance and so on, it will end up in

like 450 or something here.

The red one has a different shape and it's much lower. And that is because we also calculate in Denmark, the last part of the energy is from renewable energy, not all of it.

But also, we are taking into account the political agreements on how they're going to work with the renewable energy for the operational energy. So, that is calculated and included in our calculations. So, these two lessons learned here is the importance and the timing of the emissions.

So, we go to the next slide.

So, these are again, the 60 building cases. And from that, we could come with some kind of, giving some statistical values of mean value and upper and lower quartile. Our goal was not to decide how … or come to suggestions for like how ambitious should the targets be.

Our role was to calculate this and to show where is the mean value, where are highest buildings and that are the lowest building, and then the politicians and other people role to decide on the efficiency level. So, these are parts of our results. Here, embodied and operational energy, carbon is added together.

So, if you go to the next slide.

Then there was this governmental climate

partnerships. So, a group of stakeholders from the industry, they got the role from the government to suggest the government some … their suggestions or recommendations for how to go forward in the building sector.

And related to embodied carbon and LCA, they came with those suggestions based on the results of our study, that there should be a requirement on the whole life carbon of the building in the building regulation and here for all buildings, new buildings of 12kg CO2 per square meter per year.

And they should also know how will it be in the future. So, it should show in which future we are going into, so in 10 years or in 2030, it should be 6kg CO2. But we should also have this stricter requirements in a Voluntary Sustainability Class, which is then of 8.5 and then going lower in 2030. So, giving some incentives to go further.

So, if you go to the next slide.

It ended up that in March this year, there was this regulation where now CO2 emissions are a part of the regulation. And I think it's better if I show it on the next slide, how it looks like.

So, they have still this requirement in 2023. From 2023, all buildings larger than 1,000 square meter have to meet this limit of 12kg of CO2. And then we have the

voluntary CO2 class of 8kgs. And then every second year, the requirements will be stricter as I showed on previous slide.

And because I have very little time, I will go to the next slide.

And just to show you where it is. So, the ambitious levels is like we have to include LCA and requirements on all new buildings. So, that is a huge step. And that is the requirements from ‘23. So, maybe it's in the higher end of our results, but the voluntary class is then like trying to give incentives for the stricter regulations and so on.

So, it's just to see where it is compared to our results. And I think it's the last slide we have there.

Next one is that there is a lot of work going on now by the Danish Housing and Planning Authority. And a lot of this work is going on within my research group where we are working on further developing the tool, further developing the data available, further developing -- conducting this analysis on much larger scale of buildings.

So, preparing for ‘23 when this will be a requirement in the Building Code. So, thank you.

MS. DELL: Alright. Thank you so much for your comments, Harpa. That was a really informative discussion.

Next, we're going to hear from Daniel Garza, who

is a Senior Procurement Engineer at the California State Department of General Services, and he is working on the Buy Clean California Act, which is a really exciting and innovative program for establishing limits on embodied carbon emissions and construction materials specifically that are procured by the State of California for public construction projects.

So, Daniel, please take it away.

MR. GARZA: Thank you, Rebecca. Hi, as Rebecca mentioned, my name is Daniel Garza and I'm one of the co-leads for implementing the Buy Clean California Act here in the Department General Services.

Can I have the next slide please?

So, today's presentation is just going to be a brief overview of our program, what entails, to who it applies? What does it apply to, how is it going to be applied and when is it going to apply?

Next slide, please.

So, the Buy Clean California Act as you can see, states that the Department of General Services is required to establish and publish maximum acceptable Global Warming Potential limits for select construction materials.

This is just to target carbon emissions associated with production of structural steel, concrete reinforcing steel, flat glass, and mineral wallboard insulation. These

materials must have a Global Warming Potential that does not exceed the limit that will be set by DGS, by our program.

Next slide, please.

So, the legislation identifies the awarding agencies or awarding authorities as the following agencies. So, for this particular roll out of the program, these are the state agencies that are subject to Buy Clean California Act.

Within our department, we have the Real Estate Services Division, Caltrans, Department of Transportation, Department of Water Resources, Department of Parks and Rec, Department of Corrections and Rehabilitation, the University of California system, the California State University system and the Military Department. So, these agencies are subject to the Buy Clean California Act for their construction projects.

Next slide, please.

So, the legislation identified the following eligible materials. It identified structural steel. The staff that was assigned to structural steel have further defined this into the three subcategories; hot-rolled sections, hollow structural sections, and plate. This was due to just the fact that structural steel in of itself can entail a wide variety of materials.

So, we felt it was prudent to kind of limit the initial rollout to sections or to materials that could be identified readily. So, we have three sublimits that will be established for structural steel.

And then we have rebar and mineral wallboard insulation, and flat glass. And again, these are all identified by the legislation as the eligible materials under the Buy Clean California Act.

Next slide, please.

So, what we'll be doing is establishing the Global Warming Potential limits for the eligible materials. And we'll be posting them on our Buy Clean California webpage, and here's the link to the webpage.

And on our webpage, we have the latest information related to the Buy Clean California Act. So, if you're interested in delving further into the work that we've done, you can go to this web page and we've posted the information that we developed as we've worked on this program.

Next slide, please.

So, the implementation of it is centered on Environmental Product Declarations. The legislation specifically targets Environmental Product Declarations. So, what it requires is the Global Warming Potential that's identified in the Environmental Product Declarations is a

number that we will be using.

So, projects that come under contract after for July 1st of next year, 2022, are subject to the Buy Clean California Act. There's some exemptions allowed under the Buy Clean California Act. So, for instance, if applying the Buy Clean California Act to a project, results in the sole source situation, the awarding authority or the awarding agency can claim an exemption to the Buy Clean California Act.

As well as if it's additional project cost or maintenances of project time by applying it, they can exempt the project. It also allows for the awarding authorities to develop specific other situations that they can exempt from this program.

For instance, if the projects are maybe repair projects that are very small, the awarding authority can exempt that from the Buy Clean California requirements, but they must post on the website what their exemptions are so everybody knows in what situations they're going to exempt projects from the Buy Clean California Act.

So, we are responsible for setting the initial maximum Global Warming Potential limits for the eligible materials, but how this program is rolled out is up to each of the awarding authorities. Each of the awarding authorities has their own procurement process, their own

solicitation process. So, they're the ones that will be developing the specifics of the Buy Clean California Act into their procurement process.

We'll provide a framework because one of the items that industry has asked us for is if the Buy Clean California Act could be implemented in a similar fashion throughout all the awarding authorities. We realized that each awarding authority or awarding agency has their specific procurement methodologies and processes and procedures, but if they could be similar, it would be helpful to industry.

So, that's why we're trying to provide some guidance to them, but ultimately, the awarding authorities are responsible for the implementation.

Next slide, please.

So, one of the aspects of the Buy Clean California Act is we're to report to legislature the methodology that we used for establishing the Global Warming Potential limits. This is due January 1st of 2022. So, as I mentioned earlier, Environmental Product Declarations are the focus of the Buy Clean California Act.

So, we've been scouring online sources to identify as many Environmental Product Declarations that we can find that are facility-specific from which we can then calculate the Global Warming Potential.

Outside of having enough specific Environmental Product Declarations, we may rely on the industry average of Environmental Product Declarations for establishing the Global Warming Potential. So, we're currently in the process of identifying compliant Environmental Product Declarations for calculating this average.

Next slide.

So, more recently, Assembly Bill 137, a trailer bill to the budget passed. And what this did was it delayed the implementation of the Buy Clean California Act. Originally, the Buy Clean California Act was to be fully implemented July 1st of this year, which was last month. But due to the passage of this bill, it shifted implementation over one year. So, July 1st, so next year is the full implementation.

Also, we had previously … some of you may have seen our webpage in January where we have published the Global Warming Potential maximums for each of the eligible materials. We since have taken those numbers down since the passage of this legislation, which now requires us to publish it January 1st of next year.

And this was done to allow for more data to become available to ensure that we have the latest information in regards to Global Warming Potentials as represented in new Environmental Product Declarations. So, we will republish

our numbers January 1st of 2022 as maximum Global Warming Potential.

One of the other items that AB137 did is it now has brought in the Air Resources Board as a consultant to Department General Services in looking over the methodology. We just want to make sure that all aspects of the methodology is looked at from not only the DGS perspective, but also from the Air Resources Board, being that they're the experts in climate change and greenhouse gas emissions here in California.

So, we actually have our initial meeting with ARB next week. So, DGS is looking forward to consulting and collaborating with Air Resources Board on this project.

Next slide, please.

So, the next steps for us because of the passage of AB137, it pushed all the implementation dates back a year. We developed a new policy to help awarding authorities figure out where they were at in regards to requiring collection of Environmental Product Declarations from their suppliers right now. So, that's where we're at in regards to developing policy to help them out.

We've also been communicating with the awarding authorities about their plans and how they're going to roll those out as well as external stakeholders because the passage of 137 obviously moved all the deadlines back. So,

now industry is left wondering what status of everything is.

So, we've been communicating with industry to explain where AB137 left the Buy Clean California Act right now. And that is it in a nutshell.

Next slide.

And this is just our contact information. We have a Buy Clean California mailbox. So, if you have specific questions about the Buy Clean California program that's not on our website, you can always reach out to this mailbox which we monitor daily for any questions or comments you may have.

That concludes my presentation. Thank you for your time.

COMMISSIONER MCALLISTER: Thank you so much, Daniel and Professor Harpa.

I'm not going to try to pronounce your last name, I'm sorry. But so, what we're going to do with this juncture is open up for questions for the first two speakers because I think the Professor is already into her evening. I want to give her some flexibility and also, Daniel, has a hard stop here presently.

So, we wanted to just open up the dais for questions. Rebecca, I don’t know if you have any questions. I do have a couple quickly.

MS. DELL: Please go ahead.

COMMISSIONER MCALLISTER: Okay. well, so I am just incredibly impressed and heartened by the progress in Denmark. And it doesn't surprise me because I was at the Clean Energy Ministerial there a few years ago, and got really some in-person views of all of the advancements that are going in efficiency in buildings and somewhat of this of this arena as well.

So, thank you for your leadership and just in general, we can … California is often framed as the leader in many of these issues, but I think in the US, that's I'd say often the case, but globally, we really … in some key issues, we look toward you in Denmark and across several European countries. But in particular, I just want to acknowledge your leadership.

So, I guess my generalized question here, I guess, does apply to your two presentations, which are sort of, Daniel, you talked about the particular framework that the Buy Clean California Act kind of imposes or sets out for you.

Do you think that the infrastructure you're building for the sort of California State nexus could be utilized as platform for the markets, the building markets more generally? That's one question.

And then there's a question in the chat that I

actually want to advance as one before we move on as well.

MR. GARZA: Yeah, I think the framework for the Buy Clean California Act can be applied. One of the things that we found is that other states are implementing their own Buy Clean programs. So, I think … and on the federal level as well.

So, we've been talking to other states and GSA on the federal level. And they've got kind of a spin on kind of what we're doing. So, I think it's probably a hybrid model. I think it's not one size fits all. But I think aspects of this can certainly be applied to other construction methodologies. Maybe not in the same exact fashion, but I think definitely, it's promising moving forward.

COMMISSIONER MCALLISTER: Just a quick follow up; so, you mentioned sort of having in this initial kind of period, having to kind of settle with industry averages for some of these … I mean, I think part of the power of this is that it can help differentiate products within a market sector.

So, if you're talking about one kind of insulation over another, they actually vary tremendously in their carbon footprint and that would sort of tilt the playing field toward the low carbon, say insulation products or steel products. Is that kind of the vision eventually to

get there?

MR. GARZA: Yes, definitely. What we found, like I said, these Global Warming Potential numbers are generated from lifecycle analysis, so lifecycle assessments. So, yeah, the manufacturers that have cleaner -- and we found, especially in steel, they have a cleaner source of energy are the ones that are going to have lower Global Warming Potential. So, it would drive industry towards cleaner sources of energy.

COMMISSIONER MCALLISTER: So, in some of those less articulated sectors, it's a little bit of a work in progress, but that's the vision across the board. That's great to know.

I did want to acknowledge the presence of Commissioner Cliff Rechtschaffen from the Public Utilities Commission. So, thank you for joining Commissioner, really happy to have you here. I think this will be a collaborative enterprise.

I was really happy to see your engagement with ARB coming up because I think that'll be key and our vision could potentially be … and I don't want to really commit to this because I'm not sure it'll be the right pathway. But we do have a lot of tools in the Building Code to kick out operational carbon as sort of an FYI for building designers in the performance path of the Building Code.

And so, we have modeling tools already that are in use, and it seems like we could potentially sort of graft on a database of materials and track that and have it kick out initially maybe a voluntary number "FYI, here's your carbon footprint," but then actually use that for a regulatory approach along the way. So, I'm kind of heartened by this.

I'm interested, and Professor -- and this will be my last question. I'll pass off to Commissioners Gunda and Rechtschaffen.

Professor, have there been any particular difficult spots or negotiations in terms of establishing a prescriptive framework and actual goals and requirements and sort of bringing the industry along with that? Have you encountered any particularly difficult or sticky barriers along the way? Because you've been at this for a good decade.

MS. BIRGISDOTTIR: Yeah, of course, it has been. First, the LCA path is very new in the building sector. So, we are like introducing like a new discipline into the … introduce design phase. So, the architects and engineers need to learn this.

And of course, we have some of the one that has been in informed, they have tried it; the ones that have been working with the certification system. But now, we

have to bring it to everybody that are working with buildings with it. So, that is of course one thing.

We have been developing the tool. So, that is also of course, to make a user-friendly tool to get the data right, and get enough data into it, and to establish the knowledge about the climate impact. So, of course, there are some difficulties but what we can see also from the calculations of these 60 building cases is that the potential is quite high.

So, the difference is between -- just if you look into a single-family building, single family house, then there can be two or even three times the difference in the climate impacts of a building. So, there's a huge potential there. So, I think it's very, very important for us to overcome these problems that might be.

And now, of course, I think it has been a good idea that the government got like the stakeholders, the industry onboard, so they came with the recommendations first, so that also engages the stakeholders. But of course, and now, the questions are some are saying the requirements are too ambitious. And the other ones say, it's not too ambitious. We need to do much more. So, there are a lot of discussions going on.

COMMISSIONER MCALLISTER: That's actually good. That's a good synergy. Because you want people to tell

you, you need to go farther, because that helps you actually create the opportunity to do that.

So, I was just blown away. I imagine everybody here was blown away by the fact that three quarters roughly of the footprint is actually embodied. I mean, you have a relatively clean grid, so that's part of that. But that's amazing. And so, it really does highlight the fact that we have to focus on this.

One last thing, there was a question that's been answered; Sean Mulderigg, but he asked about; does the state provide any programs to sort of favor in-state manufacturers and position them well to supply these low GWP building materials?

And I wanted to maybe just suggest, maybe ask Daniel, is Go-Biz factor in here or tools that the state has to promote in-state manufacturing and economic development? Because it seems like maybe that might be an interesting agency to involve, at least in the sense that we …. obviously, all things equal, we would want these materials to come from California-based companies.

MR. GARZA: Not to my knowledge, like I said, our team is mainly just focused on developing the standard, the Global Warming Potential standard. We really haven't had an opportunity to go beyond that in regards to promoting the program.

And then the standard -- I think the awarding authorities, the awarding agencies, they're the ones who are working with their suppliers. So, I'm not sure what programs they have available to help them.

COMMISSIONER MCALLISTER: Okay. I mean, I can see Go-Biz, IBank and economic resources kind of helping to foster development locally in California, but this is phenomenal. So, I'm going to stop there and pass the microphone … oh, Rebecca looks like you have a question, but-

MS. DELL: Well, I was just going to add a piece of information on that or two pieces, really; one is that for a lot of reasons, California manufacturers tend to be cleaner than the national and global averages in many of these industries -- not all but many. And so, there is some kind of built-in advantage that way.

The other thing I wanted to flag is that the trillion-dollar infrastructure package that's currently making its way through the US Congress includes a provision to provide grants to small and medium enterprises to cover the cost of doing the Environmental Product Declaration in the assessment of their emissions. And you

COMMISSIONER MCALLISTER: You'd also imagine that the transportation piece of getting the materials to the site and everything, if it's coming across the country,

that's part of the footprint. But I guess our analysis would actually determine what impact that actually has in any given product category.

MS. DELL: Yeah. That is part of the analysis certainly, though perhaps my fellow panelists will correct me if I'm wrong. But my understanding and my experience has been that those transportation emissions tend to be a pretty small amount of the total lifecycle, single digits of percentage.

COMMISSIONER MCALLISTER: Okay. Great. Alright, well, so Commissioner Gunda, and then Commissioner Rechtschaffen, did you want to add or ask any questions to our … I guess, focused on our first two panelists for now?

COMMISSIONER GUNDA: Yeah. Commissioner McAllister, thank you. I think I also just want to recognize both Professor Harpa and Daniel's presentations. It's extremely informative especially for me who is just in this learning mode of trying to soak in the information today.

One question to I think both of you, if you're able to construct a response -- and - maybe actually two, and I'll just it, and then see what you think.

The first one is really Dr. Harpa for you, as you're looking through the case studies, obviously, you're looking at multiple sectors of buildings and such. But

across those different sectors or within each sector, are you observing correlation between a lower embodied carbon and anything whether it's building types, location … so kind of basically getting it to the extent that there is a current pull from the market from the consumers; where is that? And how do we leverage that? That's kind of one kind of topical question.

And the second topical question is something along the lines of, we are trying to decarbonize the economy and then put regulations and policy goals across a variety of streams, right? So, for example, you have the clean electricity goals. I know you have the building goals, whatever it might be.

Do you, in your current thinking, observe some best practices on how to think about these various regulations collectively, and ensure that they don't get in the way of each other?

MS. BIRGISDOTTIR: Should I start with building types that what we looked into. What we were able to look into in this study was mainly residential buildings of different types and office buildings.

And what surprised us a little bit was that we didn't see differences in the mean values of the different building types. So, the mean values of single-family house and the multifamily house and office was very similar.

But within each building type, there was this huge range. So, the potential is realized. We want, of course to … a researcher, we always want to expand our data and look into much more cases. So, I guess when we have much better data, then perhaps, we'll see some differences, but the results here in these types of building, it was what not.

What we hear from the industry and the engineers and architects working with us, that, of course, there are building types that will have some challenges, could be like hospitals, and the swimming pools, different types of buildings that could have some problems meeting this.

So, that is one thing that we're really looking into now, how to meet this, because of course, we want to make safe and good hospitals and so on and look into what the potential is.

There's also been where is the solution? Can we look into which materials to use? We know that using structural materials of wood can lower it. It is not just enough to say it because we also experience that the other materials in a building, although you have structural materials in wood, it can then increase.

So, it's not enough, so to just say use wood, you have to do the LCA. Yeah, I think that is perhaps my answers to the questions. I hope it answers?

COMMISSIONER GUNDA: Thank you. And Daniel, I don't know if you want to comment on anything, or add to Dr. Harpa?

MR. GARZA: No, I have nothing to add to that. Thank you.

COMMISSIONER GUNDA: Back to Commissioner.

COMMISSIONER MCALLISTER: Great. Thank you, Commissioner Gunda. Commissioner Rechtschaffen, did you want to ask any questions? I know we're all trying to kind of get our heads around this a little bit. From a regulatory approach perspective, I think there's a necessary conversation and really a lot of research almost to figure out which data authorities are the most relevant and most apt for engagement on this topic.

Certainly, likely that the Building Code will have something to say about it. And I know the Building Standards Commission has at least begun to think about something like this arena. But ARB and DGS and other agencies likely will have some engagement on this. So, not sure. And the PUC, obviously, with its program resources could possibly approach this topic as well. So, just interested in your perspective on this.

COMMISSIONER RECHTSCHAFFEN: Well, thank you very much, Commissioner McAllister, it's a pleasure to be here to continue our collaboration on these crosscutting issues.

I have a quick question for Daniel. I don't think you mentioned this or I was not on for the entire time.

When you've been establishing your standards for Global Warning Potential materials, have you looked or are there Voluntary Codes or Voluntary Standards that you've been able to draw from?

I know you said other states are following what California's done, but are there other codes or voluntary sources that you've been able to draw from?

MR. GARZA: No, we haven't seen any other codes. Like I said, the legislation identified the use of Environmental Product Declarations for establishing the Global Warning Potential. Like I said, other states are looking at establishing global warming limits.

Some don't refer to Environmental Product Declarations. Environmental Product Declarations are governed by various ISO standards. So, that's the extent that we've seen other codes is maybe some of the ISO standards that govern the development of the Environmental Product Declarations from which we identified the Global Warning Potential.

COMMISSIONER MCALLISTER: I wonder if Rebecca -- thanks for that question. That's a fantastic one. And I wonder if Rebecca, do you have any … so it's good to hear that the ISO has standards for this. I guess, I'm

interested in maybe a view of how rigorous it sounds … how sort of on the spectrum of voluntary to completely mandatory, kind of with hard oversight, where do these Environmental Product Declarations kind of stand on that spectrum?

MS. DELL: Yeah. So, that's a great question. And I'm sure we're going to hear more about it from the other panelists. As it now stands, there are a few different types of declarations, of environmental declarations for products that have associated ISO standards. The ones that we typically use require third party validation.

But as of right now, we don't have anything like a kind of a government maintained and verified database, and they continue to be a voluntary tool. And so, as more and more policies are referring to these standards, in the United States and also in the United Kingdom, and some other countries, we probably are going to want to kind of institutionalize and formalize this a little further.

COMMISSIONER MCALLISTER: Great, thank you for that. I wonder Professor Harpa, did you have anything to add there in terms of just the rigor of the of the Global Warning Potential, the embodied carbon materials and tracking, the sort of rating and tracking?

MS. BIRGISDOTTIR: No, I don't think so.

COMMISSIONER MCALLISTER: Okay. Thanks very much.

Well, so this is just a fascinating topic. Commissioner Rechtschaffen, did you have any other questions you wanted to ask?

COMMISSIONER RECHTSCHAFFEN: No. Thank you, Commissioner McAllister.

COMMISSIONER MCALLISTER: Okay, great. Thank you very much. And we could probably keep going on just with you two, but we've got to get out our next speakers. So, we're probably running a little bit behind.

We have the luxury of a little bit of time this morning because this is such a fascinating and relatively new topic for us. We're relatively unschooled sort of as a regulatory body on this. And so, it's nice to have a little bit of time to vet some ideas around. So, thank you for your engagement. I really appreciate both of you, Daniel and Professor. I appreciate that.

Alright, so Rebecca, back to you and we'll keep moving.

MS. DELL: Great. So, our next speaker is going to be Bruce King. He is the founder of the Ecological Building Network. He's a registered engineer with 35 years of experience around the world in structural engineering, and construction. He’s the author of numerous books, technical analyses, guidelines and standards related to

these issues and a real leader in the field.

So, thank you very much, Bruce.

MR. KING: Thank you, Rebecca. And thank you commissioners for having me today. Great to have a chance to talk.

I think I want to start by giving you my central message, which is that it's gratifying to see embodied carbon come into the public's attention, into governmental attention so much, so quickly, and that's great, and I'm happy to help out in any way I can.

I wanted to drive home the point that we need to do a whole lot better than zero. The conversation remains still as it has been in climate talk across society, getting to zero. Everybody talks about getting to zero. It's a commonly reframed goal; is get to zero by 2050, by 2040, whatever.

Which is a good start for sure. But what we're talking about today with embodied carbon presents an exciting possibility that hasn't been present before, which is to sequester the carbon to get it back down to earth. You cannot sequester carbon with the operation of a building. You can with the construction of a building.

Next slide, please.

This is a short answer. Why? you've all seen this kind of graph before; atmospheric carbon's been banging

around between 200 and 300 parts per million in the time that our species has evolved. And in the last century, it's quite shot up now. What's the latest reading? 416.

If we could stop on a dime burning fossil fuels tomorrow, get to zero tomorrow, we wouldn't be out of the woods. There's still a trillion tons of carbon roughly that we've put up in the air since the industrial revolution. And we're going to have to bring that back down again.

Next slide, please.

I hope that you've all read Paul Hawkins seminal book Drawdown that drives home the point that there's a lot of ways, pretty easy ways, really, to bring carbon back down to earth.

Next slide, please.

Buildings are a good way to do that. Right now, carbon is being drawn down. Ocean is the default. The carbon is being absorbed by the oceans to tragic effect that I'm sure you're all aware of. If we wanted to bring it down ourselves in a positive and non-harmful way, there are two big repositories.

Soil and everything that's happening in regenerative agriculture and buildings. Buildings use an order of magnitude, more physical stuff than anybody else. So, we are both a huge emitter, but also hold the promise

to be an absorber. And concrete is the number one target right off the bat.

When you start studying buildings, it's already come up a few times about cement. Concrete is 8% of globally emissions.

Next slide, please.

I did a little math. You hear we make 10 billion tons of concrete every year on earth. Well, yeah, it's a lot. And it's just another big number that goes through your head. So, when I did the math, I got a cube that looks like that compared to the Eiffel tower. It's a mile on a side every year of concrete that we make.

Of course, you don't see it here in California because we don't do anything close to that. It's all in China and India. But that's an awful lot of emission. Pound for pound concrete's a very low carbon material, but the net effect of 10 billion tons of anything is going to be huge.

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With that in mind, and with the wonderful seminal work of Art Rosenfeld in the Energy Commission very much in mind, we set out in Marin County to see if we might address that through Building Code, and start with concrete.

The tumblers all fell into place. We got support from the Bay Area Air Quality Management District. We had

a sympathetic building official and commissioners and so on, and with a great stakeholder process over the course of a year, we evolved some language that was adopted into law, went into effect a year and a half ago here in Marin, right at the start of COVID basically.

I won't go into the details of that. It's all available for anybody to see, and we hoped that it would go viral. We don't pour enough concrete in Marin County to fill your coffee cup, but the rest of the world does. And we hope that as with the Energy Commission's work, that we could do something that might get noticed and go viral. And sure enough, to some extent, I'm gratified to say it has.

And I've been working with a number of people, including State of New York, Australians, various places. And more importantly, right now, I'm working with a national organization. ASHRAE publishes their standard 189.1, which is the basis of our green construction code.

And this is going to be tougher going, it's going to be more watered down because the big industry players, cement and steel are there. But it's also going to be positive because it will a national standard. Probably come to fruition sometime next year and be adopted into the green construction codes in the next code cycle. That's our hope anyway. So, that process is ongoing right now.

I also worked with the Federal General Services administration as they developed over the past year some procurement standards. So, there is a lot happening at the federal level with policy.

Next slide, please.

By the way, go back, please. I show you this picture of the new San Francisco Bay Area bridge because it's our poster child. Caltrans used low carbon concrete to make this bridge. Not because they were trying to do right by the climate, though they were aware of it, but because in most cases such as this one, low carbon concrete is better concrete, more resistant to salt water and salt air and protects the steel better.

We're not talking about adding a lot of expense here. We're talking about decreasing expense and making better concrete.

Next slide, please.

The other two big ones in the Embodied Carbon world -- there are lots of little ones, but there are two other big ones. And one is steel, the other is refrigerants. And I understand there's a whole afternoon session, so I won't even try to talk about those.

Steel is the other big one, but it’s not so easy to reduce the emissions of steel. That will take infrastructural changes, going to hydrogen-based steel and

renewal energy-based hydrogen … a lot of background, upstream stuff to improve on steel.

They already recycle a very large percentage of what they make. Nonetheless, there's a lot of work happening there. We're also working on steel in our ASHRAE committee to develop a national standard.

Next slide, please.

In the world of so-called natural building that I've been hanging around in for 20 years, straw bale construction, rammed earth, bamboo, all those fun things. As you can build a house out in the woods in Mendo County with. I always wonder, well maybe the are some principles that work here that would apply to climate emergency.

And sure enough, there are, because basically, it means what's near at hand and don't try to change it too much. Don't try to bake it or pressurize or make molecules be what they don't want to be.

The prime example of natural building is to use what you've already got, which in our case is existing buildings. I believe Henry Siegel's going to be talking a little bit later and talk about this more.

But it can't be emphasized enough that though we're talking about embodied carbon, probably the biggest impact single category is to make sure that we keep buildings we've got, rather than replacing them with

something else and improve them, give them an energy upgrade.

In a sense you're talking about operational carbon there, but the embodied carbon deferred or avoided is gigantic. So, the opportunity here is huge.

Next slide, please.

The other big opportunity is agricultural byproducts. The world produces a cubic mile of concrete every year. The world also produces two cubic miles of straw in the byproduct of making our food; wheat, rice oats, barley, et cetera.

2 billion tons of straw looks like that compared to the concrete. If we turned all that straw into building products, which were rapidly learning how to do now, all sorts of companies appearing everywhere, we could negate all the emissions from all the cement, for example.

It's a huge opportunity, lots of companies in various stages of development right here in California have a history of with straw in California and plenty more opportunity in front of us there.

Next slide.

There’s all sorts of ways we can build with plants. Let the plants capture the carbon. Let mother nature do the work, and then turn it into building materials.

Our colleague, Will Srubar at the University of Colorado did a study of how much could you capture per acre per unit of land, and softwood forest and straw don't actually look that good compared to hemp which doesn't even look that good compared to algae. Algae-based products as they're just starting to appear in university labs. And in some cases, even with products.

There's a company in North Carolina, making bricks using not algae, they're using bacteria to make bricks at room temperature, really high-quality bricks. I think they have contracts with the Department of Defense now.

We're just starting to learn how to use microbes. So, the whole category of the tiny creatures that we can't see with our eyes to make concrete bricks, building products of every sort. And in doing so, absorb and store permanently carbon.

Next slide, please.

Here's some examples. The slide on the left is a company in in Europe making sort of, I call it straw bale 2.0, prefabricated straw panels with wood-frame structural system. It's all manufactured in a factory and then put together onsite. They're going gangbusters, EcoCocon. And they're starting to set up shop in North America, just getting their foot onto our continent.

On the right, I just showed that to answer a

question that some people have, well, what about plant-based materials? Aren't they going to burn? Actually, no. No more than anything else. I can give you all sorts of examples of industrial materials that burned horribly, like the Grenfell Towers fire in London a few years ago.

This is a straw bale house that went through the recent Wine Country Fire with flying colors. It did really well. So, we already know a lot about how to build a cellulosic material, it's called wood.

Next slide, please.

And I already have seen some questions in the Q&A, and even heard things in the talks implying that if you build with timber, if you build with wood, you're doing the right thing by the climate. No, I'm sorry. It's not necessarily so. Our industrial forestry practices are not terribly regenerative and they're not good for the climate.

It's a very, very complicated picture. I couldn't possibly summarize it for you here, but suffice to say, that we have to pay attention to how we manage the forest before we start amping up our use of wood for buildings.

The picture on the left is forest certified by the Forest Stewardship Council, FSC certified. It has been logged six times in the past few decades.

The picture on the right is a sustainably harvested forest by the industry standards, SFI, and you

don't need to be a forester to look at that and go, "Something's not quite right about that forest."

So, very large asterisk caveat that goes along with let's use wood instead of concrete and steel. As a structural engineer, I say, "Yes, it's fine. We can do that." As a citizen with children, I say, no, it's not necessarily the right thing by the climate.

There is a lot of opportunity, as somebody touched on a moment ago, that we could thin our forest in California, reduce fire risk and turn the trees we take into lumber. And I know there's some efforts going with that sort of thing. So, that's to be encouraged for sure.

Next slide, please.

Well, I just finished writing another book about all of this stuff and we did a bunch of calculations and came up with this; that if we shoot in that direction, we can be absorbing, durably storing 15 gigatons of carbon per year by 2050.

I put these slides together in a hurry for this thing, I should have put on there 2050. That's what 50 means. But 15 gigatons by 2050 if we push ourselves in the right direction. There's that much opportunity in the built environment globally. And people do what California does. We can set a standard, start the lead and aim towards beyond zero.

I think next slide is my final slide? Yes.

This is a book I wrote four years ago. Kate who follows me in a moment helped write it. And is doing great work up in Washington, but you'll hear about that in a moment.

A whole lot more about all of these subjects in this book, if you care to look at it. But I can't emphasize enough, we have the opportunity to not just get to zero, but beyond zero and turn buildings, the whole built environment in California from a net emitter to a net absorber. The technology is there, it just needs the will.

And I'll leave it at that. Thank you very much.

MS. DELL: Thanks so much, Bruce. For our next speaker, we have Kate Simonen, who is the chair of the Department of Architecture at the University of Washington, known to its friends as UDub, and is also the Founder and Director of the Carbon Leadership Forum, a very important group in this space.

MS. SIMONEN: Thank you, Rebecca. I'm going to just go ahead. It's just thrilling to be here with such great panelists who've really done a great job of setting the stage here.

Next slide.

So, the Carbon Leadership Forum, we've been working over the last decade focused on understanding the

impacts of material production and our shared goal is to eliminate the emissions from building construction.

And so, as has been highlighted, embodied carbon is the emissions from making building materials. And that comes from a whole range of sources. It comes from the burning natural gas or coal at a factory. It also comes from chemical reactions that take place when making materials like cement and steel. It takes place from generating electricity that's used in manufacturing, it's the diesel trucks driving things around; trains, planes, and automobiles.

So, it's all of those things -- those emissions that take place when we make building materials. And it's also the amount of carbon that's stored in the material like Bruce talked about like biogenic materials. In the creation of those materials, carbon dioxide is removed from the atmosphere and stored in the material.

Next please.

We've seen a range of things about talking why embodied carbon is urgent. And I think it's really interesting to highlight again, that those upfront emissions take place now, right when the building start to take place, and that you can't reduce them after the fact once they've happened.

And I think really interestingly thinking about

the systems that are interrelated here, we're talking about -- we can talk about it from the building scale, what I'm looking at here. These are the emissions that take place over the life of a single building and looking at them.

But we also can look at it from a sector scale. And so embodied carbon is related to industrial emissions. And decarbonizing industry is not something that can happen turning on a dime. So, if we want to incentivize industrial decarbonization, we need to start doing it now so that we can see the impacts in the next decade. And if we want to reduce the impacts of buildings, we need to do this now because those upfront emissions happen now.

Next.

And so, this is just highlighting that embodied carbon, the impacts, if we look at this is total greenhouse gas emissions globally by end use. And we can see that iron and steel and cement come up as specific segments of our industrial emissions, but there's also other industrial emissions that come through all other building products from carpet to glass and other things.

So, there's a large impact. And the building sector takes a great, high percentage, almost all of the cement, 50% of the iron and steel goes into buildings and infrastructure. So, we as the building industry is a large market pull for those materials.

Next.

And as has been mentioned, the emissions from making building materials disproportionately impact frontline communities; communities that are living and working at the manufacturing facilities. And that as Rebecca talked about, there are local health impacts from those emissions that in addition to global greenhouse gas emissions that can be addressed when looking at supply chain related emissions for building materials.

Next.

So, when we look at the opportunities to reduce embodied carbon, we can see that as was really mentioned, there are lots of opportunities available today that are low or no cost differences to impact embodied carbon.

The first strategy really is about optimizing the project. So, that means reusing buildings that are existing, reducing the amount of area, building smaller buildings, designing buildings so that you could use the materials at the end of the life, reusing building materials.

A second strategy is around optimizing the system. So, this would be where you might use those prefabricated straw wall panels that Bruce shared instead of a glass and aluminum system. And in those, when you're looking at trading out systems and strategies, you really need to look

at a total lifecycle perspective.

You need to understand the impact of operating energy, as well as embodied energy, and the maintenance and end of life impacts of them.

And then the third strategy is really around optimizing procurement. So, that would be looking at Buy Clean policy as a procurement optimization strategy. When I know that I want to buy steel and I'm going to buy two pieces of steel that have the same performance aspect, can I incentivize or prioritize purchasing of the manufacturer of that product that has lower emission?

And as was mentioned, Environmental Product Declarations are the typical ways in which low carbon procurement is done. All of these are using a lifecycle approach but they have sort of different levels, different types of tools that are available to use that lifecycle approach.

So, in optimizing your project, you're typically looking at incentivizing building and reuse and circular economy principles more generally. When you're looking at optimizing systems, you're typically using whole building lifecycle assessment tools that let you look over the life of the building and with procurement, you're using Environmental Product Declarations.

Over the last decade, there's been increasingly

available data and tools for use in North America. Whole building LCA tools exist and they are integrated into existing design software systems and they are being used right now to satisfy LEED rating criteria for whole building assessments, as well as to do individual studies.

There is an existing database of Environmental Product Declarations, the EC3 tool That database has over 40,000 materials and is being used by something like 15,000 individuals in searching for materials.

And so, these different strategies can be applied in a range of different ways. At the Carbon Leadership Forum, we've been working to help advance the data and methods in each of these different strategies.

Next.

So, I just want to highlight, as Rebecca talked about, there are really two typical approaches. One is a building-scale approach and as Harpa was talking, in Denmark, she was describing that building-scale approach.

We have research that has compiled multiple whole building lifecycle assessments over a thousand buildings. We too found something very similar to the Danish, is that based on current information, the range of impacts between materials is quite high indicating opportunities for improvement, and that we do not yet have statistically refined data to be able to differentiate between something

like an office building or a residential building. But we're moving in that direction.

And then a material-scale approach. The Carbon Leadership Forum has developed material-scale baselines. So, for materials that are in the EC3 tool, we have developed ranges of a typical value somewhere around an average and a high and a low value to get an idea of the range of those materials, based on published Environmental Product Declarations.

Next.

So, we have a team at the Carbon Leadership Forum working on embodied carbon policy. We've published a policy toolkit that provides information about how to approach different policy practices and include some of the information shown here, like in Embodied Carbon 101 for policymakers, information about Buy Clean and Environmental Product Declarations as well as additional resources available.

On the right, you can see a policy tracker. So, that's looking at US-focused embodied carbon policies. So, we see in gold there, you see California and Colorado who have adopted Buy Clean policies. Washington and Minnesota have just recently passed Buy Clean-related study bills and other states are looking at variations of that.

So, we see a fair amount of work at state level,

looking at different types of policy. But cities, we can see a whole building policy that can be highlighted in Vancouver and developing and being under exploration in Boston. Those policies at the building-scale have been related to zoning codes in particular.

And let's see … I think just in general, just wanting to offer to the state that if any of your departments are exploring embodied carbon policies, we have teams that are interested in understanding what your criteria are and trying to help answer questions around lifecycle assessment, data, tools, and policy development.

Next.

I think that was my last slide. So, yep, that was my last slide. I'm looking forward to having some discussion with all of you. I can talk about this for hours.

Thank you.

MS. DELL: Thanks so much, Kate. That was great. For our next speaker, we have Emi LaFountain who is a Sustainability Project Manager with Turner Construction, the largest general contractor in the United States.

She has degrees in civil engineering and water and energy sustainability, and she manages Turner's embodied carbon program and their 2030 goal to reduce jobsite carbon emissions by 50%. So, thanks very much Emi.

MS. LAFOUNTAIN: Great, thank you so much. If you can go to the next slide, we're going to talk about today a little bit about what contractors are doing as part of the process and what Turner specifically has done and where we're headed in terms of embodied carbon quantification and reduction.

So, before we dive in, I wanted to just give a little bit of a state of the industry in terms of where a lot of the focus has been in terms of embodied carbon and why.

So, there are limited studies on at least projects within North America, looking completely between the A1 to A5 phases of embodied carbon quantification with A1-A3 being kind of embodied carbon materials. A4 for being the transport, the jobsite, and A5 being the actual construction process itself.

So, take it with a grain of salt, but we have taken a look at a few of the phases that are out there, and I think something to really consider when talking about embodied carbon is the relative impact of each of these phases.

So, as you can see kind of here, there's a representative building where the embodied carbon of a building that was put up in British Columbia represented about 90% of these A1-A5 emissions, whereas the

transportation to the jobsite or the materials was about 5% and the construction was another, roughly 5%.

So, I think thinking about things like construction phase and emissions are important to have this plan when engaging in conversation.

But if you go to the next slide, the way that I broke out this presentation was into those different phases and how you can enact with your contractors for each of those phases.

So, for the next slide, what I brought up here was basically the process by which one can engage your general contractor. So, with your general contractor, there's several pathways for you by which you can engage on embodied carbon.

But one of the main ways is talking to the trade partners really early on. At the legislative level and at the theoretical level, there's a lot of goals to have a really good understanding of embodied carbon. But that understanding hasn't in many industries, been translated down to the trade partners, which are in the most cases different than a manufacturer.

So, you can have your manufacturers who're actively working on developing EPDs. Some of them aren't, some of them are, but the people who are responsible for procuring those are the trade partners. And so, even

finding a high level of understanding within the concrete and steel industries, but the trade partners are involved in other sectors of industry are not nearly as familiar.

So, talking to your trade partners really early on to help push the supply chain is going to yield a higher rate of success, especially for those materials that are categorized within Buy Clean California.

Contractors will also be responsible for helping collect EPDs. So, really, it's important to talk to your contractor early on to make sure that they're engaging conversations, because what you don't want to have is there are Buy Clean California requirements or other similar requirements, you don't want to have a situation where it's just paper collection at the end of the project. That takes the value out of collecting EPDs away. It really has to be considered during the estimating phase.

And other reason why we ask for that is because you want to be able to price out the lower carbon pathways. EPDs are only measuring documents. They don't help actively reduce anything. They just basically just tell you where you are.

Where it's helpful is when you compare product A to product B and use those different GWP, Global Warming Potential values, to be able to assign those different GWP values to actual cost and understand cost impacts to the

project.

Now, since your contractor is pulling the purse strings and making a lot of the procurement decisions, it's really important to analyze those things side-by-side.

So, one way that you can phrase it, is how can we get the lowest GWP at no additional cost and how much lower can we get the GWP with additional cost? And that's where your contractor partners is going to really come in handy.

Now, you can do that two different ways. One of the ways is by doing a whole EC3 analysis. And analyzing each of the pieces of the pie very granularly. You can go through a whole modeling exercise.

But it can be as simple as just having your foundations contractor, when they're doing their grout piles, for example, say, "Hey, we have performance specifications for the strength of the concrete. Give me a mix design A, give me mix design B, show me the relative global carbon impact."

And we can say, for this example on the screen, we had two different mix designs, and that the performance criteria no additional cost for either direction. And we identified that one of the mix designs had represented about a 20% reduction in carbon emissions. So, we just chose that one. It was as simple as that. And so not all of this has to have an additional dollar value.

And as we go through next couple of slides, I wanted to talk briefly about the A4 transportation emissions. So, transportation emissions are frankly in a much different place than embodied carbon quantification or even jobsite emissions. They're a little farther behind on how we can create a uniform standard of measuring that as contractors.

But one thing to note is that the EC3 tool is working on integrating in the EcoTransit tool, which will help us quantify transportation emissions in the future. And you can reduce your transportation phase emissions three different ways, really.

You can say, okay, we're going to procure it smartly. So, looking at domestically sourced materials versus getting it from Germany is going to be one way that you can do. You can say, okay, instead of using transportation method A, we're going to use transportation method B; whether it's shipping versus trucking or rail versus trucking -- each of the different transportation methods represent the different types of embodied carbon impact.

Another way that we're going to reduce those emissions is through fleet electrification. I know that there's separate initiatives going on within California on that front, but that is ultimately going to be a really big

contributor to us being able to reduce those A4 emissions.

And then another way that we can reduce it in the short term, is really thinking about interim fuel swap-outs, so instead of using diesel for the trucks, renewable diesel -- it's heavily subsidized in California, it's about cost equivalent, and it represents a significant part of savings per gallon if you look at the lifecycle emission savings. So, those three ways are how we're going to reduce the A4 emissions.

But one thing that I really want to highlight here is that because it's only 5%-ish of the total of A1-A5 pie, you shouldn't make decisions on material selection solely based on A4 transportation emissions. And if you go to the next slide, I'll show you an example, why.

So, here are two projects that both needed steel. One project needed steel and they were looking at two different places to source it from. And one of them was much closer, and one of them, was farther away in Arkansas.

And they found that the one that was closer would have smaller transportation emissions, but it would have a significantly higher GWP. So, they had just made the selection based on the proximity of the mill to the project, they would have had actually a higher lifecycle carbon emission.

Whereas they actually ended up selecting the one

that was farther away and because it represented a lower lifecycle carbon emissions for this project. So, it's important to think about it as a holistic system.

Now, if you go to the next slide, I wanted to talk about something that Turner has been spending a lot of energy on, and that's our construction emissions reductions. So, this is everything that happens within the jobsite fence from shovels in the ground to substantial completion.

And we have a few findings that we found over the course measuring about 150 projects over the past two years, all of the construction emissions that happened within the jobsite fence. And I wanted to show some of those findings that we've had.

So, for example, one of them is that it's really important to get off of generators as soon as possible. A lot of our projects don't get temporary power until seven or eight months in. And you can see the relative carbon impact of having that generator come online and replace temporary power.

Not only is it more expensive, but we're seeing that the generators typically produce about seven times as much carbon emissions to provide power to the site as when we finally get temporary power provided to the site.

So, there's a few solutions there like how can we

expedite the permitting process associated with getting temporary utilities to the site and end up saving a lot of money, a lot of criteria pollutants from a jobsite and also carbon emissions during that phase.

But there's alternative generator options out there. So, like during load sharing, where hybridizing the generators have a battery pack to help feed the lower-level loads. So, that was a finding that I thought was really interesting and pertained a lot to those different tiered emissions that we're looking at from a California-wide perspective.

If we go to the next slide, another major finding was that combustion-based heating during construction is a lot more carbon intensive than electrical. Now, if any of us read the IPCC report, I mean, I think we all know that methane is really kind of the bad guy, but this helps put it into perspective during construction as well.

So, we have two projects, one of them did combustion-based heating, one of them did electric-based heating, and you can see that the one that did natural gas heating had about 17 times higher carbon emissions associated with the heating.

Next slide, please.

Another major finding was that the majority of our electrical use happens once the project is on permanent

power. So, you can see here, you have the temporary power in purple. And once we start that commissioning phase activities, we're going to be entering a much higher phase of carbon emissions.

Next slide.

We also threw meters on a bunch of our projects, and we found that the majority of temporary electrical use happens off hours. So, if you take the area under the line, and you'll find that the weekends and nighttime represented about 60 to 70% of total electricity used during the course of construction. So, figuring out how to reduce that.

The next slide, please.

Another major finding that one might guess is that site equipment is one of the largest factors in carbon emissions on the jobsite. And if you go to the next slide, you'll kind of see the relative trend of the carbon emissions over the lifecycle of the construction process, where the site equipment doing a lot of the heavy civil work in the beginning.

The curve kind of goes down during the meat of the construction process, when you're starting to work on the envelope and interiors, and then it peaks again at the end when you work on that commissioning. And you might see some bumps in the middle because of temporary heating but

in California, that's not as much of a need.

So, this is a pretty representative of curve of projects that you might find in California. Depending on project size, the total emissions can be pretty significant during the construction phase.

So, these are the things to consider as you guys talk about policy, about how the data has been landing, you can assume the same general trends with water as well, which is a big concern for us in California of the same general M-shape.

So, if you have any questions about construction phase activities or A1-A3 embodied carbon and how to engage with a contractor, I'm happy to engage offline.

MS. DELL: Thanks so much, Emi. That was really interesting. So, we have one more speaker in this morning's panel, which is Henry Seigel.

He has been working since the early 1990s on sustainable design. His projects have won local, regional, and national awards, including Top 10 Green Projects of the Year from the American Institute Architects Committee on the environment.

He's a past chair of that committee's National Environment group and a current member of the California committee on the environment. So, thank you very much, Henry.

MR. SIEGEL: Good morning, everybody. I'm also representing today, AIA California with our 11,000 members.

So, why is embodied carbon in existing buildings important?

Next please.

Existing buildings are key. First of all, we have a lot of them. They aren't always very energy efficient. And from an embodied carbon standpoint, we can't afford to replace them all. And we can't afford to leave them alone.

As Bruce alluded to, we have a lot of resources here with existing buildings. We've built a lot of new buildings and they're generally more energy efficient, but it takes a lot of embodied carbon to make new buildings.

And over the next 10 years, which is the critical time period for global emissions, you can see that about three quarters of the carbon emissions for new buildings will be embodied carbon emissions from those buildings.

So, reusing and upgrading existing buildings reduces operating and embodied emissions. Reuse makes it possible to build fewer new buildings. So, reducing future embodied emissions.

Reuse also leverages infrastructure, the vast infrastructure of sidewalks, streets and utilities that we've already invested so much in. And retrofitting these buildings also increases resiliency, which obviously these

days protects us from the effects of climate change.

Next, please.

So, embodied carbon typically equals about 20 years of operating energy for a new building in California. And we have 10 years to address that. Renovating an existing structure typically has a much lower carbon footprint than building a new one because it reuses most of the carbon intensive parts of the building; the foundation, the structure, and the building envelope.

So, breaking that down a little bit, new buildings range from about 30 pounds a square foot for a wood-frame home to more than a hundred pounds a square foot for a concrete or steel commercial building.

Renovations often don't need to replace the high carbon parts of the building; the structure, the building envelope, and have a much smaller footprint compared to new construction.

So, saving existing buildings is one of the most effective ways to save embodied carbon. So, we really want to explore options for how we can incentivize this more. One example of that is the newly passed Historic Building Tax Credits in California. And we need to find ways to incentivize rehabilitation of all of our existing buildings, not just historic ones.

Next please.

Even though new buildings take a lot of embodied carbon to build, they still make up a smaller annual total of our operating energy because we have such a large stock of buildings that we already have.

So, we can't really separate embodied and operating energy. We need to do both. We need to provide incentives not just for preserving the embodied carbon, but also for upgrading energy systems at the same time. And of course, we need to do this as fast as we can.

Next, please.

Building efficiencies like weatherization programs that we're all familiar with still matter. More efficient homes save energy and emissions, heating and cooling systems can be smaller and don't have to work as hard, and better building envelopes make buildings more comfortable.

But we need to pay attention to how much carbon we invest in efficiency measures compared to how much carbon we save. So, we need to avoid the carbon intensive materials like aluminum and foam insulations when we do these kinds of upgrades.

Next, please.

And of course, we need to electrify and replace older gas appliances with heat pumps. We don't need to talk much about that here. We know a lot about that already.

Next, please.

So, part of the readings will be retiring gas appliances, and we still have a lot of gas appliances to retire. According to Saul Griffith of Electrify Everything, there are over 300 million household appliances that we need to replace. How do we do that quickly?

Do we announce that, like for example, we have with Carson, California, that no gas appliances will be sold after 2035, for example?

Next, please.

There are a lot of tools that have been discussed today, like EC3 in Tally and Lifecycle Analysis for analyzing the embodied carbon in buildings, and those need to be encouraged and deployed even more widely.

And we also need to look at developing tools that really look at total carbon in buildings. So, we need to combine embodied carbon and operating carbon. This is a calculator that my partner Larry Strain is working on with Architecture 2030, that looks at total carbon.

And what we find when we look at embodied and operating carbon together, is that retrofitting existing buildings are almost always going to win.

So, once you start to take total carbon into account, it really changes the calculus for how designers have traditionally thought about remodeling existing

buildings versus tearing them down to build something new.

Remodeling generally saves 50 to 75% of the embodied carbon of a new project. So, we need to find creative ways to reuse all of our existing building stock. And there are lots of great opportunities to do that, including providing much needed housing.

Next, please.

Saving buildings also saves neighborhoods. In short, we need to leverage building stock to save embodied carbon, relying on the assets we have, but at the same time, we can save communities and strengthen existing neighborhoods, build financial equity and diversity, create local jobs, and increase neighborhood resilience.

Existing buildings and blocks, studies have shown are typically more affordable and have a higher percentage of my minority-owned businesses. So, this approach serves social equity as well as carbon reduction.

Next, please.

So, there are a lot of paths to moving forward very quickly. Kate talked about some of the great work that Carbon Leadership Forum is doing and benchmarking. And that's being taken up here in my hometown of Berkeley, where our building energy savings ordinance is looking at benchmarking of all commercial buildings and an audit every five years.

And for single-family residential, looking at home energy scores at the time of sale. So, being able to track how our buildings are performing and updating them over time is really critical to understanding how we're doing.

Next, please.

So, as I mentioned, I'm also representing the 11,000 members of AIA California today. I'm on the steering committee for Climate Action and we've recently declared a climate emergency and this declaration and our initiatives are endorsed by the board and the president, and also widely supported nationally.

We're building coalitions with other organizations to accelerate action at the state level. One of our focuses is on encouraging building reuse and another is on embodied carbon. And we really believe these urgent issues to deal with more quickly. And I want to tell you about a couple of those initiatives.

Next, please.

We have a working group dedicated to embodied carbon. We're working on Buy Clean Act, low carbon concrete, code updates, a lot of the things that have been talked about already today. We're collaborating with CLF and other organizations to do that. We really believe concrete is a good place to start since the impacts are so large.

So, we really want to enforce the efforts that Bruce and others are making to really improve the codes for concrete.

Next, please.

I want to talk a bit about codes to finish just because we know how important codes are. We see opportunities in code provisions to really incentivize the remodeling of existing buildings. One important example is the California Existing Building Code.

In its present state, the CEBC only includes a prescriptive path, which has the most limited range of options from coming to remodel buildings. And we really would like to expand that. The international existing Building Code in contrast, has three compliance paths; a prescriptive one, a work area, and a performance area.

And the difference between these different pathways allows a lot of latitudes so that architects can match the best code path to the very unique circumstances that many of our existing buildings can present.

Freeing up the code approach for existing buildings will help address the needs for urban revitalization, increased housing stock, good paying jobs, and improve energy and resiliency performance. So, we're petitioning for this change and gathering support from state agencies.

Next, please.

We also would like to reboot CALgreen. 18 months ago, AIA California submitted a code change petition to bring a zero-carbon design framework to CALgreen as an optional measure for large new commercial and multi-family buildings. Our efforts have not yet succeeded, but brought to light the disconnect between the climate crisis and the potential role of CALgreen as a means to move forward.

CALgreen itself has not evolved to serve as the aspirational forward-looking beacon that it was when it was launched in 2008. CALgreen's tier concept is an ideal for foundation for getting ahead of the curve and anticipating and supporting rapid changes in the need for decarbonization. Instead, it has fallen behind.

The term embodied carbon, for example, is nowhere to be found in CALgreen.

Next, please.

So, CALgreen, and as you all know, has been split between many agencies and from the outside, looking in, it looks like nobody is looking at the big picture and driving this overall. So, we'd like to change that. And we think there are many other opportunities to innovate on codes and are looking for ways to move this process along more quickly. We welcome your support and input on how to best accomplish that.

Next, please.

So, that's just a very quick look into embodied carbon, existing buildings, and some of AIA California's initiatives. We have other ideas as well, and look forward to continuing discussions with the CEC commissioners and staff. The bottom line is we need to get moving very quickly and try everything we can. Thank you.

MS. DELL: Thank you very much, Henry, for those very useful remarks. And it's great to hear that AIA California has so many initiatives underway.

That concludes the prepared remarks of our panelists. And so, I'm going to turn it over to the commissioners for their questions.

COMMISSIONER MCALLISTER: Well, thank you all so much. I have been scribbling furiously during all four of the presentations here after our break. And I just want to commend all of you for your leadership in this area. The architectural community in particular is just so, visionary and forward thinking on this.

I wanted to …so it’s great to sort of start to catalog and develop sort of a resource base, knowing that there are tools out there and what they're good for, what they're most appropriately used for. So, I would encourage … well, I would encourage follow-up conversations after today to kind of make sure that our staff is aware of these

tools in a pragmatic way, in a practical way, and kind of understanding the current marketplace.

So, I want to just encourage that networking to take place. Part of the function of these IEPR workshops, is to begin those conversations but they really have to continue.

So, I guess wondering, let's see … I think it was Kate, your presentation, you and Bruce both just very thought-provoking and it's great to see the visionary stuff at the local level. I'm wondering -- and Kate, you talked about the various state initiatives.

I'm wondering if there's an idea of having a model bill at the state level that could you know, be a relatively broad framework to help state officials. There's very likely a legislative pathway, I would say, to kind of set up this conversation so that it has some teeth going forward.

And that would have to be done extremely carefully and with a lot of consultation. But I wonder if that has entered the conversation at your level as you gather resources to assist states on this issue. If there could be a model bill language that would help get some consistency across the marketplace and make sure that it covers the most critical elements.

MS. SIMONEN: So, well, first off, I think you can

just really … should acknowledge that California's action on Buy Clean was really influential in impacting procurement policy throughout the US and North America. So, I think that that simple framework that started with Buy Clean then has been studied and evaluated and is evolving.

And so, related to procurement policy, we do have some guidance documents on the steps to develop procurement policy and how that's been going. In terms of whole buildings and building scale policy, that's I think a place where the next step would be really useful.

And in particular, looking at total carbon assessments like is being done in Denmark. So, I think that when you look at all embodied carbon policy, there's a relationship between measuring and then acting. And that first step of measuring and reporting transparently helps to evolve industry capacity, develop that industry capacity, and evolve the methods and practices to have more standardized results.

COMMISSIONER MCALLISTER: Thank you very much for that. And we certainly would be interested in engaging if you're convening state officials that are starting to look at these issues, it might be helpful to have a little crosstalk and do a little bit of strategy.

I think we have a number of agencies we would want

to work with in California, to sort of see what the next steps might look like.

MS. SIMONEN: I would be happy to do that.

COMMISSIONER MCALLISTER: Yeah, thanks very much. But I really appreciated all the presentations and you all complemented each other extremely well. So, congrats on that.

And then actually, the final presentation, Henry, you sort of put right in front of us, I think a path forward that we … or at least a structure for a conversation that was so obvious, maybe we haven't even quite seen it in terms of leveraging the existing pieces of the Building Code to do more and embrace embodied carbon among other topics. So, so thank you for that.

I want to see if my fellow commissioners have any questions, but I'll also invite Rebecca -- if there are any gaps that you sort of see that haven't been talked about yet, any of you really, it'd be nice to go deeper or make sure that we're covering the topic in its full breadth. But commissioners Gunda, Rechtschaffen, any questions that you might have?

COMMISSIONER GUNDA: Yeah, Commissioner McAllister, thank you. Again, I think just so thankful for being here today, like just to kind of soak up all this information from all of you. So, my focus … so I'm going

to ask Commissioner McAllister for a little bit of latitude here for me to pull this conversation a little bit away from buildings for a second here.

So, my focus has been on reliability and electricity planning. And so much of our work right now, the climate policy, I think in the language that has been talked about today, we have focused on electricity planning and reliability from reducing the greenhouse gas emissions from an operational standpoint, and that's where we are optimizing most of our solutions.

Are there any kind of high-level trends and information that any of the panelists can share on what the embodied carbon issue looks like on the power sector?

As we pursue electrification as an important path of decarbonizing the economy, what are some of the things, we need to be thinking about from a material standpoint? For example, there has been information on aluminum being extremely difficult or steel being a widely recycled material. Steel is a highly source of high embodied carbon.

I just wanted think through, and we have the storage that is going to come online in buildings. We have the behind-the-meter PV, we're talking about a lot of these materials that some of them have recycling options, some of them don't. I just wanted to get your thoughts on just

kind of the power sector and the electrification strategy as we try to reduce the operational footprint of carbon, what that might be doing in terms of embodied carbon.

MS. SIMONEN: I was imagining Rebecca had a lot to say, but I can say something.

MS. DELL: I'm happy to jump in, but I'm also happy to … go ahead, Kate.

MS. SIMONEN: Well, I think the one thing I would highlight is that depending on the material, there is potential to electrify or not. And so, steel would be an example where we have electric arc furnaces, and there is a really … you can see a major difference between the carbon footprint of steel production and electric arc furnace in a low-carbon area than other places.

Whereas if you look at steel, I mean, concrete cement has to have super high heat that it's electrification isn't practical. And there's a chemical reaction where 50% of the emissions are related to a chemical reaction. So, I think we just talk about cement/steel, but that fits in many other building materials. Some of in which the electrical is the dominating factor, and therefore decarbonizing the electrical grid will reduce that on its own.

But I think the biggest challenge is the things that are high heat requirements and that have chemical

reactions. And so, then in order to decarbonize those, you're having to take different approaches than just decarbonizing the grid.

MS. DELL: Yeah, I can add a little more color to that, which is that … so, the first thing is that people have done detailed lifecycle assessments of different renewable energy technologies and determined what is the typical embodied carbon in the materials, and how does that sort of get amortized over the lifetime production.

And what the typical numbers that they come to are between 10 and 20 grams of carbon per kilowatt hour or per megawatt hour for wind. A little bit more than twice that for solar. In comparison, the number for conventional coal fire generation is like 900.

So, the emissions, the embodied emissions are not zero, but they are … even if we account for them, we're still making a big improvement. Another thing that is worth kind of keeping in our consideration is that the power sector and particularly, I would highlight the wind industry here … the wind turbines require a large quantity of relatively high-grade steel.

And so, they actually tend not to use recycled steel. They tend to use new production steel. And so, there's a real opportunity where … so, we all have this experience from here in California and in other states and

in other countries where the renewable portfolio standard that provided an early market that was a high cost, a high price market for renewable technologies was really important for getting those technologies to commercial readiness.

And we have a need for something similar in the building materials industries. We need these early markets where it doesn't have to necessarily be a huge market, but it needs to be a low risk, high price market to kind of get those technologies to full commercial readiness. And the wind industry is potentially a really interesting place to act as a partner with the steel industry to get really low carbon steel on the market.

COMMISSIONER MCALLISTER: I want to make a quick connection with the kind of evolving work landscape around hydrogen. Just because I think that it's kind of starting to permeate in interesting ways across this decarbonization conversation, and probably less in the end use in buildings and more in industrial and other kind of core parts of the economy.

And so, I think there's an interesting bunch of crosswalks there and particularly steel, it seems relevant, but industry generally is cement. So, just wanted to make that connection.

I will say I wish that we had had this

conversation before yesterday's Assembly Utility and Commerce hearing on existing building decarbonization because Bruce and Henry particularly, brought up the kind of resource that is our existing buildings in terms of preserving carbon that's already been embodied and avoiding reinventing that wheel, but also upgrading them to improve their performance and kind taking advantage of them as an optimization strategy.

So, I think very thought-provoking both of you. So, thank you.

Commissioner Rechtschaffen, did you want to ask any questions?

COMMISSIONER RECHTSCHAFFEN: I was going to ask … I think the discussion just now got … it feels like it answered the question I was going to ask. So, I don't have any other questions Commissioner McAllister.

I was interested to hear Colorado is the other state that's done a statutory fix like us. And I guess there's other … so you can say that – if anyone can say anything about Colorado or other states where they are, or are we on the cusp of something, or … I know I heard … I can't remember which one of you said that what we've done here in California with Buy Clean has been enormously helpful.

But if there's anything else you can say about the

activity in other states that's particularly useful to us or anything we can learn from them, or are we still in the lead really setting the standards here?

MS. DELL: Well, Colorado just passed legislation and Minnesota and Washington passed study policy related work. So, Washington is looking at all structural materials, so a slightly different approach than California, so that they are looking concrete, steel, and wood.

And so, I think it's interesting how states identify which materials they look at, and then also how states are identifying what the caps would be. And it's an interesting balancing point between what production is happening in a region. What are the impacts of the regional policies towards decarbonization, and what is the capacity of their building sector and industrial sector to support these policies.

So, it does come up consistently; what are the impact of small manufacturers, and how hard is it to implement?

MR. KING: If I may again, be aware that the Federal General Services Administration finished a yearlong study with an ad hoc group; Kate, you were part of that too, weren't you? Yeah.

MS. SIMONEN: Yes, that's good to highlight. So,

those were state Buy Cleans, but the GSA policy includes both procurement-based policy and whole building scale. So, I think the report that came out of that is a really great example to look at what I think is market-ready first steps.

MR. KING: And if I may interject something; echo what Commissioner McAllister said, and to your question, Commissioner Gunda -- I've just been studying all this stuff anew for the past year and writing another book. And carbon and hydrogen keep coming up over and over again, supporting a carbon and hydrogen economy.

In other words, capturing it at the smokestacks of the cement plant, the energy plant and having usable carbon that we can infuse into our building materials and other things. And likewise, hydrogen is in a source of intense energy that can replace fossil fuels as a source of intense energy that an industry like steel is always going to need.

There aren't replacements for steel. We're always going to have steel, we're already recycling it. So, now, it's a matter of using a low carbon source of energy to do so. Hydrogen on the market right now is fossil fuel-based. So, it's a two-step process. We got to have a hydrogen economy, and we got to have renewable energy-based hydrogen. I bet a lot of you are already familiar with a lot of this.

But these are the background things that I would love to see California take more of a lead in fostering, a hydrogen and carbon economy.

MS. DELL: Yeah. Maybe I'll add one more nuance on this issue, which is … so I think there's actually, I think one more state that didn't make it onto Kate's list, which is New York state. And they passed -- I know it's passed through their legislature. I don't know whether or not the governor has signed it yet.

You may have heard there's been some mishigas with the New York State governor recently. But they have a bill called the Low Embodied Carbon and Concrete Leadership Act, which is like somewhere in between a study bill and an actual regulation.

But I think that there's a really important distinction in the structure of the of the law in New York compared to Buy Clean California. So, Buy Clean California is basically structured to set a threshold for the amount of CO2 per amount of material. And they say, if you are above that threshold, you're ineligible. If you're below that threshold, you're eligible, and we're done.

So, that's great for kind of excluding the bad actors from public contracts. But if you're 1% below the threshold, or you're 50% below the threshold, doesn't matter, there's no incentive to continue improving once you

get below the threshold.

Whereas what the model that the New York State law is pursuing; what they're doing is they say everyone who submits a bid for this contract has to give us their total embodied carbon specifically for cement and concrete in this case. And whoever has the lowest, they get a discount on their bid. And so, there's always an incentive to keep improving in that kind of model.

And that's, I think a really important difference, and that honestly, has been a policy learning for this community since Buy Clean California was passed.

COMMISSIONER MCALLISTER: Thanks so much for that, super helpful. And I think we ought to … so, I want to recognize Commissioner Rechtschaffen as a leader and the PUC on the hydrogen issue. And we're all kind of trying to sniff out the opportunities and be judicious about that.

But it's likely that our legislature is going to dedicate some resources based on the governor's request to hydrogen and industrial actually decarbonization in this legislative cycle. So, we may have some resources to work with.

And then also, I'm going to just take this opportunity to lodge a suggestion to our research and development staff, actually that runs our EPIC program to try to begin to look at this embodied issue and

particularly technologies and applications that can help us manage and put downward pressure on carbon content in our construction phase.

And in our building stock and focusing on the basics that we're really talking about here is putting the structure in place and what technologies might really be the most opportune in the near term.

So, let's see … I noticed there was another report in the comment section in the Q&A here that the Advanced Building Construction Collaborative also reached/produced a report called Market Opportunities and Challenges for Decarbonizing US Buildings. So, I want to just make sure the record shows that and that we make sure to check that out.

Let's see … any topics that we have not talked about here? My notes are a little bit of a jumble here because it was fast and furious.

But it strikes me that there probably is a conversation that we ought to take this opportunity in the IEPR to kind of make sense a little bit of this and try to begin to strategize a path forward about what authorities might be relevant across the agencies, which parts of the Building Code. You know, Henry really, I appreciate your suggestions on that front.

But anything we haven't talked about in this broad

topic, any gaps, Rebecca? I mean, you've been making sure we cover them, but I just want to make sure is there anything that any other panelists would like to say that hasn't been said in terms of just what would help frame this issue and make progress?

MR. KING: I'll say that no, I think we've covered things well. I'm honored to be here with everybody on this panel. And just to say, I'm available, give me a call, because questions are going to come up. I mean, sure, it's a whole boatload of work ahead of us here, but … opportunity in California.

COMMISSIONER MCALLISTER: We have a lot of stakeholders in the state. It's a huge diverse state. And we work with builders on residential, commercial, across the board. We have the large energy users and just lots of environmental stakeholders and trade allies and labor and the whole gamut.

So, obviously, there's a huge conversation to mobilize here. And I will say our process, it's our foundation. And having a process that actually begins with the IEPR is where kind of these opportunities to make progress and lead actually start. So, the involvement of all of you is critical. So, thank you very much for helping us out.

Kate, did you have your hand up there? You wanted

to make a comment here?

MS. SIMONEN: I just wanted to emphasize what's been said here is that embodied carbon is urgent. It's the first emissions that happen on a building. And it's not a fast thing to change. So, if we look at the leadership that California did on operating energy, and we look at the timeline of how long it's been taking to have a substantive impact, we need to work faster than that if we're going to meet global climate goals.

So, as good and wonderful as the successes of California's leadership on operational energy, you have to start acting now and with increased urgency in order to address the decarbonization of the building stock and industrial decarbonization, and the intertwining of that with operating energy. They are all interrelated. We need to start acting now and need to think of it from a systems-based perspective.

COMMISSIONER MCALLISTER: Thanks a lot. I'm conscious that Emi you haven't had a chance to chime in here. And from the perspective of a large builder that mobilizes a ton of resources, and you called out a few pain points in terms of just having delayed services on the front end of a project that actually gave origin to lots of emissions. Is there anything the state could do or any sort of improvements in your ability to get things done

quicker and earlier?

MS. LAFOUNTAIN: You know, we have a huge issue as contractors. You know, we are the largest green builder in the state. We're the largest builder now, too. We do move a lot of material, and we can have the greenest personal initiatives as a company that we could possibly have, but we ultimately are tied to what the owner and designers want in a building. Because we are not designers.

So, we run into the chicken and the egg situation a lot with the owners about, well, we want to do this, but it's not our responsibility -- well, we can't get this material because there's no EPDs for it because nobody's legislated it, but nobody wants to legislate it until the EPDs are available for it. And same goes for like zero emissions equipment.

So, having legislation to provide guidance … and I'm going to stop short of providing suggestions because it's within our company code; but having legislation to guide owners and designers on embodied carbon and construction-based emissions is really what's going to be the driver depending on private companies to do the right thing is noble, but it is ultimately probably going to rely on what's required.

And if you do want to have the biggest impact focusing on the structure and comparing product specific

EPDs is the way that we're probably going to get there in conjunction with meeting design optimization requirements as well, reducing the amount of material we have to buy in the first place.

The greenest building we ever build is the one we never have to build in the first place. And so, yeah, and I appreciate the opportunity to contribute again as a contactor, if you have questions about how the contractors can get involved, I'm happy to be here as a resource.

COMMISSIONER MCALLISTER: Great. Well, thank you so much. I think we've overstayed our welcome a little bit in terms of matching up to the agenda. But all good. This has been incredible. And we do have a couple of steps left. The Zoom Q&A needs to happen. We have a couple of unresolved questions in there.

So, we want to give that opportunity to the attendees. And also, we have a public comment; not sure if we have any hands raised on the public comments yet, but I really appreciate your sticking around to help us work through those two topics, which should not take too long. Go ahead, go ahead.

MS. DELL: Yeah, no, we have two questions that have not yet been addressed. And so, I'll take the first one because it was directed to me. And the question is could you elaborate on the estimated costs associated with

moving from conventional materials to a sustainable material, particularly the cost implications for affordable housing?

And that's a really important question. And actually, this was kind of in the back of my head when Commissioner McAllister said, "What did we miss?" Because I think that something that has been maybe implicit, but actually has not been explicitly stated yet today, is that the costs here are very low.

There will be some transition costs associated with getting low carbon materials available for the first time. But there's now a number of estimates, very detailed estimates that have been done for converting entirely to low-carbon materials.

So, that means for all the cement that you use, there's carbon capture and storage; for the steel that you use, it's recycled or you're using hydrogen, or like a completely sustainable set of building materials. And the estimates that people have come up with is that depending on the type of structure and type of building that might add 1% to 3% to the cost of the building.

So, and the incremental improvements that we can make between here and there are going to be even cheaper than that. And in many cases, like the example that Emi offered us, they'll be cost-neutral. Because right now, we

are using higher carbon materials or higher greenhouse gas materials unknowingly, because we're just not measuring it and we're not managing it.

And the basic reason for this is that those greenhouse gas intensive materials, which are primarily structural materials, they just don't represent a large portion of the cost of most buildings. And so, even if we have to pay more for those materials, that doesn't actually change the cost of the building.

So, we have one other question that has been entered in -- which was kind of at least somewhat addressed in Emi's presentation.

Many EPDs in the US end at the factory gate. Are we going to get the transportation assembly, maintenance, end of life pieces addressed in Buy Clean California or maybe other policies and approaches as well? Emi or any of the other speakers, would you like to comment on those A4 and beyond stages of the lifecycle assessment?

MS. LAFOUNTAIN: I mean, I can't obviously speak to what will go into Buy Clean California, but I can speak to what has been seen around the world. There has legislation put in place in places like Oslo, for example. I think they have an all-electric construction requirement by 2035 or something. Don't call me on those numbers.

But they've already started piloting zero-emission

jobsites in Oslo and they've completed I believe three. And there's a few cities that have signed on to the C40 agreement to cut their jobsite carbon emissions by 50% by the year 2030 or more ambitious in certain cities. But those four cities are Los Angeles, Oslo was one of them, Mexico City, and Budapest.

So, there is a precedent for cities taking the initiative on reducing carbon emissions at the jobsite level. But that is not necessarily written into anything at the moment. I know that San Francisco is considering some similar legislation at the time. But it has not been put in writing yet anywhere.

So, it is city by city largely. There is nothing that I'm aware of that has been adopted at the state level for construction phase emissions. And transportation-wise, I'm not aware of anything that addresses those A4 transportation emissions legislatively.

MS. DELL: Thank you very much, Emi. So, we have two participants who would like to offer public comments. Just the guidelines on that are unmute yourself, introduce yourself, give your affiliation, and spell your name and affiliation for the record, please. And you have three minutes to make your contributions. So, I would like to recognize Scott Shell and we're going in order of hand raises.

Mr. SHELL: Thank you. My name is Scott Shell. I'm with EHDD Architects. We're a 80-person architectural firm practicing all over the state.

I'd like to build on Kate's point about the urgency and how do we get this transition started because it's going to take some time and Building Codes take time to implement and so forth?

One thought that occurred to me is if some of the state agencies or leading client organizations could take the lead, the University of California's all electric building policy that started two years ago, I thought was very effective.

And I spoke to The Office of the President a couple months ago. And they said that even though they have an exception process, no one has asked for one because they have a clear, direct … from the owner to design all-electric buildings.

And they're doing some difficult building types, including a new hospital for UC Irvine, it's all electric. So, I think having some early leadership from some state agencies could be a great help in kicking off maybe some material specific things like the low carbon concrete code that Bruce was talking about from Marin County, or be just requiring a whole building lifecycle assessment be done.

Likewise, I think the LECCLA policy that Rebecca

mentioned from New York to New Jersey is very effective because it does not just set a threshold. It gives you points for the more you reduce your embodied carbon. So, there's sort of a process there to really drive some innovation.

I do think there's enormous potential for innovation that we haven't really explored. On one of our projects, a lab project at UC Santa Cruz, we replaced some concrete drilled piers for the foundation, with Rammed Aggregate piers. It saved the project a million dollars and cut the embodied carbon in half, because it got rid of so much concrete.

So, I think there's a whole series of other foundation structures, other geotechnical strategies to reduce embodied carbon in roads and infrastructure that we really need to get some R&D dollars and brains behind. So, thanks so much. It was a great panel, I learned a ton. Let's go get it.

MS. DELL: Thank you very much, Mr. Shell. We will now hear a public comment from Claire Warshaw.

MS. WARSHAW: Hi, my name is Claire Warshaw. I'm a member of the public. I have no stake in any of this. I'm really enjoyed the panel today, I've been especially appreciating the idea of the California Energy Commission addressing embodied carbon.

My comments are kind of about definitions. As a member of a public audience who isn't really as deeply involved in the subject as all of you, I like user-friendly language and I have heard or read part of the IEPR before and it's a very lengthy document. That seems to me could be useful if more general audiences could learn from it.

Like if there was an IEPR movie or something after the document's published to make it more so that it could be broadcast.

But despite that, your subjects, I would hope that embodied carbon would be defined not about just buildings, especially if it ends up in the IEPR because fuels, it seems to me has embodied carbon element to it, and has had a lot of confusing different slants for instance, with hydrogen fuel.

When I've been reading people writing about hydrogen fuel benefits and costs on LinkedIn, it's been a very confusing thing to follow. Decarbonization, the term for me as where I came from, I always thought that like plants had carbon. And so, when we started to speak about decarbonization, it kind of confusd me in terms of building materials. Because timber, for instance, probably has quite a lot of carbon in it and I'm not sure that comes across always that clear.

And when we start to talk about bringing timber

back in as a material more, I'm not sure if that is going to make as much sense to general audiences. And I'm not saying this is bad or the past has been bad at all. I'm just saying to not make embodied carbon just about buildings when you define it. It might be good for the IEPR to explain the embodied carbons and hydrogen might be … it might be time for that.

That's my comment, sorry. Thank you.

MS. DELL: Thank you. Do we have anyone else who would like to offer a public comment before we adjourn the session?

COMMISSIONER MCALLISTER: I wanted to just see if Rosemary Avalos, the Public Advisor's Office could maybe help us navigate the phone call if anybody has-

MS. AVALOS: Yes.

COMMISSIONER MCALLISTER: Yeah, thanks. Rosemary.

MS. AVALOS: Thank you, Commissioner McAllister. Now, we'll on to the attendees on the phone line and a reminder to dial *9 to raise your hand and *6 to mute and unmute your line. If you would like to make a comment, please raise your hand and I'll give it a few more seconds here.

Alright. Seeing that there are no hands raised, that completes public comment. And I turn now to Commissioner McAllister. Thank you.

COMMISSIONER MCALLISTER: Thank you, Rosemary. So, we are going to wrap up for the morning rather. This afternoon, we have another panel looking at the refrigerant issue, another really key global warming potential conversation.

So, we're trying to identify the pockets of savings, of potential savings and really emissions potential reduction that are all related to buildings in this track of the IEPR. So, today is really, I think, seminal on both of those issues.

I really want to thank the panelists; Rebecca, you did a great job helping put this panel together and moderating. Your insights here are just super valuable. So, thank you.

And then all of our panelists, I would very much encourage our staff and you to keep in contact as we assemble the IEPR, and as we carve out a section on this and try to strategize path forward and next steps.

I often think, as Commissioner Gunda said, we're really focused on electricity reliability at the moment, and he's really leading the charge at the point of the spear, tip of the spear on that for our agency broadly with our evolution toward a carbon-free grid.

We're basically thinking of it, and if you conceive of it as historically, we've basically had a

command-and-control system where you have fossil-based generally … or hydro resources that are basically dispatchable at the flip of a switch more or less.

And as we transition to a carbon-free grid, we have to allow our grid to ebb and flow and essentially breathe at the same rhythms as nature. And I think part of the conversation that I've found most inspiring here and that graphic is actually very appropriate is we need to do the same thing with our buildings themselves.

And I think a couple of you brought this up where plant-based materials really need to move to be central to our construction industry and use them as an opportunity rather than sort of just a straight cost.

And so, that that's been kind of a slight reframing in my mind that I think is going to help me organize my thoughts on this going forward. And I'm sure my colleagues on the dais had similar reactions to the panel this morning.

So, Commissioner Rechtschaffen had to step away and will be back at two for the afternoon's panel. But I just wanted to say thank you to the IEPR team. As always great panel and to the panelists for all of your really decade-long efforts in this industry and your personal commitment to really, I mean, making the world a better place and really helping California and beyond have a

lighter touch and really preserve our environment for future generations.

I mean, that's really essentially what all this is about. Some of you said as much, but I think all of us here are feeling that urgency to address/to use every tool in our toolbox and create tools that we don't have if we need them, which is why the legislative and kind of administrative discussion is really key.

So, anyway, I wanted to pass the microphone to Commissioner Gunda for any closing remarks before we wrap up. Thanks.

COMMISSIONER GUNDA: Yeah. Thank you, Commissioner McAllister. I think you summed it up really, really well. And I just want to extend my gratitude to all the panelists. And I think two specific points that you mentioned; so much of our public policy is driven by a process that really provides an opportunity for leaders such as the panelists today to showcase the work, the learnings that they can bring to the table, to educate and inform and move the conversation forward for the state and the people of the planet.

So, I'm just appreciative and thankful for all of your individual dedication in ensuring we move forward to a brighter future.

I will take you up Bruce, on your offer to be

available to talk. I would love to have the opportunity to continue to talk with you. As well as Rebecca, I think you had some points that you shared on the ringside. I would really appreciate the opportunity to have a continued dialogue on, especially as we move towards the SB 100 goal.

What level of conversation should we have to bring into that from the embodied carbon side to ensure we're moving not just towards a more operationally reduced carbon footprint, but also more of a comprehensive look at the energy system as a whole. So, I really appreciate the opportunity to talk with you further.

And then all the participants who join us in these meetings for several hours like Claire who just made a comment. And I think the idea about developing an IEPR movie makes a perfect sense to me. But I think overall, thank you for your time and participation in the public. You help us/keep us pointed towards --and have focus towards priorities, but also accountable and have the integrity and the rigor in the process. So, thank you all for all your time.

COMMISSIONER MCALLISTER: Thank you, Commissioner Gunda. And I agree there probably are some nuggets that could be strategically edited to be quite compelling from this morning's session. So, that's an interesting idea. The IEPR has traditionally been a big thick document that

as Claire said, was not so accessible. And even before it was digital, it was on paper.

And I just cleaned out my office in our move to a new building, and I had a whole shelf full of lots of I guess, lots of sequestered wooden products that was many, many years of the IEPR documents in prehistory, really, it seems like at this point.

But these are really key questions for California and the world going forward. So, I appreciate so much everyone's dedication and passion, and I would second everything Commissioner Gunda said as well.

So, thank you again to all of the attendees and panelists. I really appreciate it. We're going to wrap up this morning and see everyone again at two o'clock.

Thank you very much.

MS. DELL: Thank you.

COMMISSIONER MCALLISTER: Thank you everyone.

(The workshop concluded at 12:25 P.M.)

CERTIFICATE OF REPORTER

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 25th day of October, 2021.

ELISE HICKS, IAPRT CERT**2176

TRANSCRIBER'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 transcribed by me, a certified transcriber 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 25th day of October, 2021.

Myra Severtson
Certified Transcriber
AAERT No. CET**D-852