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CENTER FOR ENERGY EFFICIENCY AND RENEWABLE TECHNOLOGIES
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I N D E X

I N D E X

P R O C E E D I N G S

8:33 a.m.

MR. MANZANILLA: I'm with the U.S. Environmental Protection Agency, their regional office in San Francisco. I hope everyone had a great evening last night in beautiful downtown Sacramento and Old Town.

We had a great series of presentations yesterday on the whole issue of sustainability, criteria, standards, principles as they apply to bioenergy, biofuels.

It's an important discussion. It was an important discussion to serve as a backdrop for what we're going to talk about today.

I think yesterday's presentation, several presentations talked about, well, we can develop the principles, the standards and the criteria, but then we do have to get to the point. Given the range of decisions that governments across the world, individually and together, have to make about which are, as Steve Kaffka talked about, what will be the best feedstocks. We have to figure out how to make those types of determinations.

And increasingly, at the international

level and the domestic level, we talk about lifecycle analysis and being able to come up and try to quantify many of the parameters that we talked about yesterday.

These are important decisions that governments have to make. When I was at FAO last summer we were very involved in trying to come up with these types of methodologies and using lifecycle analysis for developing countries to make these types of choices.

And these choices apparently can be deadly, because I don't know how many of you read an article about the aftermath of the cyclone in Myanmar. And it talked about the -- I don't think they used this word, but I'll use this word -- about the infatuation of the junta government with producing biodiesel from jatropha.

And, unfortunately, contrary to what they had said, that they were going to focus on marginal lands, they decided to replace many of their rice fields with jatropha. And now, in the aftermath of the cyclone, according to the article, now they have a problem, a bigger problem, feeding their population because the rice fields have been -- many of their rice fields, not all, have been replaced.

It was interesting, because when I was in FAO they had requested FAO assistance on this whole issue of jatropha, and I helped prepare the contingent from FAO that went to Myanmar, who discovered that, amongst many other things, that they were using forced labor to plant the jatropha. So, I think some of those issues came out in yesterday's discussion indirectly.

Let's see, for today's, as we look at today's agenda, we have an addition to the next session, the first session 5 on land use issues. Bruce Dale from Michigan State is going to join us. So we're going to be a little tight on time; it might cut into the break a little bit.

And then the other thing I would ask, as the moderators and the speakers of the sessions for today, as you look at the agenda for today, it culminates in a moderated discussion of lifecycle analysis methodologies.

And I would ask the speakers on today's panels to, first of all, try to be here for the whole day to listen to the other speakers, because what we want to be able to do is pull everybody back in at the end of the day to have a discussion.

So we want to really benefit from the presentations, and everybody's participation throughout the day, and really have a very fruitful discussion at the end of the day around 4:00. So that's just something that -- and I would like the moderators, Rob Williams, Anil and John to remind their particular panels about that.

We're very fortunate today to have Robin Jenkins from DuPont. Robin is a chemical engineer with over nine years of experience at DuPont. She is a consulting engineer in DuPont's Corporate Engineering Group where she guides research and manufacturing teams by analyzing new or existing processes from an engineer, economic and lifecycle perspective.

Robin has over four years experience as an LCA practitioner, and currently leads LCA efforts for biofuels in DuPont.

In previous roles she headed manufacturing operations as a process engineer for the packaging and industrial polymers business. And managed key customer relationships as a technical services engineer on the nonwovens business.

Please join me in welcoming Robin Jenkins.

(Applause.)

MS. JENKINS: Thank you. It really is a pleasure to be here today. I think it's fitting to start out the day full of lifecycle assessment discussions of methodologies, assumptions, tools, which show you an example of how industry takes these methodologies, assumptions and tools and puts them into practice at the process development level on helping us make key choices in terms of process development options and opportunities.

So we've talked about a little yesterday about the importance of the LCA assumptions, methodologies and tools to help us develop standards and policies that we'll be held accountable to, but now it's also so important to the industry's perspective to have the appropriate tools in place to make the best business choices we can make.

So, just an overview of the talk. I'll be giving you a brief introduction to the DuPont Company, specifically to our biotechnology platform. And how we approach developing sustainable biofuels.

I'll talk a little bit about our integrated corn biorefinery program, that's our cellulosic, DOE-cost-shared program for cellulosic ethanol. And then I'll use that example to show you some of the learnings, an example of some of the vast learnings that we've gained from using lifecycle assessment.

So, first of all, DuPont's mission is sustainable growth. We have evolved over the years from a regulatory compliance company, in terms of environmental compliance, to developing environmental goals, to now a much more proactive approach to sustainable growth.

We have year 2015 environmental goals both internal to the company, so reducing our own environmental footprint, but also market-facing goals. So how can we, as a company, develop products that reduce the environmental footprint, reduce the greenhouse gas emissions of our customers when they use our product instead of an incumbent product.

So, we're very proactive in developing goals that are at the consumer level, helping our customers, putting more money into research and development programs that reduce the greenhouse gas emissions of our customers, along with our own internal footprint.

Our definition of sustainable growth includes what we call the three-legged stool of sustainability: Does it have economic merit; does it deliver a functional product with societal value for the customer; is it a useful product. And then, does it also reduce our environmental footprint.

To help us meet those sustainability goals, we have a very important platform in the company, the newly formed DuPont Applied Biosciences Business. It used to be called DuPont Biobased Materials.

Under DuPont Applied Biosciences we have four key pipelines of product opportunities and technologies, biofuels, biomaterials, biospecialties and biomedical. Just briefly on a few of those platforms, and of course, we'll talk mostly about biofuels today, but our bioPDO plant that started in Loudon, Tennessee, is a feedstock for several important product offerings that are coming out. We have the omega-3 fatty acid and then some biomedical products.

Specifically for biofuels we've planned

significant investment to strengthen our presence, to get into the market quickly, to demonstrate our technology.

And for biofuels, partnerships are key. We have, of course, our pioneer company that is owned by DuPont, is key to the development of the seed that will go into the feedstock for biofuels in some cases. We also partner with John Deere, working with feedstock collection, infrastructure and all of the parts that go into collecting a new feedstock potentially.

And then, of course, we have our collaboration with BP on biobutanol, among other things. And we also have the newly announced joint venture with the Danisco Company, DuPont/ Danisco Cellulosic Ethanol. Initial three-year investment of $140 million to develop corn stover and sugarcane-to-gas cellulosic ethanol.

Just a case in point of our biotechnology. This is biotechnology working currently today in Loudon, Tennessee, in our bioPDO plant.

And under DuPont Applied Biosciences our strategy for biofuels is really threefold. First of all, it's improving the ethanol yield from the pioneer seed in the first place. Developing better attributes in the corn seed to reduce the footprint of the feedstock.

We also then have our cellulosic ethanol efforts. And then working downstream with BP on the development of biobutanol.

And with developing biofuels we talked -- I think somebody yesterday mentioned some of these questions and challenges already. But many challenges we all face, and the biofuel producer faces on a daily basis. How are we going to collect this new feedstock. What feedstocks should we use. Which one has the smallest environmental footprint. Which one is best to use in our conversion technology.

And then what co-products are we making, what are we going to do wit the co-products. Can we make this co-product into a viable saleable product.

And then what conversion process should we use. How do we choose the fermentation organism. Which one is going to work best for us. Will the lignin be a value-adding product, or will we use it as a fuel for our facility.

And, of course, how much is this all

going to cost.

And then from a sustainability perspective we're faced with so many issues when we're developing biofuels. As an industry we have the logistics questions and everything that goes into the technology. But also the same sustainability perspective. Considering all of the sustainability questions along the entire fuel supply chain and pathway.

Concerns around land use and soil health at the agricultural phase. Then also in the biorefinery, are we using our feedstock, energy, water, resources as efficiently as we possibly can. And then what does that fuel deliver in terms of performance in the vehicle and also considering the tailpipe emissions.

So, DuPont's approach to considering all of these many challenges and questions. We are looking at a holistic view, trying to consider the entire value chain, and using lifecycle assessment as a tool to help us evaluate the environmental footprint of the entire supply chain.

Also looking at near- and long-term solutions on parallel paths, looking at current investment and current capabilities in biofuels.

But also looking at long-term solutions like cellulosic ethanol and butanol.

And then we're a tightly integrated technology development system. Engaging the right partners at the right time, as I mentioned. And also looking at the unaddressed needs, like the logistics and the infrastructure that's not already there.

So, in our approach I'm going to use the example, as I mentioned, of our integrated corn-based biorefinery. So this would be a very generic well-to-wheel lifecycle assessment system boundary that we, in DuPont, would use in evaluating any of our biofuels programs.

This is always where we start. Looking at the entire system; what feedstock are you using; how are you producing the fuel; and then the use in a vehicle. Considering all inputs and outputs.

And then we're also integrating our LCA in a -- this is the generic approach that we use, but specifically for the ICBR, as well. We're closely integrated with process development, as I mentioned.

So process ideas are formed. Alongside

with economic evaluation, we'll do a lifecycle assessment of that process option; feed that information into our business and research and development teams. And select the process that has the most advantage for us and the environment and from an economic perspective. And maybe it is that we go back and we reiterate this process.

Inside the LCA box several different activities are going on. We're identifying relevant issues, comparing to benchmarks, setting quantifiable goals. And then monitoring, sometimes internal, process goals, process opportunities along with external benchmark comparisons.

We develop these goals and targets and important metrics with DuPont leadership, but we also find that stakeholder engagement is key to helping us define the right metrics and goals, to helping us critically review the methodology that we're using, the assumptions that we're using, are they appropriate.

So, inside the ICBR specifically we've developed the ICBR lifecycle assessment advisory panel. The panel is made up of representation of stakeholders all across the fuel pathways, starting from the farm all the way through the auto industry.

We have representatives from all these different groups that you see up there. That information is used by the LCA practitioner, like myself, to advise the business. But the business leadership are extremely engaged -- strongly engaged in this discussion. Strong support for this kind of work inside DuPont.

Another example of our stakeholder engagement that is more public and that you can see all the details of, is on the website that I've listed there on the slide, that you're welcome to write down.

And that's our general biotechnology advisory panel. We talk about all biotechnology concerns. This is a multi-cultural organization. We have representation from Africa, from China, from Europe. And we are working to understand the concerns globally around biotechnology.

And at the website there are papers that have been written by the group, and bios of all the group members. And it's also very supported by our CEO. Whenever we have biotechnology advisory panel meetings, our CEO even comes and has discussions with the panel, with the panel alone. This is a key group; top leadership is involved in this organization and feels very strongly about stakeholder engagement.

So for DuPont's holistic approach lifecycle assessment, engaged with process development, critical to use stakeholder engagement.

So, now getting into a little more data, which is more my comfort zone because I'm a chemical engineer and we do a lot of data. This is the ICBR cradle-to-gate system boundary. So now we're going to compare different cellulosic ethanol process technologies to help guide our process development, looking at core process options.

And this is our conversion of corncobs to ethanol product. And we get our value-added co-product, electricity, from our combined heat power system that we have in the design.

And the corncob LCA data. We worked closely with Michigan State University to develop this data. There will be a publication on it soon. That's another key partnership that's been critical for us in this development.

And then like I said, we're developing key metrics to define R&D targets. So, inside that process, the core process, greenhouse gas emissions, also energy consumption, process water use at the ICBR, so the core water use there.

Process energy, how efficient are we in the process in using our energy. And then land requirements, also.

So these were the top five metrics defined and identified by our stakeholders and by our leadership.

And then in looking at these metrics, we want to compare to appropriate benchmarks. This is our DOE joint, $38 million, four-year project in the ICBR, so this is a U.S.-based scenario. So we're using U.S. data, and we're comparing to a typical U.S. dry grind, even a cellulosic ethanol benchmark that NREL developed. Comparing to U.S. gasoline. And also comparing, as I said, internal technologies in the cradle-to-gate system boundary versus going well-to-wheel to be able to compare to various other fuels.

And then it's very important that we align the data so that we're looking at a fair comparison. Again, getting in our LCA methodology technique.

So I'm going to show you an example here of how the process team, how the LCA team would develop the data for sharing with the process development.

So, for example, this is cradle-to-gate fossil energy for our basecase in the ICBR. And this was a case several years ago, so it's not the current case. We've gone through many iterations at process development. What you're going to see here is some of the key pieces that helped drive and focus research and development and guiding them to the most sustainability solution and process option.

So what we would do is look at the contributions of this area of our system to the total cradle-to-gate fossil energy. So you can see there is some supplemental fossil fuel required in this system, but we do get electricity credit, as I mentioned, from our CHP.

So this is just one example. We did this in many different scenarios, looking at various different process options. This is one example of looking at how we're using energy in the biorefinery. So, for the basecase you already saw.

Then we decided, what if we don't have that CHP and we're not generating our own electricity and have to buy it from the grid. We can see what happens to the fossil energy footprint.

And then, what if we improve our use of energy inside the biorefinery. So, working on energy efficiency, energy integration, how can we improve our footprint. Well, you see that the requirement for the fossil fuel has decreased in the improved efficiency case.

And then, what if we didn't need any of that supplemental fossil fuel. Now, you can see the best scenario for cradle-to-gate fossil energy.

This is just an example of how, at the very beginning of research and development we're helping drive this program to the most environmentally, the most sustainable solution.

And then we're also taking it, as I mentioned, on a well-to-wheel basis. So how do we compare to the incumbent, how are we going to measure up to various other technologies that are in existence. And so you can see that the DuPont cellulosic ethanol compares to favorably to grain ethanol, and of course to gasoline. And to even the more challenging cellulosic ethanol benchmark.

This is one case -- this is not the same case as the basecase I showed you earlier. This is a more current case that does not need supplemental fuel, which is why it's an even more improved scenario.

So, we're continuously driving process optimization. Driving energy efficiency, waste minimization, water recycle. We're driving improvements in resource efficiency, energy efficiency and in our isolation and separation steps.

And just to leave you with this thought that I really want to emphasize today, it's now embedded in DuPont business that sustainability, environmental footprint is the way we make choices. It is inside many businesses' best practices what is the environmental footprint.

I've seen business leaders in DuPont make decisions based on the LCA. They will look at the results and go in a different direction, based on what the LCA is saying.

Very early on in research and

development they're asking for this information. And they're very interested in what our stakeholders have to say. We're thinking big, and globally, but we also understand that the application will often be on a regional level, which is why we're looking at the logistics and the regional opportunities, as well.

Just want to thank you again for your attention this morning and, again, it was an honor to be here, and I want to thank, of course, the DuPont Biofuels Team, and I think Bruce Dale is in the audience, too, from Michigan State University. And, of course, our ICBR LCA advisory panel.

Thank you.

(Applause.)

MR. MANZANILLA: I think what we're going to do because we added a presenter to the next panel and Robin is going to be here throughout the day, we're going to hold questions perhaps to the end of the day, at least for Robin.

And then now we have Rob, if you want to start bringing up your folks.

MR. WILLIAMS: Well, good morning. I'm Rob Williams from UC Davis and the California Biomass Collaborative. Could I get today's first panel to come on up here. We've got Keith Kline, Robert Larson, Don Smith and Bruce Dale.

So this should be an interesting set of presentations. And we've added Bruce Dale onto the program at the end, he'll speak fourth in this group. So it might make time a little bit tight for everyone, but these are going to be some very interesting presentations.

The topic is loosely land use and land impact issues from biofuel development I hope to hear.

Let me introduce Keith Kline. Keith has been a research and staff member of Oak Ridge National Laboratory since 1990, where he supports international program analysis. Keith has coauthored the ORNL Biofuel Feedstock Assessment for Selected Countries, a recent 2008 publication.

Keith also has 20 years of experience in natural resource management programs aimed at addressing deforestation and sustainable agriculture in developing nations, including work with U.S. AID in Central America and southern Africa.

Keith served as a Peace Corps volunteer in Ecuador, and holds degrees from the University of Michigan and Farmingham State College in Massachusetts.

Keith will speak on global land use issues, so please welcome Keith Kline.

(Applause.)

MR. KLINE: Thank you. Good morning. It's truly an honor to be here, and I also want to thank Robin for setting me up and putting global issues on her last slide. Thanks, Robin.

I think it's exciting that California really is leading the way in the world on how to try to find a more sustainable, equitable future for energy. And it's really an honor to be here and perhaps contribute a little bit to that.

Just to get an idea of where we're at in this group, and to make sure everyone's awake, could I have a quick show of hands, how many are familiar with the February "Science" articles of Searchinger and Fergione? Pretty much everybody, not surprised. Great. How many are familiar with USAID? Pretty good, U.S. Agency for International Development. Great.

And how many have training as economists? Good. I might be needing you soon to assume a new identity.

Witnessing land use change on the ground in developing countries does give me, perhaps, a somewhat different perspective than what the typical researcher has in the United States. And I'm going to try to share a little bit of that with you this morning, as soon as I figure out how this works.

So, I'm going to quickly try to cover, because I've just been asked to shorten this a bit, what land is out there, where is it at, what is driving land use change really out in the rest of the world, especially the areas that we seem to be most concerned about, tropical forests, areas of biodiversity, wetlands.

How might we be able to address that issue equitably, and how does that all fit in with lifecycle analysis.

Some of the key points that I hope you come away with is that there's actually a lot of land out there that's available for agricultural expansion without needing to clear new forest. Yes, land is a finite resource on earth, but there's a whole lot that we're not using productively right now.

Yet, we all know forest clearing

continues. And if we want to do something about it, we want to change that process, we have to really understand what's driving it. And making assumptions about that without understanding it could lead to actually more deforestation.

There are some effective strategies out there to address this. A lot of these issues we're talking about are not new. Land use change, deforestation, sustainable production, they've been around for awhile. And what's really exciting for me, and interesting, is that the effort to promote bioenergy has kind of put a spotlight on these issues, which is a real opportunity.

And I think that's an opportunity that we should seize and work with, because we can use this to achieve some of the things we've been wanting to achieve for decades.

I think there's a potential for win/win on energy security, food security, sustainable development and reducing emissions all at the same time.

When we get into connecting the land use change process with lifecycle analysis and put things into perspective, into scale, we come up with some interesting things.

One of the issues is that land use change is not the same as land cover change. And we often rely on satellite imagery and remote sensing analysis to look at land cover change. But that really doesn't tell the whole story.

Another issue is that if you consider things like the reference case that Searchinger had put out, which reflected huge impacts in greenhouse gas emissions from indirect land use change, that was based on an assumption that our increase in corn production here would cause about 108,000 square kilometers of new clearing somewhere else around the world, probably in tropical forests.

And that 108,000 square kilometers represents a tiny fraction of what our best information says is out there and available without clearing and additional forest. It's available for agricultural expansion. So I think we need to question some of the conventional wisdom, and really look at the data for what these indirect impacts might be.

So, how much land is out there. To save time, I'm going to skip over -- there were several studies on this. There was one in 1999; one in 2002; others that I didn't even try to put in this presentation.

The key point in this slide is that there's a very small yellow sliver in the upper right-hand corner. And that was projected by the food and agricultural organization in their "World of Agriculture Towards 2015 to 2030." That was the amount of additional land, crop land that was expected to be added to active cultivation between roughly 2000 and 2030. It was 0.8 percent of total land available, and a tiny fraction of what was considered suitable for rain-fed agriculture.

This study did not really include, however, where the forests are. Subsequent studies looked at that much more carefully. If we have time later I'd be happy to go back and discuss the bar graph on this slide, which is really interesting. But I know to do so right now is going to take too much time.

The key point here is that this more recent study in 2007 on bio -- factors looking at rural agriculture and rural land use set aside all closed forests; it didn't consider that as available. It set aside all protected areas, all legally protected areas. Didn't consider that as available.

It set aside all irrigated land. It didn't consider that as available. It only looked at rain-fed rural areas. It set aside all urban areas, even semi-urban areas in what were originally classified as rural areas.

After they did all that, they still found that there were about 26 million square kilometers of pretty good to highly suitable land. The really prime land is consistently identified as really scarce. And that's an incredibly value resource, and we should all do everything we can to conserve good prime agricultural land, and not let it be lost to what we consider more permanent land use changes.

However, there's a lot of land that's relatively good. There's a lot of classifications, and it can support cultivated crops, annual crops, sustainably, based on rain-fed agriculture, according to these studies. Good lands, 26 million kilometers squared; less favorable down to marginal lands, but still productive, another 36 million. These studies have all had very similar results.

But where is this land? It's not all distributed evenly, unfortunately. We don't all have the same endowment.

What's still available for the future, and this might be hard to read in the back, in this graph at the bottom, what you have is Latin American and Caribbean, and the large blue box represents the amount of potentially rain-fed arable land that's available. The orange box is how much is currently in use. And this is going back to the FAO study in 2002.

The next one is subSaharan Africa. The next one is east Asia. Then you have southern Asia, which is almost totally used. The Near East and North Africa. And then there's industrial countries which still have a relatively good share of land that could be used, and transition countries, they kind of broke it up different ways.

But the point here is that where most of the land is right now available for expansion lies in really just a few countries in the tropics where there is a lot of forest. And where there's also a lot of problems with governance, enforcing rules and regulations, basic services, high degrees of poverty.

The subSaharan African countries that have the most land are Sudan, Democratic Republic of the Congo and Angola. And the histories in those three countries are very interesting.

Trying to move along. Now, this additional land that we saw that was just a sliver and the graph on this table reflects something that's been occurring, and perhaps is best reflected in the United States and was discussed a little yesterday, and that's that productivity per acre has been going up tremendously over time.

And over 80 percent of total production worldwide has been based on increases in yield and increases in intensity of use of land, sometimes double-cropping what was previously single-cropped. Not on land expansion. And that percentage is actually a lot higher in the United States and developed countries than it is in under-developed countries, which is what this little graphic is illustrating.

The cultivated land at any given point in time is going to be a fraction of the total available in part because in these countries where it's less productive, there's a lot of shifting cultivation still going on. And it's that shifting cultivation that creates some uncertainties and a lot of the remote sensing analyses and drives people crazy with what is pasture versus what is land speculation versus what is grasslands. What is a mosaic of rotating crops.

But most studies that are documented and referenced, that look at land use change and what is causing it will illustrate that this is a process that's occurring at a much broader scale, kind of way out ahead of the curve of the decisions to grow a certain crop such as soybeans. And it's a process that begins based on a lot of other factors.

Geist and Lambin, and excuse me if I'm not pronouncing those names quite correctly, but in the literature they have done actually a lot of work. And one of their publications is an analysis of over 150 empirical studies based on qualitative data from the ground, studies that actually measure land use change and what is causing it.

And their conclusions were that there's no single cause you can point to, but there are patterns that can be discerned at any given local scale. It's hard to put it all together globally without getting a little complex, but we'll try to do that anyway.

One of the other key things that they're illustrating through these case studies is that this is not a single point, single event action. It's a constant flux. Land use changes go in both directions. There's recuperation along with loss of forest.

And what you find the study, it's always going to depend on how long you look at it, and what area you look at. And you can get totally opposite results just by being a little selective on those two points. So you have to be careful when you're looking at this. The little flow chart, which again may be a little difficult to see, is an example from the United States showing shifting cultivation between cropland and reserves and forest, 1982-1997.

And if you only looked at one point change, you could see a huge shift from one direction to another. But, the net changes are relatively small and are actually net gains for the forests in this case.

People have looked at this on a larger scale and have looked at it around the world, have come up with something that sometimes is referred to as the Mather Curve, or the forest transition. And if you have studied U.S. history of natural resource use, you'll see that we have gone through this process. Pretty much every developed nation has gone through this process.

We go out and get resources. We claim the land, we use the land. We often over-use the land. We reach a bottom point, and then eventually the land starts recuperating and the use of the land starts adjusting to its capacity.

And this happens to be a very classic depiction of that for France. But the studies are indicating Costa Rica, El Salvador, Dominican Republic, a lot of countries around the world have now made the curve.

This applies to both developed and developing countries. And when you consider this issue, it raises an equity issue when you start trying to apply rules from a developed country's perspective. If you're in a developing country and they're telling me I can't clear any more forest for agriculture, if that forest is actually in a good agricultural land, and I've already got my reserves for biodiversity and for preserving ecosystem services set aside, if I'm doing what's right for the environment, who's to tell me I can use some of this to feed people.

You've already done it in your countries. In the developing countries there's a real issue there with some of these proposed rules.

To try to move quickly, on this slide, which does depict this curve at the state level in the state, the key point is that another separate study recently found that for countries that have large forest estates, any country with a per capita GDP over $4600 was shown to have it forest biomass stocks increasing. So there is a relationship between development and this process.

Now, what are these drivers and how can we understand it, maybe make a difference. I could spend my whole talk just in this one slide, but given that I only have about two minutes left, I'm going to have to try to be very quick.

Basically in this graph the circle could begin almost anywhere depending on when you pick a site. But if you're looking at tropical forest areas on the frontier, before you have the land use change, before you have human interventions, what usually happens first is you go in after the low-hanging fruit. You go in to get the biggest tree, the most valuable tree. You go in to get oil, diamonds. You go in to get a new hydroelectric plant, perhaps.

But you create access to a new area that didn't have access before. You begin to bring in workers and you begin to bring in people. You build some roads, and a whole process begins to follow that. And it's a classic process, we've seen it in many countries around the world, slash-and-burn agriculture, subsistence agriculture will almost always immediately follow this.

There will be informal land markets. These can go on for decades with land changing hands. And this is the beginning of the land use change process. It's critical, because if you don't address this process early, it's inevitable what's going to happen later. This will be cleared for crops.

So, there's a process that begins usually decades before you get three or four steps down the road, to consolidation of land tenure, people have the connections, the funding, the ability, not always legitimate, to get the land in their name and to make investments and to put it into perhaps soybeans.

And that's when the satellite imagery picks it up. And they say, oh, my gosh, the tropical forest is now soybeans.

If we want to affect this we need to somehow get out of this cycle and get more sustainable land use on the land that's good for production. And that's going to take a little assistance in developing countries.

Fire is really important, it's huge. It's mostly happening in these agricultural frontiers. There's no incentive if you don't own the land to stop the fire. In fact, it's a lot of work to clear these forests and the more that burns the better. In most situations, the majority of these fires are intentional. And they recur on the same land over and over again, as well as consuming new land.

And if we're going to look at a baseline to compare land use change, you might want to look at this cycle that's occurring out there, and not assume that we're looking at a stable mature green forest, because that's not really where a lot of this expansion is happening.

This is very dear to my heart. I spent a little over a decade working with the Guatemalan government to help set up a park service, and to promote the management, actually declaration of management of the Mya biosphere reserve.

What you're looking at here is about 20,000 square kilometers in northern Guatemala, Mexico and Belize. The red areas are areas that have been burning recently in 2003, 2005, 2007. The left-hand upper corner is Laguna del Tigre National Park, a wetland of international importance in the Ramsar list. Many archeological sites. And it was opened up and began being settled based on basic petroleums, roads, ferry and access for oil exploration.

What's interesting about this is you start to find a lot of the fallow season, what sometimes we believe, there national parks there that have much higher rates of deforestation than multiple use zones, zones where agriculture is permitted and is practiced in traditional ways.

There's forest management concessions there that are productive and they have the lowest rates by far of deforestation. In the graph, there's a green line right at the bottom. That's roughly a third -- let's go back just quickly -- can you see the cross-hatched areas that look a little bit cross-hatched in this slide? Those are certified forest concessions managed by local communities who live in the forest.

This was a multiple use zone; it wasn't made core zone because people weren't living at the time -- people were living at the time, the reserve is declared in these areas. The parks generally do not have people living in them when they were declared.

But working with these communities, the rate of fire and rate of deforestation has been very low compared to areas where there are not certified forest concessions. So maybe this certification can help. I know that it hasn't always given everyone the results they want.

Okay, I'd also just read in last week's news that this true environmental advocate, Marina Silva, resigned after losing a series of battles, kind of the one that broke the camel's back is this new hydroelectric development out in the Amazon. And the concern there is basically the same process.

I'm going to have to very quickly run through the few slides. Let me just say I have a friend who broke his leg when he fell off his field. People, the point of that is that people are farming a lot of areas that were classified as unsuitable for agriculture. Slope and terrain, if it was too steep was considered unsuitable. But people are farming that land all over the world.

Protected areas are considered unsuitable. People are farming that land all over the world. There's no really clear lines here. There's a lot of fuzzy lines. And we need to figure out what we can do in each situation to address the issues of sustainability.

You can go online, you can find this section 118, 119, foreign assistance act studies. What are the threats to tropical forests; what are the threats to biodiversity, and what is recommended to do about it for each country the USAID works in.

And I did that for some of these countries, Sudan, Brazil, Angola, that have the land and tried to put down what some of the common themes were. Governance, corruption, illicit activities are threats, along with poverty. And there's a list of solutions that I don't have time to really get into.

We just had the Council on Sustainable Development in New York. They had a list of conclusions that were very consistent with what we're trying to do with sustainable biofuels.

In Southeast Asia, similar issues. Even TNC, working in Brazil, believes that increased crop yields and enforcing laws and regulations are key to slow down deforestation.

You got to get your incentives right, but you also have to have some enforcement. Now, if we have biofuel production and we have certification, wouldn't that help to build these things.

The rest of today we're going to talk about lifecycle analysis. I'm not going to get into this slide much beyond saying I think there's a real risk at not taking advantage of the opportunity to do some positive change here. I think we can use the science and move forward.

We've done a lot of things, but when you put things into scale the bar at the top is the available land, based on these studies, not cropped actively now, not closed forest. And the little one at the very bottom is the area that's considered indirect land use change impact to biofuels.

I would think it's more likely to be in this big area that's available, but that's really something that has to be looked at on a case-by-case basis.

And the other points in between are some of the other takes, such as urban areas that are bigger over a ten-year period than the expansion of biofuels.

There's a lot of uncertainty about some of this data, and a lot of it's related to the remote sensing interpretation. But because we need to go quickly, I'm going to have to move very quickly to this.

Let me just go to the conclusion. No one size is going to fit all. We need to adapt, I think we need to adapt sustainability criteria to situations, just as they've done for the forest certification. There are principles, there are criteria, -- the specific do get adapted to local conditions to help people move up a process and improve the sustainability of production.

It was just announced at SEKAB out of Sweden, a private company that distributes biofuels, has signed contracts with Brazil for sustainable biofuels, certified sustainable biofuel supply with third-party auditing.

And I think that that's the sort of thing that we should try. It might not be perfect. I'm sure it might require some adjustments as they go along. But I think that's a good direction to go.

Partnerships are going to help. And we should learn from the experience. Some of these ideas about credits for degraded land, for example, could backfire because think about how you get degraded land.

Think about yesterday, what caused the degraded land here in the southern San Joaquin Valley, the salinization. It was basically kind of an over-use. And if you're going to get extra credit, the biofuels on degraded land, are we creating an incentive to degrade land?

I've seen people actually planting poppies in Guatemala because there was an incentive to then turn them in. So, you got paid more for that than anything else you could produce on the ground. And that was funded by --

Anyway, we have to look carefully at the credits. And the bottom line, sustainable use is going to have to be something that's simple and manageable and is based on clear criteria about that land and that condition and how it's used.

And the land use change issue is not so big as water and other ecosystem services that are impacted by the actual land use.

Thank you very much.

(Applause.)

MR. WILLIAMS: Thanks very much, Keith. I appreciate you moving quickly through your slides. And I appreciate that effort. There'll be a chance, hopefully, that you can participate later in the afternoon roundtable and get more input.

Our second speaker this morning is Robert Larson. He's Associate Director of Transportation and Climate Division Office of Transportation and Air Quality at the USEPA.

This division, the climate division, is the EPA group responsible for developing and assessing options to reduce greenhouse gas emissions from transport sector.

Bob has spent 38 years working to improve automotive emission control. For the past 34 years, has worked at the EPA. Has spanned all aspects of federal programs. He's authored many regulations, including in the 1970s the first federal fuel economy regulations. And since then, other regulations affecting sources ranging from chainsaws to heavy-duty engines.

For the past several years Bob has focused his attention on greenhouse gas emissions from the transportation sector. And while Director of EPA's Transportation and Regional Programs Division, he's led development of the EPA's smart way program targeted at encouraging voluntary reduction of greenhouse gas and other emissions from the transportation sector. For example, this includes the truckstop electrification to reduce idling of trucks.

Recently, Bob has led work on the renewable fuel standard adopted in 2007. The first federal rule to assess the lifecycle of greenhouse gas benefits that would result from the use of renewable and alternative fuels.

He also has the leadership role in developing greenhouse gas emissions rules for both vehicles and fuels aimed at implementing the President's 20-in-10 goal for reduction in transportation petroleum use.

Here's Bob Larson.

(Applause.)

MR. LARSON: Thanks, Rob. The introduction took up half of my time.

(Laughter.)

MR. LARSON: It's nice to be back in Sacramento, been here a number of times. This time around my asthma is bothering me, so some advance apologies for that. Let me launch into this.

So I'm going to talk about the Energy Independence and Security Act and the land use modeling impacts that are associated with that piece of legislation.

But there's a little history behind the work that we're doing that I want to quickly share with you. It'll give you kind of a perspective of the work that we're doing now, and also I suffered through it so I want you to join me.

So we had the renewable fuel standard, which was adopted as part of the Energy Act of 2005. We launched -- the Energy Act was published in August, so we launched into what we felt at that time was a very rapid assessment of putting those rules in place, and assessing their impact. Including the greenhouse gas impact. It's not a greenhouse gas rule, it was a volume mandate. But we knew that there would be greenhouse gas implications of this acceleration in the amount of renewable fuel, so we went about establishing a lifecycle greenhouse gas assessment for it.

For the primary fuels that we thought would be in around in this, you know, next five years, through 2012.

We're real proud of the work that we did, relying on the GREET model for a lot of our assessment. This was, as mentioned a moment ago, the first federal rule that included a greenhouse gas assessment as part of the impacts.

So all of that, we thought we had done a real good job. People that commented on our rule thought we had done an okay job, and had suggested that there was plenty of opportunity for improvement.

We agreed, but because we didn't have much time to take into account all of their comments, we said, next time for sure we're going to do this.

So we published that rule, and little did we know that just a few short days after we finally published the rule last May, that the President gathered at the White House with some of the administrators and secretaries of his Administration and announced his 20-in-10 program. And directed EPA to initiate that rulemaking effort, which would have 35 billion gallons of renewable and alternative fuel by 2017.

So, what we did then is we had a weekend off is what it amounted to, and then we started over again, this time living up to our promise of doing a better job of doing lifecycle assessment. So that's what we launched into here, addressing particular issues of the secondary impacts of changes in crop patterns, livestock usage, the indirect impacts on land use, both domestically and abroad.

We're making real good progress along that line, getting ready to propose rules in December. And Congress, much to my surprise at least, was able to get together and come up with the Energy Independence and Security Act, which the President signed in December. And lo, and behold, the Energy Independence and Security Act has a much different set of requirements than what we were modeling as part of the earlier previous six, eight months worth of greenhouse gas rule analysis.

So, in effect, we had to start over our analytical work. But we had learned a lot in the meantime, so we were able to carry that knowledge along with us.

As pointed out here, the EISA, EISA, we haven't made any progress on figuring out how to pronounce the legislation, but we have made progress in some other areas that I hope I can share with you today.

So, it greatly increases the volume compared to the original renewable fuel standard, which is now called RFS-1, and this is RFS-2. And it sets a number of other standards for some components of that total volume here. So there are now several categories of fuels that have to be included. And it is only renewable fuel, so it does not include any alternative fuels that are not made from renewable feedstocks. And there are a couple of studies and reports that I'll mention in a couple minutes.

So, four separate standards and a table. You're welcome to a copy. Let me point out then that there's a biodiesel requirement. They list it here as 1 billion gallons of biodiesel. It can go higher, but there has to be at least 1 billion by 2012.

And in this table we've kept that level about the same. There are some economic issues of trying to get a lot more biodiesel.

Greatly ramps up what most people would have thought would have been business-as-usual case for cellulosic biofuel, not just ethanol. It could be other fuels, as long as they're from cellulosic feedstock. To 16 billion gallons by 2022.

The total advanced biofuel, and I'll mention what that is in a moment, reaches 21. The total renewable fuel is 36. The difference between 36 and 21 is 15, for you math majors out there, and this is what's left over for corn starch-based ethanol.

So there's not a requirement for corn starch-based ethanol, but this is the room that's available, that's allowed in EISA.

So, there are nested standards;

complying with one set of standards could also help you comply with another part of the standard there, certainly the whole renewable fuel standard of 36 billion gallons by 2022.

So, there are some sustainability aspects of EISA here that have land use implications. First of all, we have to do a full lifecycle analysis here.

The renewable biomass must be produced from nonfederal forests. They mention tree plantations. Has to be existing cropland. The intention there is to not allow biofuel to be produced in new areas going down the Amazon type of issue.

There's several studies here that are mentioned, including the anti-backsliding study that we have to do within 18 months to look at what the emissions performances are. If there are, from a criteria pollutant perspective, and if there is degradation due to biofuels, we have to go in and change the fuel from that perspective.

So, getting into the theme of the day here. The definition of lifecycle greenhouse gas emissions, this is from the Act, that I've highlighted in red on everybody's screen, that it includes direct emissions and significant indirect emissions such as significant emissions from land use changes.

So they had kind of anticipated that land use was an important factor. The existing cropland criteria impacts of the land use issue, as I mentioned before. There are a number of issues involved in what is existing cropland.

If you're a renewable fuel producer and you're getting corn coming in the door, do you know where that corn's coming from. Is it from existing cropland or not. So there's kind of an enforcement trail.

What is existing cropland. Is it actively managed right now, or recently, or, you know, back to colonial times. So, some definition work that we need to do there.

And then there's the aspect that fuels, biofuels can be imported. Feedstocks for biofuels can be imported. And so there's the international aspect of how you apply these requirements internationally.

And last bullet there, this focuses on cropland that produces the feedstock that goes into the biofuel. But then there's a secondary impact. What happens if that cropland displaces other uses, and those uses move into new areas, new lands. This doesn't prevent that.

So, I mentioned that we have these four separate standards. There's the conventional biofuel in order to meet the 36 billion gallons, supposed to have at least a 20 percent reduction in greenhouse gas emissions compared to the fuel you're replacing, so ethanol would be replacing gasoline. You make that kind of comparison.

There is a grandfathering in there and it has a significant impact. Production facilities that were in place or under construction, so we have to figure out what that means. By December when the Act was signed are grandfathered. They don't have to meet this 20 percent reduction.

The advanced biofuel requirement is a 50 percent reduction. Biomass-based diesel could apply there. If it's a fuel that is somewhere between 20 and 50 percent, it can still apply to the renewable fuel standard, but not meet the advanced biofuel standard; and cellulosic has to have a 60 percent reduction.

So, let's finally get to a little bit of land use here. This is -- Axel Friedrich yesterday showed you some numbers that he was willing to stand behind. Joel Velasco showed you some numbers he was willing to stand behind. Others did, as well.

I'm not doing that. I'm showing you numbers, but these are wrong numbers. These are -- you can write them down if you'd like --

(Laughter.)

MR. LARSON: This is an old analysis, we're scrambling to update the analysis. These numbers will change. I don't really know how much or in what direction. But it'll give you a sense of what we're looking at and why. Land use is, at least on the basis of this analysis, why land use is an important factor here.

So we're looking at domestic land use impacts here. We're seeing an increase in corn production; some decreases in other crops as there's land use shifting around. And this is happening just in the United States.

A big chunk of the, in this case, corn that's going to ethanol production in the United States is not coming from new production here; it only went up a couple million acres, according to this analysis. It's coming from what would have been exports. So there's a big impact on export emissions -- I'm sorry, exports of crops, including corn and other crops here.

And all of that, then, impacts what can happen internationally as two things going on, greater demand in the United States for corn is raising the price of corn. Corn is a fairly fungible product, so corn internationally prices go up. Because we're not shipping as much as we would have, we're shipping an awful lot of corn, but not as much as we would have without this mandate.

There's some lack of corn on the international market at high prices. Other farmers around the world recognize that there's money to be made, and they rush off and start planting more corn. And that's the international impact here.

What happens then is there's a decrease in U.S. exports and increase in crop production internationally. Our assessment here is what happens on the international sector as far as how much corn is going up. And then there's some analysis of what the land use changes might be that result from that.

This shows a -- so we did an international land use impact here that said Argentina, on the far left, the bluish line is their increase in corn production. They're going to respond to our decrease in exports with planting a lot more corn. But their land use, the second bar there, is only a little bit increase.

What that means is that they're shifting crops. They're more intensively using their cropland for corn production. And in their case, they're decreasing soybean production.

Moving over to Brazil it's a little bit different story here. In Brazil they're doing a lot more corn, but their land use is actually going up even more. And lo and behold, this analysis suggests that they're not only planting corn, but they're planting soybeans, too, in response to our efforts.

And we've analyzed this for the rest of the countries around the world.

So, what happens here. Next page. The bar on the far left is gasoline; the second bar from the left then is the impact on greenhouse gas emissions from ethanol production using corn in the United States, but including the international impacts.

So there's some decreases below the zero line here due to higher prices. Mean the feed that's going to cattle is higher and that increases cattle costs and that reduces consumption. That's what economists tell us.

So there's some decreases in those areas, some crop decreases. And then there's some increases above the line, above the zero line there. But on net, this analysis suggested that there would be a 17 percent benefit from using corn in the United States, even considering the international land use impacts. This is a different number than Tim Searchinger came up with.

Now, that's assuming that the land that you are changing came from Brazil, pasture land, which had some stored carbon, but not the most stored carbon.

If you move to the third column here, what happens if that land change instead occurred in the Savannah, which has a little bit more stored carbon. Well, your net benefit then changed to 11 percent, went from 17 to 11 percent.

What happens if -- the third column here is the crops went into the pasture, but those pasture lands then migrated to the Amazon and they mowed down some trees. Well, things aren't so good then. There's a net increase of 28 percent.

So it makes a difference where this land shows up. So, one of the things that we're doing is looking at what are the land use changes that are occurring as part of the biofuel production in looking at the incremental effects of the increase in requirements of the EISA language, here.

What we've done is had to make a number of assumptions in this analysis. One of which is there's an annualization rate of 30 years was used in this analysis that I just showed you. When you have a carbon -- when you have a land use change, there was stored carbon there. And what do you do with that stored carbon, it's all released in the first one to three years. But how do you treat it when you're farming it for a whole long time.

And in this case we picked that we would amortize that over -- or annualize it over 30 years.

So there are some topics here that we ought to be talking about here. First of all, you got to figure out what the total acres are impacted. And this includes a combination of intensification and extensification.

There's an issue here. We know a lot about what is going on in the United States. And we can kind of predict what might likely happen in the United States because we have lots of data. USDA does all this projections. Through perhaps in the 2022 time frame.

But we're also applying the same analysis to Argentina. So what we have to do is end up predicting what the farmers in Argentina are going to do in 2022. Is it just a matter of planting more acres, or are they going to throw some more fertilizer on there. Are they going to -- they grow about 70 bushels per acre in Argentina. And in the United States we have around 145 bushels per acre. So there's some opportunity for Argentina to not just plow under more land, but actually do a better job of growing corn.

So those are the kinds of issues that we're looking at here. We're working with everybody including our partners at the California Air Resources Board to improve our lifecycle assessment. And we're inviting everybody to look at the work that we are doing when we propose our rule. Trying to be very -- overly used term -- very transparent so you'll know exactly what we're doing and what we assume.

In some cases we might have some logic behind our assumptions that we'll share with you, in other cases we won't. But we'll at least tell you what we're assuming. And allow you to give us better information so that we can improve this work.

So, I appreciate it very much, and I think that was it.

(Applause.)

MR. WILLIAMS: Thank you very much, Bob. Next up is Dr. Don Smith. He's a James McGill professor and Chair, Department of Applied Sciences at McGill University in Montreal.

During his 22 years at McGill, Professor Smith has worked largely in production and physiology of croplands. More recently with an emphasis on plant microbe interactions including nitrogen metabolism, nitrogen fixations, et cetera.

He's also involved in the physiological

responses of crop plants to increasing atmospheric CO_2 and to climate change.

He currently leads the NSERC-funded green crop network project on climate change, including work on biofuels. And I think he'll address a little bit on food-versus-fuel issues.

Welcome, Professor Don Smith. Thanks.

(Applause.)

DR. SMITH: Okay, down from the frozen north. Yeah, so I just, I guess the idea here is the whole business with food-versus-fuel. Quite suddenly it's come to the fore, at least only really in the last four, five, six months. And so I'm going to try to give a broad perspective on what the issues are.

It's definitely become the case that biofuels has taken quite a hit on this, and I think that's probably not completely fair. So I'm going to walk you through this.

This is my little layout here -- anyway, okay, so biofuels, I'm just going to give you a little overview of what's out there, and I'll have to ask you to forgive my occasional Canadian perspective on this.

The food-versus-fuel, what's the deal on that. What's happening there overall. Some of the other factors that are impinging on this whole thing at this time. And then maybe some optimistic notes at the end about how things might work out in the long run.

So, biofuels background. Just, well, I guess this is my perspective on this. Three of the great challenges, there are others, for the 21st century, energy, climate change and food security will probably be another one.

Biofuels are where these three things come together. Climate change is ultimately an energy issue. We have the issue because we burn fuels. And at the same time, our consumption of the fossil fuels has really just started to shift the global carbon cycle.

In the long run, the biofuels from foodcrops has coincided with food price increases. And this is where we've come to sort of take a knock for this.

This is just looking at the whole thing with biofuels, what's driving us to do this right now. We've got this whole thing about peak oil. When was it going to happen. The data's clear, it happened in the U.S. about 1970. In Canada, conventional crude extraction peaked in 1971. We're busy digging up all of northern Alberta right now, then sending it to you guys. That's a different story.

The picture I show you here, if I can do this, this is from an Austrian paper. This gentleman says that peak oil extraction globally happened in 1999. Now, you can get different estimates on this, different models, different assumptions. And I've seen some as late as 2030. But it's about now.

And if you look at what's happening overall, increasing energy demand is a big issue in all this, one part of the equation, as well, in oil prices, et cetera.

This is a picture of the China National Bank. I took the standing at the bottom of the Pearl Tower in Shanghai. Always an interesting thing if you're a Canadian. Shanghai has the same population as Canada.

(Laughter.)

DR. SMITH: So, extremely humbling. I took this picture. If you look out over -- if you go up in the Pearl Tower and you're looking over Shanghai you'll see that at any given time they're building about 1500 of these towers. It's extremely energy intense.

So energy demand is rising there in a big way. And now in India, as well. But on the greenhouse gas pressure side, you've got -- things are melting everywhere. Certainly glaciers. I visited, with my family, the Athabasca Glacier in the Canadian Rockies, a very big slab of ice. We visited it six years apart, 60 meters shorter. So it's happening.

Greenland ice sheet, arctic ice, arctic sea ice is disappearing. The ice shelves break up about every year or two in Antarctica. It's going on.

In the north where we are, we're looking at larger temperature increases than at the equator. So in the Canadian north we could be looking at 8 degrees. It's not trivial. We're already seeing the biosphere respond, birds returning sooner, plants are flowering sooner, all of that's happening.

So where do we go with all this. We've got to deal with not emitting as much and we've got to deal with less energy to be had anyway. So we've got all these alternatives here.

Hydro is largely done, the big rivers are all -- I think there's only one large one in the world that's not dammed, I think the Okavango in Africa is not dammed yet. And we probably shouldn't dam it, but we probably will.

Nuclear is expanding rapidly. I think the NRC here in the US, about 30 pending applications right now, something on the order.

Coal, a big shift to coal. In China they start a new coal-fired plant every three days right now.

Photovoltaic solar, I have a lot of hope for this. Wind, tidal. But I come down to the bottom of the list, here we have biosolars. This is where we are today.

So biofuels, what can we do. Biomass for direct combustion. I have a nice insert in my fireplace, do a little of this every year. There's all the fermentation things. Biodiesel from some oil and also from gasification. Biomethane, hydrogen. Hydrogen's always, I don't want to say hydrogen, it's one of those technologies that's always 15 years off.

(Laughter.)

DR. SMITH: So, little history. I'm a

university professor, I like history. So, early cars were designed to run on ethanol, right. So this is over here in the corner we have Henry Ford's quadracycle; ran on ethanol. This is Rudolph Diesel's first engine; ran on peanut oil. But in 1859 Edwin Drake brought in the first oil well, looking for a cheaper, more reliable source of kerosene. And things went on from there.

Okay, this is Canadian data, but this is just to give you a sense of how things have gone over the last century. This is oat production, as a fraction of total cereal production. Canada took quite awhile to dig all this data. It goes back to 1900. And in 1900, if you look over on that side of the slide, you'll se that it was about 50 percent. So this is for horses, which at that time is heavy equipment and transportation; that's what it is.

And you see it slopes off steadily with a pause for the depression and the Second World War in the middle of the century. And then keeps going. Hits rock bottom about 1992 where it's about 4 percent. It comes back up a little after that, but not so much because oat hectares came up, kind of took some hectares away from wheat.

So what you see is a steady shift during the 20th century of our economy from a biobased one to a fossil fuel based one. And we're a little bit in trouble on that, I would say, now.

So, anyway, it's interesting, well, I thought it was interesting. I dug it out. Of course, I'm completely unbiased about this.

Transportation fuels is probably where we're going to need to be with all this. There's a number of places where biofuels can be used, but we need that high density liquid fuel. Although having said all this, I'll tell you maybe we don't. But probably we do, at least for our car transportation fleet. That's where probably biofuels would have a role in the short term.

A lot of controversy about this. I'm not going to talk about the greenhouse gas balance because everybody's talking about it today, so I thought I'd be completely off topic, as is my -- it's just typical.

Okay, corn ethanol, you can see the energy balances. Controversial; generally not given to be overly good. Biodiesel a little bit better. Soybean nitrogen fixation helps. The transesterification reaction is less intensive than distillation.

Sugarcane is even better, partly because they burn the bagasse as an energy source for distillation. And some people (inaudible). With cellulosic it can look even better. This is all about how much fossil fuel in for how much biofuel out. My argument is in the long term we should just have zero biofuel, zero fossil fuels in. That should be, I think, an objective for the biofuels industry.

Biofuel considerations. It can be a nice sustainable energy source, and at least on the plant basis, no net CO2 emissions. But it's worth using, at least initially, and as you might predict, croplands, ones we use to raise food.

And when we developed these we weren't thinking about greenhouse gas analysis or greenhouse gas lifecycle analysis. We weren't thinking about energy balance. So, they're not the best of this in many ways.

Again, this is one of my fiddlings. What was your best greenhouse gas or -- biofuel plant look like. Should have high photosynthetic rates. High overall starch contents, depending what you're growing for. Good oil profile if you're doing it for biodiesel. Stems should be high in cellulose, low in these other things that cause problems.

Roots should be high in lignin so they'll hang around with the soil and offset maybe some of the soil carbon inputs that they might have had from the tops, if you're taking away, say, crop residue. Shouldn't use much in fertilizer. Huge source of energy in fertilizer. So if you can remove that energy input or minimize it, it's good. Low ash if you're burning it or gasifying it.

High water use efficient, and nice if it's a perennial. Keeps a big root system below ground. Doesn't require tillage energy, et cetera.

Sorry, this is my Canadian stuff, right. We're only 32 million people. About the same as Shanghai, right. Shanghai's not the biggest city in China. That's even more humbling.

At 45 million hectares of prime agricultural land. And we probably have something like about, I say marginal, depends on what you mean by marginal. I guess I'm using the broadest definition here. Marginal lands. So that's a lot for a small population.

Biofuels industry process just getting going. We have a number of crops available to us. Just passed a law yesterday mandating 5 percent ethanol by 2010, 2 percent biodiesel by 2012. They passed it yesterday; it took them awhile to get it through. And I think it's crystal clear by this time we won't make it.

We're a northern nation, so climate change issues, as I said, are a big deal for us. If you look at some of the native people up north, they bring stuff in every year on ice bridges across the lakes. And the duration of the ice bridges get shorter and shorter. It's causing problems.

Yeah, okay, food-versus-fuel. Let's talk about this, the actual topic of my discussion here. So food-versus-fuel. Diversion of corn and some other foodcrops into biofuel production has coincided with a sharp increase in price of a number of staple foodcrops around the world.

Concentration construction of biofuel plants. Actually some of them have stopped because the price of the feedstock became too high. So some issues here. Price. Food -- I mean price for crops. So this is what's happened over the last 50 years especially, with the last 100 years really.

This graph I have here is actually, this is the price of a bushel of wheat. And it's inflation-adjusted. So after you adjust for inflation, what you see is dropped dramatically over the last 100 years. And that's been a big problem for producers in Canada. It led to a situation where the Canadian crop production sector was really verging on the edge of collapse.

So you have to say to yourself, hmm, what do we do about this. Biofuels helped a lot. The sector is now fairly robust for the last year or two. The question is, you know, was this a good policy that maybe has gone too far or not. We'll talk about this.

But this has been good for the Canadian crop producers, but it's come at some expense elsewhere in the world. There are people who are facing sharp increases in food production and people who just got off the bottom rung of poverty and are now looking at going back to it. So that's an issue.

The western world. What are we doing here. Again, I had originally put on here that a loaf of bread in Canada costs about $2. I was corrected at $2.50. And the woman I was sitting next to on the plane yesterday said, no, no, closer to $3. So I put it in there. I didn't get her name or I would have cited her.

(Laughter.)

DR. SMITH: You know how it is when you meet people on jets.

But sadly, the amount of money the farmer is receiving for the actual wheat in this was in about 2006 was five or six cents, up to about 10 to 12 now. I don't know, you know, so it's -- price goes up a little bit, it doesn't -- it shouldn't change the price of a loaf of bread a lot for us. We're in pretty good shape to stand this.

Food, as a colleague of mine said recently, was probably the cheapest it will ever be in 2006. And you can see here, this is US data, here's data from a number of well-to-do countries, developed nations. This is Canadian data. You see that a lot of us are spending about 10 percent of our income on food, or you know, household income on food. It's not a lot.

And it means, in fact, we don't think about it very much. So, it probably contributes to obesity, this is a big problem in North America. I have this picture here. You can't see me because I'm hiding behind the podium here. But my wife always says -- this picture, you see, you don't need the picture, just turn sideways.

(Laughter.)

DR. SMITH: Oh, those who love you. Anyway, the problem is calories have gotten cheaper and cheaper. So you just go out and get them. It's easy.

Sedentary lifestyles, as well. But inexpensive calories. I mean food, for us, is just not a big issue. We don't think about it very carefully before we buy it.

This has led to a lot of waste. There was a study came out about two weeks ago showing in the U.K., households throw away almost a third of the food they bring in. Just discard it because it goes off, one way or another, past the best "before date". For fresh fruit and vegetables it's closer to 40 percent. So a huge amount of waste. And it's because it's cheap.

On the other hand, use the flip side of all this. What's happening in subSaharan Africa is always looked on as the most desperate place in the world for this kind of thing. And really a major problem for them has been global subsidies, international subsidies.

Their agricultural sector is always a big one; about 80 percent in Rwanda, we call it the worst in Rwanda, is the ag sector's -- it's a big slice. I had a discussion with a Russian scientist in Uzbekistan awhile ago. She was explaining to me that about two-thirds of the economy there is agricultural. And she asked what the situation was in Canada. I said, oh, 1 or 2 percent. She gave me one of those looks, you know, you liar. Took me three days to convince her.

Anyway, what happens is these very large sectors in subSaharan Africa particularly being crushed by grains coming in that are below the cost of production even in subsistence farming conditions. And interestingly, with the increasing price of foodstocks recently, a number of countries have indicated a willingness to reconsider their subsidy structures. So this could be very helpful.

The speed of things is a problem. It's hard to adjust in one year or six months. So, hopefully in the long term this will help these economies get their ag production sectors going.

Having said all that, there will be some people who will clearly be hurt by this. Sort of like playing with the mouse here, it's kind of fun. Rural poor, and especially the urban poor in developing countries who are just approaching this, or just past the situation where half the world's people now live in cities. And more and more of these people are in cities in developing countries. So these people are going to be affected in a very negative way.

So there have been protests and riots. I have a list of countries here. I tried to keep up, but I lost. So I kept up until about two months ago. I think the total number now is about 30 countries where there have been protests and riots.

The prime minister of Haiti changed about a month and a half ago because food prices. And I like this one in Camaroon, a taxi-driver strike started out over fuel prices, and then turned into a larger bit of disorder over food prices. So they went from fuel to food.

Okay, some other factors that are definitely impinging on all this population, right. The stage is already set. I mean if you look at global population, we, as a species, bumped along at between a third and a half a billion for most of the last two millennia.

Once the industrial revolution came along we started to increase population dramatically. And the increase in the last 150 years is just breathtaking. And we need to think about that. It's gone from a little over half a billion to we're now at about 6.5 billion, headed for, well, depends on whose estimates you use, but this one says around 10 somewhere around 2060. It depends.

But it's a big increase and feeding all these people is a challenge. Puts pressure on things.

At the same time, in the Asian countries, as wealth has increased, people have increased meat consumption. And as all the inefficiencies that go with moving from trophic level to trophic level. So that has also put pressure on world grain stocks.

At the same time the rate of the yield increase over time, due to our various research efforts, et cetera, has decreased. In the center you can see it's gone from a little over 2 percent in the '60s to the '80s, the early '80s. But from the '80s through to the '90s, about 1.5 percent per year. And then finally into the period where we are now, it's about 1 percent a year.

That's a concern. And you can see what's happening is that increase in cereal yields per capita haven't really kept up with world population growth recently.

Energy limitations. This is a problem. And it's a serious one, it's come on the same time as biofuels, for obvious reasons. Western production methods are, for crop production methods, very energy intensive; and nitrogen fertilizer's a very big on in all this.

So we really took off after the Second World War, right. If you get into the history of nitrogen, it's all tied up with explosives and munitions. And so we built a lot of plants during the Second World War. It really allowed a lot of use for nitrogen fertilizer after that, but it makes it expensive.

So, increased energy prices increased the price of this, and also transportation. So, this is also a price issue involving food production.

Climate change. We've had the elevated CO2. That's good for plant productivity, but ends warmer, drier, and we are seeing more extreme weather events. I think we're closing on the tenth year of a drought in Australia. Southwestern U.S., I think you guys are having droughts here. U.K.'s had mixtures of droughts and flooding. It's a small country, but still, droughts and flooding in the same country, different parts.

Water. You know, agriculture uses a lot of water. Mostly for irrigation. And there's ongoing increase in competition with urban use. Aquifers are being pumped out. Land is salting up in some areas. Rivers are being fully exploited. There's a number of rivers that don't reach the sea in the summer anymore.

In 2006 I took a train ride along the side of the Yellow River. And until about two-thirds of the way up it's empty. That's one of the world's great rivers. And as a result, there's a lot of areas alongside that used to be irrigated and are not anymore.

So, the upshot of all of this. The larder is almost bare. When I started working at McGill when I was actually young, there was about 150 days, 140 days worth of grain stores in the world. So, given that we harvest one hemisphere and then another, it was almost enough that everybody could eat if we have a complete hemisphere crop failure. It would get us through to the next harvest in the other hemisphere.

We're down now to about 40 days. But you can see that it's been declining steadily over time. Biofuels is one-minute wrap-up. Yeah, I'll go there actually.

Speculation comes in when things get thin like that. And that's an issue. That's happened, especially with rice. Rice prices have gone crazy. Some other issues that are out there, glaciers have been melting net because of climate change, and that's going on in a big way. It's been a source of water in rivers in the summer for irrigation. But some glaciers are just about melted out now.

So, degradation, erosion, salinization, urban sprawl covering up good ag land. Political instability and warfare which sadly, as food becomes more tight, food supply becomes more tight, will become more prevalent.

And the last section, and it's a short one. I can do it in 30 seconds, what do you think.

Crops that we could look at for second generation, so things that grow quickly, don't require a lot of input. Grow on marginal lands. And things that hopefully can be transformed reasonably easily.

Engine type. External combustion engines burn it all. You don't have to leave anything behind. You don't have to transform. Sterling engines are a good example of this. And actually, in the late '70s and early '80s, after the OPEC crisis, the American Motor Corporation built a Sterling engine prototype car. If you did the Sterling engine hybrid electric with the new capacitor type electrics, this would look really promising.

Genetically modified organisms. We can improve the crops a number of ways. And there's a long list of things we could do.

Crop production, precision agriculture, this is the usual stuff. Improved storage. Interestingly in the tropics they lose about half of their crop, 50 percent every year after harvest because of storage problems. We throw away a third. There you go.

Biodiversity. There are things we can do with mixing crops that make them produce more. Adapting to climate cycles like el nino.

So here we are at the last slide. Overall, we're now being squeezed between energy scarcity and food scarcity. There's things we can do, and certainly as prices go up there will be expansion of production, et cetera.

But in the broadest context, both of these and our climate change, the broadest context all three of these need to be considered with a view towards population and resource conservation.

And that's -- this is what we're doing at McGill, but you don't need to know that. There you go.

(Applause.)

MR. WILLIAMS: Thanks, Don. That was very interesting, and hopefully there'll be a discussion with Don later in the day.

Now we have Bruce Dale. He's University Distinguished Professor of Chemical Engineering at Michigan State University. He's been working to improve the economic, environmental and social sustainability of cellulosic biofuels for 32 years.

He's going to talk on land use changes and LCA.

DR. DALE: Well, we'll get this thing figured out eventually.

Yeah, I'm going to talk about lifecycle analysis, biofuels and how that might be applied to land use change issues.

I've been working for over 30 years in production of cellulosic biofuels. About eight years ago it became apparent to me that we were actually going to have large-scale cellulosic biofuels before I died or retired. And so it would be a good idea to start looking at making them not only economically, but environmentally, sustainable. So we started doing LCA work, and I'll talk to you about that briefly.

This is the fundamental reason why cellulosic biofuels are going to happen. The slide shows you -- the horizontal line is the cost of oil in dollars per barrel. And then on the Y axis you have the cost of biomass at dollars per ton.

The heavy black diagonal line is where the energy cost of oil is equal to the energy cost of biomass. In other words, the energy content or the heat value of the biomass is equal to the heat content of the oil.

I've worked most of this time when oil was around $20 a barrel. And that turns out to be a fairly significant number. At $20 a barrel the energy content of oil is just equal to the energy content of biomass. In other words, you can afford to buy the biomass, but you can't afford to convert it into anything that will replace oil. So you can pay for the raw material, but you can't pay for the processing to convert the energy content of the biomass into something to replace oil.

That's different now. We have a different world. We have this large margin now to put processing in to convert the energy content of plant material into something that can substitute for petroleum. This is why it's going to happen, and I believe happen much more quickly than most people realize. There's a lot of money to be made. At $100 or $120 a barrel oil, there's a lot of money to be made converting plant material to replacements for oil.

So, my assumptions here are that inexpensive plant materials are going to catalyze the growth of new and existing biofuels industry. It's going to happen.

We have a unique opportunity to look forward and design these systems for a better environmental performance. I emphasize better because I don't believe in the idea of some sort of absolute sustainability. We can benchmark where we are and try to improve it.

But I think it's futile to pursue some utopian vision of a perfect world that has no environmental impacts. Okay, you and I impact our environment; 6.5 billion of us impact our environment, 6.5 billion times.

So, one important tool for this, I believe, is lifecycle analysis. Has a great value, but it's a limited tool. And it can be, in fact, I believe, just dangerous or pervert the use of it if it's misused.

I can't overemphasize this enough. LCA exists to make comparisons. LCA should not be done in the abstract or the ideal. It exists to make comparisons between your options. That's what it's for.

So, what are LCA models? The first system studies the mass and energy balances. Using those mass and energy flows, you inventory the environmental impacts of those products and process; and you select a few key ones that you're interested in.

You know, with this conference, which I understood mostly greenhouse gases, bear in mind that there's other things that -- other environmental impacts that we have.

In my mind the most important objective or most important use of an LCA is to benchmark, evaluate and then improve your environmental footprint. Use it as a way of measuring where you are and how to get to a better place. Much along the lines of what Robin Jenkins talked about DuPont's use of LCA.

It's a relatively new field. It was born about 1990 and it's still being developed. It's still being argued over. One of the chief points of argument is how to do allocation. Almost all systems have multiple products. So how do you allocate the environmental burdens in a multi-product system. It's not fair to make one product bear the entire burden, so how do you do the allocations. It's important; it's controversial.

This is the LCA framework that's laid out in the ISO standards. So we have goal and scope definition. You do the inventory analysis, the impact assessment. And at all stages you have interpretation of what you're doing; I would say importantly stakeholder participation. Robin also mentioned this in her talk, their extensive use of stakeholders.

Searchinger and also Fergione papers had no interaction with the stakeholders. The reason you talk to stakeholders is because they're going to be impacted by your study, but also generally they have information that you don't have.

LCA, credible LCA, is data-driven. It's information-driven. So you need good information. Go to the people that have it; or try to work with them.

This is just the first page of ISO-14040 standard for lifecycle analysis. You can gauge, to some degree, how sincere a particular author or set of authors are in their attempt to apply lifecycle analysis if they show any familiarity at all with these standards.

These are internationally agreed-upon standards for doing LCA work. And yet they seem to be ignored or completely discounted in some of the more prominent recent studies.

So for translating in plain English, what are these standards. These are no-brainers, in essence, okay. You use the most recent, the most accurate data that you can possibly find. It's data-driven, relies on good data.

You select the reference system and the functional unit. What exactly are you comparing. Comparing gasoline to ethanol; are you comparing corn for animal feed to corn for ethanol. What exactly is it you're comparing.

You make it easy for others to check your data and math, call this transparency. Then you set very clear system boundaries. And I want to emphasize that there's two types of boundaries to set. There are physical or spatial boundaries, and there's also temporal or time boundaries, okay. When and where and how are the products generated that you're comparing.

They need to be equal or at least very comparable for both your product and the thing that you're comparing it with. In multiproduct systems you need to allocate their environmental costs. And then you perform a sensitivity analysis. Why do you do this. To check to see how robust your conclusions are. Basically how good your study is, or how reliable it is.

So I want to briefly go over the Searchinger work using these criteria. We'll take them one at a time, kind of go through the analysis, analyze the Searchinger work on that basis.

Use the most recent and most accurate data possible, okay. Land clearing was taken from data in the 1990s. It was not checked either by modeling or by more recent data.

There are four linked models. So, actually not empirical data relating the decision to make up corn in the United States to plowing a hectare of Brazilian serrato, okay. They're linked models.

I understand modeling. I know its

limitations, I know its value. But that wasn't really made very explicit in the work.

Here are the linked models. You have the ethanol demand to the corn price. There are other things that affect corn price other than just ethanol demand. But that was not explored in the long way.

There's corn price to corn or soybean supply. These are economic models. They don't call it the dismal science for nothing, by the way. I'm thinking as a physical scientist.

There's the corn or soybean supply to the land use change. And then there's the land use change to the greenhouse gas consequences of that land use change.

Fifth, and this was not just in either of the two papers, the Searchinger or the Fergione paper, is the land management post land use change. Turns out this is really important. But land doesn't cease to be managed once the conversion is accomplished. What are the consequences of -- the greenhouse gas consequences that simply weren't considered by either of those papers.

Now, those of you that have physical

science training will understand the idea of propagation of errors. So, if you have outputs from one model or one system that serve as the inputs, and there's an uncertainty in those, then the uncertainty grows as you tend to propagate down the system to your final conclusion.

In other words, the less and less reliable your ultimate conclusions are, because you have uncertainties all the way along in these five linked models.

I basically conclude that the Searchinger in certain analysis is just inadequate. Monte Carlo simulation based on some distribution of the uncertainty is the standard for LCA, and it simply wasn't done. It was a very simple sensitivity analysis done. I think it's frankly inadequate.

So, number two, select the reference system we're functioning in. What exactly is it that we're comparing. Is it ethanol versus gasoline. I'm going to take his word for it that that was what he compared.

But in reading the paper you can actually talk about when comparing corn ethanol to cellulosic ethanol, how about tar sands oil to gasoline. Is that part of the comparison.

Very significantly, is it backwards looking or forward looking. What are the temporal boundaries. What is the -- are you comparing corn for ethanol, or corn for animal feed. It has both uses. Well, I'll talk about that in a moment.

Allocation would help to resolve Searchinger's preference. Frankly, the preference in the paper for a feed versus fuel use as a corn, but no allocation was given to feed uses of corn.

I want to make this very clear because I'm going to come back to it. Most corn is not used to feed people directly. It's fed to animals. And, in fact, we could remove any conflict you want between biofuel and land use if we decided to go to a diet that basically eliminated red meat. We can keep dairy, have cheese and milk, but you get rid of red meat the land use issue goes away because we free up so much acreage that we devote to supporting beef animal production. That's just a fact.

Okay, so the fact that Searchinger's analysis said you're going to have to maintain animal feed production constant in the face of raising fuel demand, said in essence, that's a preferred use for corn, is to feed it to animals. And biofuels have to compete with that, again on a disadvantage sort of basis.

So what are the temporal boundaries, again, physical and temporal. For biofuels the temporal basis of the Searchinger work was future, forward-looking, 2015, 2016. The physical boundary was the entire world land. Okay, you can do that. You can set your system as the entire world. Makes data gathering more difficult, but you can certainly do that. So, it includes indirect effects on greenhouse gases.

For petroleum fuels, okay, which was ostensibly the comparison here, the temporal scale was past, just looking back. The GREET model, which is a backward looking, you know, it was based on historical data, look at the greenhouse gas and petroleum fuels. Not where we'll be with petroleum fuels in '10 or '15 or whatever years it is.

For petroleum fuels the physical boundaries also were restricted. Those indirect effects on greenhouse gases were not included. So what are the indirect effects. Okay, if indirect effects are valid for corn, corn ethanol or cellulosic ethanol, then they're certainly valid for petroleum derived fuels. Were they considered? No, they were not.

All the product systems have to allocate environmental costs, okay. Again, the system we're using here is land use of the entire world. Land produces ample feed, roughly ten times more total land is used to produce animal feed as food that's directly consumed by human beings. Human food, biofuels, pulp, paper, lumber, clothing, cotton and so on and so forth, and obviously environmental services.

Searchinger, however, allocated the entire incremental land use costs of biofuel production to the biofuel. It ignores the fact that the replaced agricultural production actually went to provide animal feed. So the additional corn or soybeans that were supposedly grown in response to the removal of corn, of U.S. corn, from the total world pool of corn, the entire allocation there was against the biofuel with no sharing of animal feed, although animal feed actually has comparable greenhouse gas, I should say livestock production has comparable worldwide greenhouse gas emissions, as does the transportation sector, about 18 percent total world anthropogenic greenhouse gases associated with human livestock systems.

Therefore, analysis advantages animal feed production versus -- from land versus biofuel production. Animal feed production is, quote-unquote, "sustainable" but biofuel production is not. Notice a prior use trumps a later claims, or we used to call it squatter's rights. You've got the resources, you're there, you get to keep them. Okay. Squatter's rights.

Sensitivity analysis. How much results vary if assumptions change. Well, for example, no productive use was assumed of existing forests. You have this nice tropical hardwood, worth a lot, but just burn the trees down, make no attempt.

Were decreased land clearing rates and/or different ecosystems converted -- types of ecosystems? Was that considered? No.

Corn yields increasing in both the U.S., it was pointed out, versus the Argentinean farmers have a long way to go. No inherent reason why they can't increase their yields.

So carbon debt, just the temporal issues here 2015 versus 1999. Increasing efficiency of future ethanol plants. Achieve greenhouse gas efficiency.

Then there's the uncertainties that I mentioned in the global equilibrium models. They should be tested to the Monte Carlo simulation. That wasn't done.

And then allocation of environmental burdens just among feed and fuel use of corn, not just of fuel. So how is land managed after conversion, which I'm going to address briefly.

None of these factors were considered in the sensitivity analysis. I believe they should have been. Part of good sensitivity, part of a good LCA study is a sensitivity analysis. How much, if your results change, if you change or modify some of your important assumption.

So, get -- models here, the four in black are the ones that were considered. The fifth one that was not considered is what happens to the land management, what do you do, how do you manage the land after the postulate or hypothetical land use change? Either forgot or ignored that fifth one. But the land doesn't stop being managed once the transition is executed.

In his analysis only the ethanol

greenhouse gas contribution was counted, but not the land's continuing ability to sequester carbon.

So let's explore briefly whether the greenhouse gas consequences of post land use change management options. To do that I have to tell you briefly what we've been working with, again for about eight years, in cooperation with DuPont and others. We're looking at soil organic carbon CO2 nitrogen -- using a model not developed by us, but a very powerful agroecosystem model called DAYCENT. Another version is called CENTURY.

But it allows you to predict carbon and nitrogen flows that agricultural and forest ecosystems based on site-specific data. The crop you're using; climate; the soil types; tillage -- and very significantly, tillage practices.

Okay. This is a slide here to most chemical engineers or modelers, just shows the flow of carbon between the different pools. For instance, aboveground life carbon, that would be the tree trunk or the corn stalk. And belowground life carbon, that would be a root. And all the other different carbon pools, they're there.

So what we did was to take this model

and to look at various land management post land use change. And specifically at the sizing, how the land was tilled, the crop tillage practices; and also the use of cover crops. The cover crop is a crop that's planted -- about 20 percent of U.S. corn farmers plant a cover crop.

After you harvest the corn, you plant an annual grass for some other use. Either for land benefits or to harvest it. It's an annual grass that grows up a few inches, takes up excess soil nitrogen significantly limiting nitrous oxide generation, by the way. And then spring, before corn's ready to harvest, it grows rapidly, use it as a green manure or the first feed.

So, anyway, we looked at six different scenarios here, three with grassland conversion and three with forest conversion. And the B and E here are the indirect effects. Convert the corn field to ethanol production and then convert grasslands somewhere else to a corn field dedicated to animal feed production.

This is based, by the way, on data for eight U.S. corn-producing counties representing different climates, different tillage practices and so forth -- sorry, different climates, different rainfalls. Here are the tillage practices.

So starting in the upper left-hand corner, these are the results. The upper set of lines is the set of lines dealing with grassland conversion. The lower set of lines, in all cases, is the forest conversion. And the bundled sets of scenarios there track. You don't really see much effect of cover crops or different rotations. It really matters whether it's a grassland or whether it's a forest that's converted.

So, under current tillage practices, if you take into account, as we believe you should, what happens to the land after the land use change, the supposed biofuel carbon debt is erased under current tillage practices in about 45 years from the forest. From grasslands you are essentially zero, a zero change, okay, no deficit right from the first year. And within 10, 15 or 20 years you actually have a greenhouse gas benefit. There is no biofuel carbon debt under that condition.

If you look under -- the next top right-hand corner, plowing tillage, if your corn field is plowed using conventional plowing, then your biofuel carbon debt lasts about 60 years for forest conversion. And there's a zero benefit for about 20 or 25 years. This is just the agricultural part of the system. Doesn't include the fuel use part of the system.

And then if you look down at no tillage, okay, and it's pointed out that with diesel getting more expensive farmers are increasingly using no till, about a 30-year timeframe to get to zero deficit for forest. For grassland conversion, again, there is no deficit. If you include then also a cover crop, it's 20 year for forest and, once gain, no time at all for (inaudible).

So, using that as a backdrop let me just finish up with a couple thoughts about food-versus-fuel. We hear this an awful lot, and I would like this audience which is sophisticated and educated, to please stop using food-versus-fuel. It's not correct. It's inaccurate.

What we actually use agricultural land for is to grow animal feed. Now these data show that to you. Okay. Primarily we use it to produce dairy and beef animals, ruminants. So the total amount of protein total energy requirements for our entire U.S. livestock, for total U.S. livestock consists of about 56,000 million kilograms of protein per year, okay. And about 1000 trillion calories of food energy. That's roughly ten times the amount of protein people need and about five times the amount of energy, calories, that people need.

We don't use our agricultural land in the United States or I think in any developed country to grow food. We grow feed, okay. So please be accurate about that.

I don't mean to -- obviously we eat the things that the animals produce, but replacing, as I'm going to show you, replacing or supplementing the animal feed on the byproducts or co-products of the cellulosic biofuel industry is actually quite an attractive and easy thing to do, as I'll show you.

Okay, so we've been looking for a long time trying to develop what we call a sustainable economy, or based on integrating cropping systems, the biorefinery and an animal operation.

We looked at the integrated agricultural system, the biorefining system where the fuel products are made, and an associated animal feeding operation that can use either protein coming out, which doesn't make -- it's not a very good fuel, and/or enhanced digestible energy feeds from the biorefinery.

One of the things we've learned in our analysis is that all biomass is local. Okay. Some of you may recall Tip O'Neill, the former Speaker of the House, who was fond of saying that all politics is local. So we can do a syllogism here. If all biomass is local, and all politics is local, then all biomass is politics.

(Laughter.)

DR. DALE: Which actually turns out to be true.

(Laughter.)

DR. DALE: Okay, so let's talk -- two bioreactors. We have on the left a mobile cellulosic refinery, also known as a cow, a ruminant animal. We have on the other side the stationary cellulose biorefinery. Taking in also lots of cellulose material, also known as hay.

If you improve the cellulose conversion for the biorefinery, make it easier to convert, to make fuels, ethanol or any other fuel, you also improve the cellulose digestibility for cows.

So I'm talking about integrating animal feed and biofuel production. We use a particular process we call afex, or ammonia fiber expansion. We heat biomass with hot concentrated ammonia to increase its conversion. And I won't talk in any detail about this, but this is what my lab uses. There are other approaches that are being used.

But the point is, again, they all simultaneously increase the digestibility of the cellulosic material for the biorefinery for fuel production as well as for animal feed production.

This is the proof of that statement. This is a particular afex-treated or ammonia-treated grass we've used. On the lower axis rumen and NDF digestion, this is a standard test for the digestion using rumen fluid of the plant material. And on the Y axis the enzymatic conversion to glucose plus xylose in the biorefinery grouping, 12 hour digestion, 24, 240 hour digestion. The fit's excellent.

Again, you increase the digestibility for the biorefinery for ethanol fuel production, you increase it for ruminant animal. Let's follow the consequences of this idea and see where it takes us.

So, again, I believe, what I'm working to, spend essentially all my time doing, is trying to prove the economic, the environmental and now the social, particularly in the last two or three years, the social sustainability of biofuel systems.

I believe it's important. And I think one important way, if you've looked at recent history of rural areas around the world, our rural areas have suffered while the rest of society has tended to prosper.

One of the ways to help really break the existing paradigm is to allow rural communities throughout the world to help provide for our fuel needs and capture part of the value added by doing some of the processing locally. Okay.

So, I believe that will tend to make our systems not only more economically and environmentally sustainable, but socially sustainable.

If the rural world, in particular, not just the United States, is allowed to participate in a meaningful way in the developing biofuel industry, it'll be the single greatest alleviator of poverty that the world has seen for a very long time.

Okay, enough said about -- our objective, the way we're working on this is to take plant materials into what we call regional biomass processes that are based on our afex process, but there are other processes that could be used. And the point is that you treat the plant material there to generate high value, more digestible energy feeds, perhaps some protein products. Okay.

So, what does this look like. We're working with Dr. Mike Allen, a dairy scientist at Michigan State. We started looking to compare the value in animal feed rations, both for dairy animals and beef animals, replacing what they currently eat, okay, with material grasses that have been treated by this ammonia process. And there are other processes that do that.

But the point is that if we feed dairy animals and we feed beef animals an awful lot of corn and an awful lot of corn silage, the disadvantages of doing that are well known. The reasons they're done is because the stuff is highly digestible. Corn's highly digestible.

So the animal's on the brink of

metabolic disaster all the time, okay. That's why they use so much antibiotics. But you do it because of through-put; able to get a higher yield. What happens if you had a higher yielding grass? What would be the consequences of that?

Anyway, on the left-hand side is a circle -- I'm sorry when I re-sized these it didn't get the sizing very well -- but, this is the cost to a farmer who's providing for his particular set of dairy animals, 150,000 a year to provide a particular dairy herd with that set of feed ingredients. It takes 265 acres of his fields to do that, to provide for the dairy.

If you have an ammonia-treated grass that you substitute, in this case it was switchgrass that we used, most of the diet now, or almost half of the diet becomes the treated grass. The rest is grain silage. The farmer's cost to feed his animals drop by 50,000, almost 60,000. In other words, profitability increases. And importantly, the amount of land required to feed the animals drops by 100 acres. Okay, this is land use change with a vengeance.

It's making agriculture more efficient. By the way, we're assuming six tons per acre of switchgrass yields here. Okay, so a fairly conservative number for good land.

Same thing for the beef diet. In this case the ammonia-treated grass replaces all of the grain and all of the silage. It's been known that this kind of thing could happen for a long time. Okay, in other words, you look back in the literature you'll see the attempt to integrate animal feed production with biofuel production, but it hasn't been practical to do it until the recent run-up in oil prices.

So, in this case over 100,000 decrease in feed costs and 200 acres of new land, quote-unquote, "new land" freed up because you're making more efficient use of existing land to produce a perennial grass, C4 perennial grass like switchgrass.

So, over time what we would see is that you'd build up your biofuel industry by having a larger number, pick a number, 10 or 20 or 30, of these regional biomass processing centers providing treated biomass to a single biorefinery. Again, offering the opportunity for regional and rural economic development.

So, why these regional centers? Again,

the concept is to separate the operations of pretreatment, hydrolysis and fermentation. I call this distributed biorefining. Pretreatment enhances the value of the cellulosic biomass for both animal feeding and biofuel production.

Advantages, logistics in aggregating, processing and storing and supplying the biomass. You densify it while you have it in this pretreatment center for easier transport. Plus you homogenize different biomass materials by pretreatment. So you control a larger supply area.

Increases the economic scale of the biorefinery. Simplifies your contract. Instead of having to write contracts for 2000 to 4000 farmers, the biorefinery can now write contracts with 10 to 20 of the regional biomass centers.

It gives you locus, a place to have rural economic development and wealth creation, again which I think ought to be a critical goal for all of us here.

It allows you to co-produce animal feeds and biofuel feedstocks and really, I think, does a lot to resolve this food-versus-fuel issue. Increases the land use efficiency of biofuels.

And in those regional biomass processing centers I think would be a logical place to have the vehicle, the certification standards that you want for biomass production and processing, which is an important objective of this group.

So,in conclusion, I like this quote from Sheilah Yamani, the stone age didn't end for the lack of stone, the oil age is going to end long before the world runs out of oil. We're in the end of the age of oil. It's going to be painful. I think ultimately we'll come out on the other side with a much better society overall.

I have -- people keep asking me how to pronounce cellulosic or cellulosic, okay. I have a solution for us. Let's don't call it cellulosic or cellulosic, but we'll just call it grassoline, okay.

(Laughter.)

DR. DALE: And allows us to have a name to put on this. So, I look forward to the discussion session. Sorry I'm keeping you from your break, but I am done. So please use it, grassoline in your tank. Thanks.

(Applause.)

MR. WILLIAMS: Thanks, Bruce. And

thanks for the -- participate later. And we're going to have a break or -- okay, we're going to start exactly at 10:45, so that's less than ten minutes. Quickly get your coffee and come on back for the start of an interesting discussion on LCA models.

(Brief recess.)

MR. PRABHU: We still intend to, you know, use up the full two hours for this session, so we'll give about a half an hour per speaker.

Our first speaker is Alissa Kendall who joined the UC Davis faculty in August of 2007 after completing a multi-disciplinary doctor degree at the University of Michigan School of Natural Resources and Environmental Engineering Department. Kind of unique department.

Before pursuing her doctoral degree she worked in the automotive industry on advanced vehicle technology development. Broadly speaking, her research interest focused on the design of more sustainable energy and infrastructure systems.

So let me welcome Alissa Kendall.

(Applause.)

DR. KENDALL: Hi, Anil, thanks so much

for your introduction. So today I've got a big task because I'm presenting work that was largely completed by Mark Delucchi. Mark Delucchi is a researcher at the Institute for Transportation Studies at UC Davis. And he and I have initiated a lot of collaboration on lifecycle assessment, so hopefully I can do his research justice, and maybe generate the same kind of polemic discussion that he usually does after giving his presentation.

So, with that said, I'm going to do what everyone else has done, and fiddle with this machine for a second.

Okay, so first I'll go over a brief overview of lifecycle assessment, of biofuels, and, of course, in this context we're really focusing on greenhouse gas emissions, which are generally represented as CO2 equivalent emissions. And we'll compare results from other studies, and we'll also go over some important issues in lifecycle assessment for biofuels, including the ever popular land use change. But also changes to the nitrogen cycle that biofuel cultivation and production might have. CO2 equivalency factors, which are essentially kinds of global warming potentials. And if we've got some time, we'll talk briefly maybe about economic effect.

So, to start the presentation I'll give you the take-home message. The take-home message is that there are a few really important factors that are generally left out of lifecycle assessments for greenhouse gas emissions of biofuels. Or if they're in there, they're not really treated fully.

And those include the land use change issues, but also the issues I outlined before of nitrogen cycle and CO2 equivalency factors. And really, to get an idea of what a biofuels policy will mean from a climate perspective, we've got to integrate these parameters a little better.

So, usually when we do one of these lifecycle assessments our purpose is to really determine impact of a policy. So we have some baseline condition which we usually represent by traditional liquid transportation fuels like gasoline or diesel. And then we compare some other option to these baseline conditions.

And that means that whatever action we're taking, in this case usually a policy action, we really have to specify that action very carefully. And predict, in fact, how the world is going to change as a result of that action.

This means that we need to integrate models that are usually not integrated. So, we engineers are really good at technical engineering models and there are economics models out there, and certainly very complicated climate and environmental models. And if we're really going to get a clear picture of what a biofuels policy means, we have to integrate all of these models.

One thing also to point out about lifecycle assessment, I'm really honored to follow Bruce Dale. But he also outlined quite clearly that lifecycle assessment is really a tool that was created, and is generally good at analyzing a product, or clearly specified system. But, of course, it becomes very complicated to apply the same methodology when we talk about policy changes with really broad impacts.

So we've seen a lot of diagrams about lifecycle assessments. In part I show this one just to emphasize how much a traditional lifecycle assessment, which is shown in the blue boundaries there, takes.

So this is a really -- we have so many factors to include, so many inputs and outputs to track. And then also considerations of co-product allocation, for example, that are part of a traditional lifecycle assessment boundary.

But if we're going to use lifecycle assessment to evaluate biofuels and biofuel policies we've got to expand these boundaries. So when it comes to inputs we might model agricultural land inputs, but now we have to worry about indirect land use change, cascading effects of a biofuels policy.

We also have to recognize the difference between land use intensification and actual land cover or land use change.

And then in terms of co-product allocation, that's a complex process in and of itself, but when we start looking at economic effects of a co-product market, for example, that can complicate the issue a lot. And so we're talking about large-scale production and long-term production, we're probably going to drive co-product markets, right. So that would change how our allocation procedure might work.

And finally, we've got global models and global modeling considerations. So, how does a biofuels policy affect global carbon and nitrogen cycles. What's the effect of time. So, most of our models when we look at emissions we have some sort of global warming potential that isn't really time sensitive. So if emission occurs in 2008 or 2030, it's treated the same way. And we know that that's probably not the right way to go. So time sensitivity in models, so temporal considerations are really important.

We also need to treat other emissions. So a lot of the times we focus just on sort of the conventional or major greenhouse gases, but we don't look at climate effects of other emissions from the system.

And finally, the interaction between our economic system and markets, and the biofuels policy also really needs to be examined and integrated.

So here's just a slide of an approximate range of results. So these are just essentially telling us how different studies have found biofuels perform compared to their conventional gasoline or diesel counterpart.

And I think the big take-away here, the LEM, by the way, stands for the lifecycle emissions model. This is a model developed at UC

Davis. Mark Delucchi was the primary lead on this, but of course, there was a lot of contributions there from other researchers and graduate students.

In any case, what I wanted to show here was just how big that range is. And that we don't even know what the sign is, right? So we go from negative 50, which means we see an improvement in terms of emissions compared to gasoline, to positive 20 for corn ethanol. And if we look at cellulosic ethanol or biodiesel we see even greater ranges.

And so the various studies are shown below, but this LEM model estimates also have quite big ranges, right? So, even in a single model we have a range of results.

So I think an important distinction to make is where that variability comes from. So, we have one source of variability, which is modeling-derived variability. So this means that we've, perhaps in different studies we look at -- we have different system boundaries, different co-product treatment. We have climate modeling assumption differences; time horizon differences; treatment of land use changes different, and that list goes on and on. Those are really modeling-derived differences between these studies.

Then the real differences that we don't want to lose, right? We want to keep in mind that there are different production pathways, and those production pathways have different levels of efficiency. And, of course, geography. So, climate and soil conditions are different all over the world. Water sources, everything that goes into geography is important to consider.

So, we need to be able to distinguish better between these two different sources of variability, preserving one and eliminating the other.

So where does that leave us? Well, we could talk about some ideal model, right. So we have this giant policy action that's going to happen. And that policy action will drive all these energy and material flows and land use change.

And then that policy will also drive prices. And actually those flows, themselves, will interact with prices and then so we're having feedback mechanisms here. And, of course, we've got carbon and nitrogen cycles to consider. And then a whole host of emissions that have climate impacts associated with them.

And finally, we have other things that aren't emissions related, per se, but could really affect climate change. So albedo changes, water cycle or evapotranspiration changes. And all of these are going to affect climate and, in turn, affect land cover, et cetera, et cetera.

So we have this complex model with lots of feedback mechanisms. And, of course, if we want to put that in Excel spreadsheet and calculate something, I think we're probably not going to do a very good job of it.

But we have conventional, or more conventional greenhouse gas lifecycle assessment models. And I've shown that in the middle there. And there we specify some system. And I'm broadening it from a product life cycle. This is really a system life cycle we're talking about.

And that system drives energy material flows, which result in some emissions that we know have an effect on climate change. And those we characterize usually using global warming potentials, but we don't really house them in terms of a climate model We don't show this interacting effects.

We do have to worry about co-product allocation. And in conventional LCA co-product allocation is a very involved and difficult process.

So while I'm showing this sort of simplified model, I'm not trying to imply that lifecycle assessment is every very simple. But certainly the conventional lifecycle assessment kind of focuses on a linear flow of information and materials and energy, rather than thinking about all the different feedback mechanisms and cycles that exist in the real world.

So, there are clearly a lot of parameters that we've left out of these LCA studies. And I've listed eight here, but we're just going to focus on three due to obviously time constraints.

But land use changes and cultivation; climate effects other than the conventional or traditional greenhouse gases we're accustomed to working with of CO_2, N_2O and methane; and then the nitrogen cycle and how that could interact with the carbon cycle, as well.

So why did I pick these out? Well,

these are results from the LEM model, and they're just to emphasize the effect of these different considerations on results.

So NO2 and NH3 emissions, which are related to the nitrogen cycle, have essentially net cooling effects, according to the LEM model. So that's why you see a negative number there. So rather than having a positive global warming potential, they could be models having a negative or a cooling effect.

N2O emissions, of course, result in a high global warming potential, and essentially counteract the effects of these negative numbers above them.

And land use change, of course, has a net positive effect in terms of increasing greenhouse gas emissions.

I've shown co-products there, too, because we shouldn't forget that the way we treat co-products has a big effect on results.

Some factors that have never been quantified, so what I've shown here is all from the LEM models. There's been intent to quantify these, even if it's been done in a, you know, preliminary fashion.

But net methane from plants, soil and agricultural dust. And finally, price changes have never really been fully integrated with lifecycle assessment models.

So, going to that first land use change and cultivation consideration, the LEM model has attempted to include changes in carbon sequestration and soils. Also in crop types. And also thinking about the kinds of ecosystems that are displaced as we increase biofuels production.

So rather than just looking at climate change in the general fashion, thinking about what kinds of ecosystems are being displaced.

And a lot of -- these results are presented in present value terms, which means they've been discounted over time. The discount rate is not a conventional exponential discount rate, because that would make everything happening in the future seem really unimportant. So it's a declining discount rate which is a well accepted way to handle environmental costs over time.

Of course, this means we're converting things to cost. And we need to present these values not just in terms of economic cost, but also environmental costs. But somehow maintaining the temporal information with regard to environmental emissions is really important, so we have a good understanding of how they'll interact with the climate.

There are plenty of other studies that have done really detailed analyses that include land use change. One thing that hasn't been considered is reversion, or what happened to this land after the biofuels program ends.

And the program refers to the fact that we have policies that drive biofuels use. And at some point those policies will change, or not exist anymore. And so we expect some kind of land reversion to occur at the end of it.

So, in terms of a conceptual model for this, if we put new land under cultivation, or even if we intensify cultivation, we're going to emit carbon, and then we're going to grow feedstock crops on that. That's what the (inaudible) Sodal curve represents here.

And then at some point we're going to abandon cultivation and there'll be a rebound, or a sequestering of carbon in that land. That sequestering is probably not going to be fast, and it won't be as big as the original natural undisturbed ecosystem that was there before, if that's what we're really removing. But at some point that land's going to take up more carbon. And that's usually not included in any models.

So, as we put this information into a climate model there's a big effect of considering land reversion at the end of whatever biofuels program we enact.

And in turquoise is shown atmospheric carbon; in red is the temperature change; in blue is ocean carbon stocks; and then in brown is the land carbon stocks.

So you see the land carbon stocks are dropping as we enact biofuel policies, or we produce more biofuels.

Atmospheric carbon rises. The ocean takes up more of that carbon. And then when this program ends, the land takes up carbon and we actually get a net -- a brief period of cooling and a loss of atmospheric carbon just because of he diffusion rates between ocean and atmosphere.

This is a very simplified model. It certainly is not -- I would not call it an ideal or real model. Other factors haven't been included here like what happens if that land gets converted to food production; then we don't have a reversion, right. So we haven't addressed all the details here, but it's just to exemplify how important it is to consider how long biofuels will be produced, and what happens when that biofuels program ends.

And we don't include reversion at the end of a biofuels program. This is what we got. We got essentially ever-increasing stocks of carbon going into the ocean. We don't see a rebound in temperature, so we still have a temperature increase. It never drops back to zero.

So we can at least see that it's really important to think about the long-term, what's going to happen in the long term to this land that's being used for biofuels production.

What happens if we don't consider land use at all. So this is from the LEM model again, but if we don't consider land use, and this land use here includes that reversion part, we see real differences in outcomes for how well biofuels perform against their conventional counterparts.

So this clearly shows that we have to consider land use change whenever we talk about biofuels LCA.

It also matters what land we think is going to be used for biofuels production. So it's not enough to just say that we know land use will change, or some native ecosystems will be displaced, because if we displace certain ecosystems the results will be essentially less good than other ones.

So the 2 percent here shown is the baseline in the LEM model. But essentially, as we increase the proportion of wetlands that get displaced for biofuels production, and this includes direct or indirect displacement, so when I say displacement I mean it could be food crops that have been displaced, but then displace a wetland, for example.

But as we increase the proportion of wetlands that are being displaced, we clearly have declining CO2 equivalent performance for biofuels. So, we also have to consider exactly where and which ecosystems will be displaced.

Other factors that will probably be important if we integrate all of this with the real climate model, our changes in albedo and evapotranspiration due to land use change. And agricultural processes. And Dr. DeLucchi likes to point out that deforestation in northern latitudes could even cause a net cooling because of albedo effects outweighing carbon release.

So we might get really surprising effects if we actually model a full complex climate model when we look at biofuels.

Finally, we have pollutants that have other, that have climate effects that are rarely modeled. So most of us rely on IPCC global warming potential values. There are essentially two shortcomings with these. One, they don't have global warming potentials for all of the emissions that can affect climate, but they're not time sensitive.

So, as I said before, if I model an emission in the year 2000 and then one in 2030 I apply the same global warming potential, when in fact we'd expect that climate to be in a different condition and gases to have different effects.

So, shown here are carbon equivalency factors. So we can think of global warming potentials as one type of, or one version of carbon equivalency factors.

The years shown beneath them are

essentially the year of release. So they change based on when the emission release occurs. And one important thing to point out is how many gases or emissions that have effect on climate aren't assigned a carbon equivalency factor for IPCC. And so a lot of these have cooling effects.

This is very complicated and these numbers, I would say, are high preliminary, but it's important to illustrate how important it could be to look at all these different emissions and their effect on climate.

So, what is the effect on the outcome of if we use these carbon equivalency factors in place of the IPCC global warming potentials. It's not quite as big as some of the other things I've shown, but there is certainly a change if we use these carbon equivalency factors compared to the global warming potentials.

And if you look at the methanol value down there, there's a 17 percent change in grams per mile emissions if we use these carbon equivalency factors instead of global warming potential numbers from the IPCC.

Finally, we have the nitrogen cycle. You know, the nitrogen cycle is a big global nutrient cycle that's very complex. It does interact with the carbon cycle. And so just to highlight a few important features here, the deposition of nitrogen, for example, in nitrogen limited ecosystems could increase the carbon sequestration potential of those ecosystems just as acidification in some ecosystems could reduce carbon sequestration.

So, there are lots of interactions between the nitrogen and carbon cycle. And it will be important to model these.

The LEM model attempts to model some parts of the nitrogen cycle. And there is an accounting for multiple fates of nitrogen, as particulate matter, as NOx, as N2O, as ammonia, et cetera. And has some model for global nitrogen deposition transfer and transformation. In particular, other models haven't incorporated nitrogen cycle consideration.

Again, these are really preliminary values, but they're just to emphasize how important it is for us to start including these concepts in our models for biofuels.

The effect of particulate nitrate, which you'll see at the bottom there, is a negative 50.

And that -- so, in this case we're seeing nitrogen having a net cooling effect, even though we might really not like the sort of criteria pollutant characteristics of NOx and other -- and particulates. They could have a net cooling effect.

So the take-away from this is just that we have to start thinking about all these other climate effects from emissions that we should be considering.

So, important future research directions. It's really going to be important to incorporate essentially an economic model or a price dynamic economic effects into biofuels or transportation models. We need to really get better at how we treat byproducts and coproducts. The assumptions that we embed in coproduct allocation can really make or break the performance of a biofuel. And we need to come to some consensus on how to do this, and how to do it right.

We need to improve our estimates of changes in land use. A lot of the previous speakers have done a great job of sort of, I think, showing how complex it's going to be to be able to do that.

And we need to work on estimates of carbon equivalency factors. So, what I've shown here are highly preliminary factors, but we need to think about alternatives to the simple CO_2 N_2O methane calculations that most of us do.

And finally, we need to think about other climate effects. So albedo and evapotranspiration that would result from agricultural practices and changes in land use.

(Applause.)

MR. PRABHU: We have time for a couple of questions.

MR. UNNASCH: I have one. Is there a specific policy or activity that's going to cause the LEM to revert back to biofuels? Because I just don't see it. Unless someone has like, you know, unless the population is going to die off. Where does that come from?

DR. KENDALL: That's a great question, and a question I ask Dr. Delucchi all the time, too. So essentially if we're meeting a biofuels demand and we -- and the policy, we're going to have some portion of that land converted back to the ecosystem, or away from cultivation, at least for some period of time.

There certainly are conditions where you can imagine that essentially all land being used for biofuels might convert to food production, for example. But we have to find a way to credit that carbon between food and biofuels, if, indeed, it's going to transfer back to -- or transfer into food production, for example.

So we have to figure out a way to kind of split up the carbon impacts between those two things. And so we need to figure out what would happen if land reverted to a native ecosystem and maybe compare that to a condition where we expect land to revert to some other use because of population growth and food demand, for example.

DR. KAFFKA: Steve Kaffka, California Biomass Collaborative. Hi, Alissa. Do you know, on the land use change issue, you know, we heard some comments earlier today -- I don't know if you heard them -- about various types of land quality being available around the world, not simply range forest or lowland tropical, peat moss wetlands.

So, how does the land handle that issue? Do you have a sense for that? Is it highly specific about land type conversion, or is it more generic?

DR. KENDALL: It is, I believe, more generic. So, it relies on land supply curves. And so it is somewhat generic and so you saw that there is an assumption that 2 percent of land conversion would be wetlands, for example. But that is just a parameter that we can change in a model.

So, there isn't really, I would say, yet a full treatment of what kinds of land, or likely that would be changed. But it is a parameter that can be modified in the model.

MR. SHAFFER: Hi, Alissa. Steve Shaffer, Department of Food and Agriculture here in California. You mentioned the need for more analysis in terms of the energy embodied in input seed, farm equipment, et cetera.

Do you anticipate a similar analysis defining the system appropriately so we're comparing apples to apples in terms of oil exploration, the energy embodied in drilling platforms and drilling ships and ferrying people to and from those platforms, the tankers involved?

So a similar type of system definition and then analysis.

DR. KENDALL: That's a great point, and I think one of the slides said one of our needs for future work was to better characterize the petroleum system that we rely on. Because most of us are busy modeling biofuels and using other people's data to compare to petroleum products. And those maybe haven't been characterized fully, either.

And certainly, you know, even geographic differences for petroleum refining and exploration can make a big, you know, difference on what we think the carbon footprint is for those fuels.

So we do need to treat those with as much care as we treat biofuels.

MR. PRABHU: Thank you, Alissa. We'll keep --

(Applause.)

MR. PRABHU: If you have any more questions, I'm not sure if she's here for the whole day, probably not. But I'm sure you can Google her or go to the UCDavis website and have specific questions emailed to her.

The second topic for this session 6 is about the GREET model. This morning we heard from Bob Larson that the USEPA is using this model for their lifecycle analysis work. And my employer, the Air Resources Board, is also using the same model.

So it probably is very informative for some people who are not familiar with the GREET model, to have a 15-, 20-minute -- I'm sure everybody who knows the GREET will say a 15-, 20- minutes, I can't even read the first two pages.

But our thinking is, you know, for people to be familiar, the fourth speaker in this session is Ken Cassman, who will talk about a different model, which is, you know, a similar model, but he'll have his own flavor to the BESS model.

But let me introduce our speaker. Stefan Unnasch is a general partner with Life Cycle Associates, a consulting firm specializing in the analysis of fuels and clean energy technologies.

Over the past 25 years he has worked on numerous projects supporting state, federal and international efforts to examine the greenhouse gas impacts of electric power production and alternative fuels, including California's zero emission vehicle program.

He has worked on a variety of biomass projects including the development of a biomass gasification system; evaluation of biomass-to-ethanol production in California; and several lifecycle assessments of biofuel technologies.

Let's welcome Stefan.

(Applause.)

MR. UNNASCH: Thank you, Anil. So, as Anil pointed out, I'm going to try to talk about the GREET model. And typically this is covered in an eight-hour training session. Argonne National Lab has done these. Other folks, including ourselves, have also done these sessions.

The session pamphlet gives the motivation for my talk which I'm going to go through the obligatory flow charts on lifecycle assessment, try to review a little bit of the California policy that's come into play, and just give you an overview of how the GREET model can be used, and its limitations, and what future work might be incorporated into it.

First of all, in general, to do a lifecycle assessment you want to follow the ISO procedure or an appropriate procedure that looks at having appropriate system boundaries in comparing a biofuel to a comparable fuel.

And the GREET model, even though it's not explicit in its documentation, attempts to do this. And you can see how that's done by comparing different alternative fuels to gasoline.

Some of the key things to consider with biofuels are the land use change and indirect land use change, and notice their sustainability lies somewhere on the fence.

There's a lot of efforts to put land use change on a gram-per-megajoule basis. And maybe sustainability just doesn't lend itself to that, because there's so many different cross-cutting metrics.

A lifecycle analysis wants to follow the fuel from source to wheels. And what I've shown here is how you might want to track biofuel from growing the crop, handling the feedstock, making the fuel and finally delivering it to the vehicle.

And one thing that's often done with biofuels is you recognize that the carbon is recently removed from the atmosphere, so you can net out the carbon in the biofuel against the carbon in the atmosphere. And I'll go through some nuances on how; it's a little bit tricky to interpret the GREET model results.

There's a lot of lifecycle models that have been used. And the first four are basically fuel cycle models, where they analyze in incredible detail the nuances of different transportation fuels, trying to compare ethanol delivered to a California fueling station with California emission standards. Or hydrogen with three different delivery modes.

In contrast, there's also a lot of generic lifecycle databases that are used in the field of lifecycle analysis. And GREET has really grown in its user base, partially because of the interest in fuels, and also the large amount of work they've done for DOE has provided a great deal of data for GREET. And that's why it's used in the California processes today.

When I was preparing for this talk I thought, oh, this is the California Biomass Collaborative, everyone's going to be talking about what's happening with the power plants, and what kind of fuel are they using, and you know, how can we make green electricity from biomass.

And it seems that the topic has expanded into biofuels. And so I'm going to talk about how you can apply the GREET model to one particular pathway, making ethanol from cellulose and also making ethanol from corn. And, of course, you can imagine that you could have many different fuel pathways and feedstocks, so enough on this.

Okay, there's been a lot of work in California on the lifecycle of fuels. It's gone back to the late '80s where there was interest in methanol. The California Energy Commission tried to compare methanol with gasoline. There's been the ZEV program, efforts on petroleum dependency, vehicle fuel economy, the hydrogen highway. More recently, AB-1007, and now the low carbon fuel standard. All of these have involved lifecycle assessments. And more recently, they've all been based on the GREET model, largely because of its availability and large user base.

Of course, the federal EISA, is how it must be pronounced -- it was an issue yesterday -- also uses the GREET model.

If you take that list of pathways that I showed you, there's many combinations. And there's smart people in this room who can, you know, think of combinations that aren't shown in the GREET model.

But the GREET model is wired with many discrete feedstock-to-fuel pathways. So it's preconfigured to look at converting, say, natural gas to CNG, or natural gas to methanol. You can also turn natural gas into gasoline. Or you could turn it into ethanol. I mean there's any number of options.

But the way the GREET model works is it's a spreadsheet that's preconfigured to take a lifecycle inventory for feedstock, combines it with process information for fuels, and then works out all of the arithmetic.

It took me quite a few years to get comfortable with the term model. When I do my taxes on TurboTax, I guess that's a model; and EMFAC is called a model. And so GREET is called a model. But when I was in school I thought like the Navier-Stokes equations was a model, and general equilibrium, global circulation models for climate change are models.

This is really an accounting tool. And one thing I wanted to point out is if you take all of the same assumptions for all of the different lifecycle models and plug them into the same -- into each model, you'll pretty much get the same answer.

Now, there's some issues that, you know, GREET doesn't necessarily cover all of the features of LEM, but if you put in the same assumptions you get the same answer. So, the take away here is that GREET is really a calculation platform.

So a little bit on how it works with switchgrass-to-ethanol. There's many biomass-to-ethanol pathways in GREET. And when you're converting switchgrass to ethanol, looks at farming switchgrass as an energy crop with fertilizer inputs. There's the coproduct of electricity that's produced, which is credited against the average electricity. It's hauled to a fueling station and put into a vehicle. And the ethanol is also blended with gasoline.

The inputs to the GREET model can be structured in these simple drawing that shows the fuel production phase and the agricultural inputs into it and the farming inputs. And the primary assumptions that are just ethanol-specific are fairly simple.

There's how much energy you're using per ton of biomass, and how much ethanol is produced per ton of biomass, and how much electricity is coal-produced, how far do you haul the ethanol, how much of it do you lose along the way. There's also some crude oil used in the process. So the complexity really lies in integrating all of the fuels and feedstocks.

The GREET documentation shows that it's laid out in 20-odd worksheets where you have inputs on the fuel properties, on the process for the ethanol plant, itself, emission factors for the different types of combustion equipment. And then finally there's calculations for each of the different fuel pathway groupings. And these all come together in some results.

So, I'm not going to try to cover how that model inputs works. It's really quite -- it takes awhile to get into all of the details.

Most of the work with the GREET model is done with the spreadsheet that's available on the Argonne webpage. And if you do download the model there's also a user interface. And it doesn't necessarily provide you the same flexibility as working with the spreadsheet directly.

There's inputs on input sheets; there's inputs on various cells having -- various worksheets having to do with different fuel production processes. And it's quite a bit of nuance in queuing up all of the analysis.

But once you're plugged in your numbers -- I'm sorry -- and then the GREET model goes through and calculates all of the energy inputs on a well-to-tank basis. And you start with your feedstock.

And here we show crude oil. And you look at the transportation and refining. And there's various loss factors that are taken into account along the way.

So, for every fuel that you're looking at, and here, again, with switchgrass from ethanol, the model looks at the feedstock component, all the coproducts, transportation and distribution, and finally sums it up as the ethanol. And it gives you your summed results.

One point also to bring up is the GREET model doesn't model land use change. It has a land use change as an exogenous value. So there's an input for corn, which is based on some rather old modeling from the Department of Agriculture. There's an assumption for energy crops that is based on the roots of the trees actually sequestering more carbon than otherwise, so you actually get a land use conversion credit, at least with the GREET model input assumption.

And there's questions on how the system boundaries might be applied for land use conversion if you do try to plug it into GREET, because GREET is basically a process-specific analysis where you're looking at tracking all of the energy inputs for a specific set of processes to make a fuel. Whereas the land use conversion is being treated as a market-mitigated effect where you have impacts all over the world. And it's very important to make sure that those are treated consistently.

Another question might be how to deal with sustainability. And there's so many attributes with biodiversity and food and prices that I think that might be more difficult to put on a gram-per-gallon basis.

So, if you're willing to follow how you might sum up switchgrass-based ethanol, I just want to explain to you what some of the GREET inputs mean.

GREET shows the results on a well-to-tank basis. And those are the yellow numbers on the charts. So, what this is showing is all of the energy input to make a fuel. So in the case of ethanol from switchgrass there's a roughly negative 50 grams per megajoule.

And that's shown as a negative number because the carbon is removed from the atmosphere. And then the vehicle emissions are also shown separately. So that's how the GREET model works.

And, of course, you would look at those on a summed basis, so you'd have a net. If you take the default values in the GREET model you'd have nominally about a 25 gram per megajoule impact for ethanol from switchgrass.

So this is sort of a tricky nuance that you might want to be aware of if you delve into the GREET model.

Now, in the case of fossil fuels like gasoline or CARBOB blending component, the fossil carbon was removed from the ground so that doesn't get netted out, doesn't get treated the same way as biogenic carbon.

Another point is that in some cases the whole carbon is not explicitly treated like in the case of making electricity from woody biomass. If you delve into the GREET model, there's really no -- CO_2 is just kind of ignored because it comes from the atmosphere, also.

So, when you're looking at the carbon intensity of different fuel options, you might want to be able to understand how different processes work. And here's an example of how we used the GREET model to look at different corn ethanol processes, which shows the farming phase and the energy used to run the ethanol plant, and the distribution of the ethanol. And all of these results can be teased out of the GREET model with a little bit of effort.

So, some of the limitations to the GREET model I'd like to go over. The documentation to the GREET model has been going on for ten years, and it's an ongoing process.

One of the great things about the GREET model is that it's available, it's free, and there's over 5000 users.

The GREET model also calculates the average of fuel production in the U.S. So it's calculating the average of the corn ethanol. And if you had a specific case of say, a corn ethanol plant based in California, those results affect the average of the other fuels to the extent that gasoline is used in the fuel cycle. So that needs to be considered when using the model.

Also there's regional distributions of energy. If you're making, say, ethanol in the midwest, and you're growing crops in the midwest, and the ethanol plant is in -- let's say you're growing corn in the midwest and you have some electricity that's used there, and you haul the corn to California. Now you have electricity running the plant in California. There's a composite of air quality regulations, as well as energy inputs that need to be considered.

And that's sort of a challenge in the GREET model. And also calculating other pollutants like toxics requires more work. And land use change, at this point, is an exogenous parameter.

So how do we deal with some of these. Documentation is simply a matter of more work. I think that's on the way. The model availability is actually quite great. And many of the logistical issues with GREET are quite solvable and I'll go into some of those briefly. And toxics and land use change do require more work.

Also there's more feedstocks that might

be considered. Right now GREET supports sugar cane in Brazil, U.S. corn and soybean oil. There's a variety of other biocrops. There's also nonfood feedstock and feedstocks that's looking at your classic energy crops, and forest thinnings. There's many other feedstocks that could be considered. And there's new pathways that could be incorporated into the GREET model.

So one of the things that might be interesting is what are the energy inputs for today's biomass that's used to make electric power. Right now biomass power plants run mostly on urban woodwaste and agricultural residue, which has a different lifecycle inventory than looking at growing energy crops.

We also heard a lot today about mixed crop systems, maybe growing corn with switchgrass, or cover crops. I'm glad to hear that Bermuda grass has some value I don't see at home. And there's advanced biofuels. The coproducts need more work and consideration. And finally, there's data that could be improved. What are the specific emissions for individual ethanol production processes and how do they vary by region.

So, I'd like to briefly in the last few minutes talk about how we deal with some of the process-specific issues in GREET. If you thought my explanation of how the GREET inputs was a little bit challenging, it is. There's input from many worksheets. Some of them are in hidden cells and it takes awhile to really get a handle on it.

And there's challenges when you're looking at fuel production in different regions. So if you have electricity in the midwest and California, how do you mix and match all these things.

So, what we've developed is a user interface which allows you to plug in -- and, by the way, there is a user interface on GREET, but this is really getting into a lot of detail -- that allows you to get an overview for any fuel pathway. So what's shown here is corn ethanol and just a summary of the primary inputs.

And you can basically run the GREET model as many times as you'd want. So you could do a composite of runs. You could do the corn ethanol in the midwest and then you could -- or the corn in the midwest, and then you can run the model again for the ethanol plant in California.

And you can composite all of these different results.

And this basically means running the model several times for generic data, to look at regional parameters, and to look at specific fuel production process that you're interested in.

So we've developed some software tools that basically serve as overlays to GREET which allow you to deal with some of these regional and process-specific issues.

So, where does GREET stand in the mix of lifecycle analysis tools. I think GREET will continue to be used in this area for a number of reasons. It has a growing user base, I think approaching 5000 people across the world, not counting the people who have simply emailed the spreadsheets. I only recently downloaded it.

Argonne National Lab works closely with the Department of Energy and they do quite a bit of research on new pathways and new fuels, and they continue to grow the GREET model. They're adding features such as water consumption and new pathways.

So the GREET model will continue to evolve. And I think if there's one message I want to convey to the audience, it's really a calculation tool. And it's not so much whether the model does or doesn't give you the right answer, it's really the input assumptions that drive the model.

It's being used to support the California low carbon fuel standard. And recently the ARB posted some documentation for five pathways, and more on the way, to look at all of the biofuels that might be -- or all the fuels that might be provided under the low carbon fuel standard.

And finally, and very importantly, there's ongoing work on land use conversion. Argonne National Lab and UC Berkeley are working with Purdue University on the GTAP model to try to assess land use conversion. And these values can be plugged into the GREET model. And presumably there'll be other approaches to dealing with land use conversion also.

So, I hope I've successfully conveyed eight hours of overview of GREET into 20 minutes. Thank you.

(Applause.)

MR. PRABHU: We have time for a couple

of questions. Just a reminder, please introduce yourselves and your affiliation.

MR. WHITE: I'm Chuck White with Waste Management. And I guess it's more of a -- question that I find myself confronted with. Waste Management, for example, California operates about 3000 trucks. We're getting a lot of requests from communities that we serve to reduce our carbon footprints.

And one of the ways we can do that is transition to alternative fuels such as biodiesel. What we're confronted with is trying to figure out what is the standardized approach for using a model such as GREET to estimate the carbon intensity of the various fuels that we might seek to choose from.

You go to various biodiesel providers, for example, and they're all over the map on what they think their carbon intensity is.

The low carbon fuel standard doesn't really exist yet as a regulatory tool. And as you pointed out and other speakers have pointed out, all these models have a whole variety of inputs. And of course, you always get the problem of who's tweaking the knobs. And before we can actually make a decision we need to have kind of a standardized approach. I guess -- I don't think that exists yet.

But I guess my general question, how far away are we from having a standardized approach that we can rely on for making business decisions? And is the low carbon fuel standard to be California's low carbon -- to be that model, you think?

MR. UNNASCH: Yes. The low carbon fuel standard is going to come up with a documentation and approaches to the GREET model. There is already documentation on the web on how the numbers are calculated. But that doesn't necessarily -- that's only part of the work. It's really just showing you how the math works.

I guess from a business decision point of view there's been various California fuel studies. The AB-1007 study is published on the CEC webpage, you could read the results for biodiesel. You might not get the flavor that the land use conversion question hasn't been fully addressed. Of course, it's not addressed today, as we speak.

But I think probably the safest thing to do is to read some of these documents where they've tried to look at a list of pathways. And I guess, for the user to be safe, you know, maybe download the spreadsheet that was associated with that study, and then try to run perturbations, yourself. I think that's --

MR. WHITE: Or hire a consultant. Anybody out --

(Laughter.)

MR. UNNASCH: Well, I'm glad you came to that conclusion.

(Laughter.)

MR. SHEARS: Thanks for a very condensed introduction to GREET there, Stefan. Since we have some folks from USEPA, and you know, part of the challenge going forward is going to be seeing what synergies can develop between the low carbon fuel standard and the RFS, I was just wondering if you could comment, you know, on some of the aspects in terms of the implications of efficiencies for facilities such as ethanol plants, and making sure that we're using the right sets of data such as, you know, the recent Argonne survey gives us one snapshot. What the implications are in terms of, you know, looking at facility efficiencies. And that, as a moving target. And how that plays into all of the other uncertainties that we're dealing with.

MR. UNNASCH: Well, I have an opinion on that. I don't know if it has to do with the interagency cooperation, but I think for the biofuels it's very important to come up with inputs that are consistent with the type of biofuels that you're looking at.

So if it's a corn ethanol plant that's a dry mill, it's really not an average of a coal-fired and a natural-gas. I mean there's corn ethanol dry mills out there, and we've visited them. And we know how much energy used. And the range isn't that huge.

I actually think it's not productive to come up with averages because you tend to not incentivize the technologies that are best. And it's even troubling to come up with the composite average for the U.S. ethanol plants.

Maybe there's technologies like oil refining, or maybe there's biofuel technologies where there's not much latitude, perhaps CNG. But I think it's important to get a feel for making the right buckets, and not expanding it too broadly. Because otherwise, surprising things will sneak in under your umbrella.

MR. FRIEDRICH: Axel Friedrich, Umweltbundesant. If we seek to have a worldwide scheme for certification, and we have different modeling in different part of the world, I see a lot of problems. As people coming up in Europe, countries one version of GREET from one area; another version of GREET, which is not exactly the same. Using modeling in Germany, using modeling --, using modeling in U.K., just try to figure out this in Europe to harmonize this.

How you think we can, in the end, harmonize all this modeling. Because principally I think it's not such a big difference in all the modeling approaches --

MR. UNNASCH: Yeah.

MR. FRIEDRICH: -- only some assumptions, some combination of things are different.

MR. UNNASCH: Yeah.

MR. FRIEDRICH: Otherwise we have no change to have a harmonized set of --

MR. UNNASCH: Right. And we've solved it. It's not a problem.

(Laughter.)

MR. UNNASCH: The challenge is that people will develop different versions of the GREET model, sometimes for real good reasons. You have a near-term need, a budget, got to get it done. And now you have this special version of the GREET model. No need to do that.

With a spreadsheet with the interface we showed you, everyone across the world can make their own interface to GREET, and you can push it into the GREET model. And so then the question becomes how can we show our assumptions in a consistent way, you know. What's the art of showing the assumptions.

You could have a vector that's 5000 lines long, but if you can say here's my assumptions, it's very possible for people to be able to use the GREET model with different sets of assumptions.

MR. FRIEDRICH: But it's -- GREET model, the question is they have different models --

MR. UNNASCH: Okay, different models. Well, then I think the challenge is on this table of assumptions they're very reasonable assumptions. You can expect people to make a calibration page and say, well, this is the standard format for the assumptions. The model's different, let's just at least compare the assumptions on consistent basis.

AnD I think that's quite do-able. We've looked at the JEC study, and of course, you know, the assumptions are comparable. You know, some of the assumptions are silly units. You know, you have a compressor energy and efficiency. But these can all be put into, with a little bit of work, into comparable units.

MR. FRIEDRICH: You mean in -- per second?

MR. UNNASCH: Yeah, and -- seconds per (inaudible) mile.

(Laughter.)

MR. PRABHU: I guess, since we have the two gentlemen waiting here, we'll let them go, but please be quick and let's move on to the next speaker after the two people here.

MR. THEROUX: I will make it quick. Michael Theroux. You note the data need, of course, for MSW moving into the GREET model. Certainly some waste characterization has used GREET to do this.

Can you speak briefly to the difference that we see when we run GREET on what is a waste, compared to what is a commodity?

MR. UNNASCH: The simple approach, which is not necessarily right, the simple approach is that if it's a waste it's got a zero impact. That's not necessarily right. MSW is a great example. This really needs to be thought out.

If you're going to take MSW and you have two choices. One is to bury it where the fate could be digestion, conversion to methane, recovery in a flare, or conversion to electricity, you have quite a chain of options.

So if you were really to do -- and this is one -- draw your system boundary diagrams, because it's not obvious that taking forest residue into ethanol has a zero lifecycle inventory. It could be negative, it could be even better. And MSW is very complicated.

So these inputs -- the wastes are not treated with the kind of nuance that you would think is appropriate. More work needs to be done there.

MR. LARIVE: Jean Francois Larive, CONCAWE. Just a remark more than a question really, to reinforce what you said about GREET.

I think we should stop calling these things models. They're not models; they are number crunchers.

MR. UNNASCH: Yes.

MR. LARIVE: And what is important is not whether you use GREET or something else. It's what you put in. It's the data you put in, and that's the data that makes the pathway. Calculating the pathway, that's what these things do. They just put boxes together and arrows in between. That's all they do.

And I would like to, just at one point to maybe answer the first gentleman from the Waste Management. I think what has been done, probably the U.K. has gone the furthest so far into trying to codify how things should be done, and how things should be compared.

And they way they've gone about it is to say, well, you've got default values at various levels. So you use a certain methodology which is, you know, just putting all these boxes together.

And you put a number in each box, depending of how much information you have. And if you don't have much information on that, you get a conservative value, i.e., a value that's not very good for you as a producer.

And that's the way the biofuels producers have to, or will have to report and to declare what is the value of their particular offering. And on that basis somehow you could, you know, make a judgment in a kind of framework.

MR. UNNASCH: Yeah, the art of the tool is as much in the documentation as it is in the arithmetic.

MR. PRABHU: Thank you, Stefan.

(Applause.)

MR. PRABHU: Before we go to the next speaker, just to let everybody know, we will not have a keynote speaker for lunch. So Martha informed me we can go a little over 12:30, so we should have enough time for the next two speakers.

The next speaker is Johan Six. He's an Assistant Professor in the Department of Planned Sciences at the University of California Davis. His research focuses on the feedbacks between ecosystem management options and global change elevated CO2 and climate change, and biojoule chemical cycling, including greenhouse gas fluxes.

More specifically, he studies the complex interactions between soil, soil biota and the carbon and nitrogen cycles in agricultural, grassland and forest ecosystems. He conducts experimental work at both the plot and landscape level, and subsequently integrates it with simulation modeling to identify gaps in our knowledge.

So, let's welcome Johan Six.

(Applause.)

MR. SIX: Okay, so I'm actually going to focus into a very small detail of the lifecycle analysis. It's small, but it's quite important. And that's namely what's happening within the agricultural landscape.

Because if we talk about the, you know, the two main areas actually where research is needed, it's having the economical and environmentally sound production of biomass; and then you have the economically and environmentally sound conversion of biomass.

And in the lifecycle analysis models there's quite a bit of focus on the latter, so on the second one, it's all about the conversions. But since we're talking now about biofuels, not about any other fuel, what's happening in the agricultural landscape is a whole new component to the lifecycle analysis.

And the models or spreadsheets, or whatever you want to call them, are not necessarily addressing that in a very good way. And there's reasons for that, because it is actually rather complex, and I'll show you some of that complexity throughout my talk.

So what I'm talking about is indeed not the latter part of the whole lifecycle analysis, so I'm not talking about what happens at the ethanol plant, what happens at the station. But basically talking just about what's happening on the land.

So, we have to produce that corn if you're interested in the ethanol. If we're interested in cellulosic we have to produce that switchgrass or whatever plant material that you need.

And there's many ways that you can produce that crop, that biomass. And some of it might be a good thing; others might be not as good. Especially when it comes to the emissions.

So, in order to address that there's

actually an interdisciplinary approach that's needed. There some basic plant sciences that comes into it because you are going to have to probably come up with different varieties of what we're having at the moment to make it really efficient. We also have to understand how these plants are functioning.

Then we're going to integrate that into a biogenic chemical model, because in the end what we want to get to is the greenhouse gases -- is this due to the methane and the nitrous oxide that's being produced while we're producing that biomass.

And then obviously we're talking about the agricultural landscape. And so, it has to be economically feasible, also. Now, with the prices of oil today that feasibility might be quite a bit more than it used to be, but still there are restrictions there. Farmers are not going to do just whatever we can dream up so that we have a perfect biomass stalk.

And then obviously all of that has to go into these lifecycle analyses. So then we provide, you know, what's happened in the agricultural landscape with the greenhouse gas.

That gets then fed into these lifecycle models.

As you could see from Alissa, you know, she had nitrous oxide as quite important gas. The uncertainty is huge around it. Well, that's exactly also the gas that we're producing quite a bit while we're producing the biomass. At least if we're producing it in certain ways. And I'll talk about that more.

And so it's in the end to really make sure that we have a long-term potential of that biomass production. And that it is, indeed, efficient all the way from the farmer's field to the gas pump.

And so what we've been doing, in essence, is trying to get also to that complexity is when we're talking about California, for example, traditionally there's not been that much biofuel crops being grown here. Switchgrass has hardly been grown. Other grasses, also.

And so we're basically back to setting up simple field experiments at the moment to figure out how we can produce that biomass. It's been done quite a bit in the midwest, in the great plains, Texas, whatever. But in California we're still having quite a bit of uncertainty around how to get that biomass produced.

And if we want to make the model working, you know, on the greenhouse gases, then we basically need still some basic data to make that model work and accurately model the greenhouse gases.

And so that's what we're doing. We're having these field experiments. But then obviously we're already looking into some of the data that's out there in other parts of the U.S. But you'll see also in some of the modeling results that if you just transpose whatever has been done there to California conditions that you're missing, and you're not having very accurate predictions.

And so we're using that published data, but we're still a little bit worried about how much we're getting out of it.

And then we integrate that biogenic chemical model with the economic analysis. And then the main thing that we're trying to get, in essence, is, you know, having your agricultural landscape, there's quite a bit of spatial and temporal variation in greenhouse gases. That's depend on what kind of land it is, what kind of soil type you're having, what crop is it growing, how are you growing it, what are the environmental conditions, what is the climate.

Even though, you know, in the Central Valley, you know, you could say it's a fairly similar climate, but if you go from north to south it has already huge implications actually for which crops can be grown and which ones cannot be grown.

We actually, in the five field experiments, already notice if we have different varieties of switchgrass. In the northern part of the state they don't grow -- they don't grow here, but they do grow in the southern part of the state. And then they're showing other varieties that it's the opposite.

So it's right there that spatial variability that you have to deal with if you want to grow that biomass within the landscape.

And then if we can actually get these greenhouse gas emissions predicted, then we have to kind of condense it again to be able to feed it into the lifecycle model. Because none of these lifecycle models can deal actually with all the spatial, temporal variability that we have in the agricultural landscape.

Especially, you know, if you go to, for example, the midwest and you have just a simple corn-soybean rotation, that's fairly easy done. Here in California, we all know, the landscape is not just corn-soybean. We have a huge variety of crops. And then these differences in environmental conditions.

And so we need that condensed and in a sensible way aggregated, and feed that into the lifecycle model. And hopefully then have better predictions with the lifecycle model what the greenhouse gases are.

So, when it comes to the greenhouse gas budget, what we're doing is, first of all we get at the biomass production; that's what we -- you know, that's the first thing that we have to see.

But then in producing all of that biomass, how much carbon do you have sequestered, how much nitrous oxide emissions do you have. Is there methane absorption and how much of it. And then all the inputs that are required for the farm operations will play a big role in how much emissions you have basically to produce that biomass.

And just to reiterate again, it's all about in what specific environment you're doing it. And that will make big differences in how many greenhouse gases you're having produced.

Just to give you an example of why, or show you a bit more of why it is actually complex, is the three are very much interlinked. So you're having nitrous oxide, you're having CO2 and methane. It's all related to how the organic materials are cycling within the system. And so we're having soil organic matter that's in the soil We're having that that is being mineralized. And you're having nitrogen, it's ammonium nitrate that are being formed.

But during these transformations, so the nitrification, the denitrification, you do have these greenhouse gases being produced. Namely here it's nitrous oxide. So nitrification, denitrification will lead to a production of nitrous oxide if you have it in soil organic matter and you're having methanogenesis. That's only in rice systems, really. You're going to have a production of methane. And then any cycling of soil organic matter you're always going to have also CO2 being produced.

And then, as you can see, the cycles are very much interlinked, and so then when you manage your field in different ways, you'll basically affect how many of these greenhouse gases are coming out. And that's what we're trying to predict.

You all know this, but it becomes very important if you look at the agricultural landscape, that nitrous oxide is a very potent greenhouse gas. We're having small fluxes of nitrous oxide in our systems. But because of it being so potent, it is one that becomes a big player when we crop.

And so it's actually nitrous oxide is very much related to how much fertilizer you're using. One of the ways to produce more biomass is obviously fertilizing. But then you have to be careful of how much nitrous oxide you're getting out at the same time.

So you might be getting more biomass, but you also might be producing more greenhouse gases while doing so.

And so the way we do it, in essence, then, is we have long-term field experiments around that we use to calibrate the model, so that we get confidence in that biogenic chemical model under the conditions, you know, the local conditions for which you're trying to make the predictions.

And then we have just all the spatial information on soils, on climate that we feed into the model, the biogenic chemical model, and then make predictions of what the yield is, what the production is, and what the greenhouse gases is.

And then that gets fed into the economic model so that they can do some feasibility studies, economic feasibility studies. And then also that, after it's being condensed, goes into the lifecycle model. And so then hopefully you can come to some decision support system.

As the speaker this morning showed you already, there is the DAYCENT model, and that's the model that we chose to work with. It's a daily version, so it's on a daily time. And it simulates the plant production, the nitrogen nutrient dynamics, and then soil, water and temperature.

So, obviously you have to actually get a very good handle on temperature and water in the soil because that will determine how these processes of nitrification versus denitrification are going to play out.

And so the model, itself, which you saw already, that's basically the module for the carbon. But then we have a similar module for the nitrogen. And then we have a similar module for the soil water. We have a similar module for the plant production. And a similar module for the water -- the temperature.

So, you're having basically all these different modules, and as you can see, then, you're having a lot of calibration that needs to be done, lots of different parameters. But I won't bore you with that, because -- well, it would really bore you.

(Laughter.)

MR. SIX: So the main point is, though, that what I kind of want to get across is that it's a rather complex simulation modeling that you're doing. And that's why it is very important that we do have, you know, the correct data and have lots of data, in essence, to get this to work the way it's supposed to be working.

So, it's similar to the lifecycle analysis, what to input this is of huge importance.

Nevertheless, though, when we do this, you know, we use several sites here in California and started looking at the, you know, at different crops. And they were far from all biofuel crops, but they would be crops that could provide residues, at least some of them. I wouldn't think about tomatoes.

But the thing is we're modeling also these other crops because obviously on the landscape it will change. And if biofuels come in, then you would have some of those that go away.

You do basically the comparison, always versus what's business-as-usual. And so if you have a transition of land use, then you'll have to take that into consideration.

So what you're seeing here is that we, you know, we do a fairly good job on the yields of the different crops. But obviously there is variation around and we're never going to be having it much better than this, I think. You know, there is going to be variation there no matter what.

Some of the variation that we actually

cannot pick up is, for example, because we have already the water model module, we have the production model, we have all these different modules. But we don't have a pest module. And obviously pests will play a big role in agriculture. But then we're talking about a whole different model to get pest populations to go.

But so some of that variation that we basically do not pick up has to do with that.

When we look, you know, when we do it then for these different crops here, you see what we first of all want to see then is on how much do you have a yield change if you do now different practices. Because it's not only about what crop are you going to choose, but also how are you going to cultivate that crop.

There's different practices out there. As you can see here, we're basically, you know, we're having some that we use the chemical fertilizer. We're having other ones that we use manure. We bring in a cover crop, yes or no.

And then one of the main ones that we have started looking at is actually if you just now reduce a little bit the fertilizer use than what's conventionally being done, by basically 25 percent, how much of a decrease do you get in yield. And then also in greenhouse gases.

And so as you can see, though, with these different ways that we do the practices, have these different cropping systems, there's some differences in yield, but most of the time they are actually not too big of a differences.

However, when you go over then to the greenhouse gases that's when you really start seeing the differences. And so you can basically, you know, you have systems that are close to being net emitters versus systems that are then more net mitigators.

So, for example, if you do that reduction in fertilizer then to 75 percent, you usee that, you know, you saw in the previous slide, the yield is not changing that much. But we do get quite a bit less nitrous oxide coming out.

If you then -- so that's one way. But then it also becomes evident that one of the main things that you have to do, though, is try to have as much inputs of carbon into the system. So you're going to bring in your cover crop; you're going to bring in that manure. And that's when you're basically going to get a carbon sequestration and a reduction also in nitrous oxide emissions. And so the way you do produce these crops is of importance.

Then when it comes to the biofuels, though, so this was like really specific biofuel cropping systems with, you know, with switchgrass or one of the cellulosic things, then again we're in California we're not having a lot of data.

And so we're basically back to calibrating and validating the model. So that we can then accurately predict what happens in these biofuel systems.

So what we're doing at this point, then, is making a database. We're using the wealth of data that's out there for other parts of the U.S. to get a first ID. But then, as I said, we have these field experiments, in essence, to try to get it for California conditions.

And so these are the plants or the species, I guess, that we're considering at this point. The list is endless, but those are the ones that we said we would focus on first.

And so then I can show you here a little example of what we've done already. So we took some data from Pennsylvania, and one of the things I want to point out, too, is that, you know, when you go in the literature there's quite a bit of data out there.

But what we quite often miss is actually time series. So we want to have not just one time point in data, but we want to have it over several years. Because it's very easy to make a model fit one data point. I mean that we can very easily do.

But making a model fit really the time series and how it varies from year to year, that production, and the greenhouse gas emissions, that's where the challenge is.

And so if you want to do a rigorous calibration validation what you need to do is really use these time series. And then it becomes already much less how much data is out there to do that.

Now, here it shows in this one example in Rock Springs, Pennsylvania, those are just some of the basic characteristics of that site. And then, you know, they did fertilize their switchgrass.

And then we have our own experiment that we've done in Davis, California. And basically had a similar fertilization rate. And then we used that basically to kind of validate the model.

And you'll see immediately then that, you know, we go through the calibration of the model and we get a pretty good -- I mean we're within 5 percent of what the yield was for the switchgrass in Pennsylvania.

But so we parameterize then our model and now we're just saying, okay, now I'm just going to run it for Davis conditions, and I'm not going to re-parameterize it. And then we're getting a 20 percent, you know.

So then it just shows you on how if you want to do it for all these different environmental, and the different conditions, that you have to go through this calibration and it's not going to be done without more data out there. And it is inherently just very variable.

Then also if we do the greenhouse gases what you see immediately is that the nitrous oxide is playing a big role again. We're only having about 4 to 6 kilograms in Pennsylvania that's coming out. So it's not a huge flux. But when you calculate it out, it actually dominates quite a bit your global warming potential.

Then if we go to Davis and we're under different conditions, then we even have quite a bit higher nitrous oxide emissions.

Now, I want to say, though, at this point that in Davis, the switchgrass was the establishment year, so the crop was not growing, you know, full at its full potential. It was still establishing. And so that's where we then have -- obviously we added, in essence, too much nitrogen. And so that's why it's coming out as nitrous oxide.

But it points out that you better make sure that if you fertilize you fertilize at the right rate. And that you don't over-fertilize just with the idea, oh, I'm going to just get more production here, you know, I want to just produce, produce biomass. You want to do it in a sensible way or otherwise you're going to be in big trouble with the greenhouse gases.

And then to our surprise, actually, the CO2 emissions, we effectively had CO2 emissions, you know, quite often it said if you go over to these biofuel crops there's going to be more carbon inputs to the roots and whatever. And that you would effectively have a carbon sequestration. While it doesn't seem to be the case in these systems, now that might also be again due to the establishment year.

But still it seems to be -- I've actually then gone into the literature and now I'm finding more and more that that carbon sequestrations not necessarily happening with the biofuels.

So, it might be that the CO2 emissions are quite a bit -- well, are playing big role compared to the nitrous oxide, too.

And with that, I want to thank you. And I guess also acknowledge the funding agencies. Thanks.

(Applause.)

MR. PRABHU: We have time for a couple of questions.

MR. UNNASCH: Are the CO2 emissions from -- those are the net between what's in the plant and the soil?

MR. SIX: So, it's -- no, it's basically what's coming from the soil. So while you're producing. And so it's a decline in the soil carbon.

So it's not taking into account -- I mean, the harvesting, that goes away. So it's basically whatever is left in the field and is turning into a longer term, because that's the one that we only consider for sequestration.

MR. PASWATER: Pat Paswater, Integrated Waste Management Board. I'm curious, the different crops that you have as candidates, do you find that the pest situation, pest threat, varies from locale to locale, country to country?

MR. SIX: Well, I guess when it comes to pests I'm not a -- far from an expert. But, there's clearly, I mean there's quite a bit of differences, you know, if you go up and down the valley. I'm definitely -- further going to be dealing with different kinds of pests.

At this point, though, when I was talking about, for example, the switchgrass and seeing differences, you know, north versus south, in establishment had nothing to do with pests. It wasn't that we have pests, you know, making the establishment fail. It's just little differences in how fast, you know, the spring is over and that you have your planting day correct with these different varieties.

MR. PASWATER: Was there any pest control performed on the crops grown in California?

MR. SIX: Yeah, yeah. Yeah, it was done.

MR. PASWATER: Thank you.

MR. SHAFFER: I think your last slide may have answered my question, but I'll ask it anyhow, Johan. Steve Shaffer, Department of Food and Ag.

The lists of crops that you analyzed, I didn't see corn or sugarcane, some of the more conventional crops. Was that dictated by your partnership, then?

MR. SIX: No, no, the -- no, no, actually we've done quite a bit of modeling on corn, also. Corn is obviously a crop that's -- I mean it's grown here. But it's actually -- corn is, most of the time, just grown also because they have to rotate. And they're more interested in their tomato, you know, because that's the one that's giving the cash.

So, but the corn is definitely part of it. And now with the price increase in corn, obviously we're seeing it more on the landscape.

But, no, there's definitely -- I mean we've done actually quite a bit on the calibration and validation based on corn. Because the corn database was actually one of the bigger ones that we could get together.

MR. SHAFFER: And how about sugarcane?

MR. SIX: No, sugarcane we haven't done.

MR. PRABHU: Excuse me, I'll allow two more questions and then we can defer to the other questions after the next speaker.

MR. STEWART: Bill Stewart, University of California at Berkeley. Are you measuring in the soil the soil carbon? How are you doing that? Or is that part of the CO2 equation, or are you measuring what's actually there after the harvest?

MR. SIX: The data I was showing is purely coming from the model. So that's not measured. But the plan is obviously, you know, now -- well, we've had one year. Within the one-year timeframe it's actually quite difficult to pick up differences in soil carbon.

But we're obviously planning then on doing those measurements in the coming years so that we have actually more data to calibrate the model with. Because now the calibration basically has only been done on the yield. And then we're just getting the numbers out for the CO_2.

Obviously, I mean, if you want to make it more accurately, then you're going to do it based on the soil carbon.

But, that's, I mean, it's quite often also a problem that in lots of these production systems the focus is so much on the biomass production. And that's what's being measured in every detail. But anything that's happening in the soil, I mean, is not being measured. So we're having even a harder time getting data for that.

And then soil carbon is still okay; if you go over to nitrous oxide, then you're totally lost. I mean then you're talking, you know, if I do that for the whole of the U.S., we can find about 150 studies for corn on nitrous oxide. If I do it for, for example, the orchards here in California, then we have zero.

So that's the range we're dealing with.

MR. JONES: Hi. Andy Jones from UC Berkeley. I'm also interested in this finding of the loss of soil carbon. And I was just curious what the previous land use was.

MR. SIX: Oh, in Pennsylvania?

MR. JONES: Yeah, or --

MR. SIX: Well, in Davis, both of them are actually just basically agricultural. So agricultural systems. They were under a variety of crops.

MR. JONES: So, row crops, so the annual row crops --

MR. SIX: Yeah, but actually also on the Davis side there's been sometimes alfalfa on it. So, I mean, and that soil in Davis is, for California standards, is on the higher end of soil carbon. So, it might be just, you know, the shift.

But I think at this point it's more that you had crops before, and then you had that establishment year. And in the establishment year, the root growth has not been that much. And so you're basically having a bit of a loss. And I would not be surprised in that it will take -- or at least come back to what it used to be. Yeah.

MR. JONES: Okay, thanks.

MR. PRABHU: Let's thank our speaker, again.

(Applause.)

MR. PRABHU: Our final speaker for this

session is Dr. Ken Cassman from the University of Nebraska at Lincoln. He's the Director of the Nebraska Center for Energy Sciences Research.

In previous positions he was a research agronomist in Brazil, Egypt and the Philippines, and was a faculty member at UC Davis. He fundamentally wanted me to just introduce himself as a former faculty member of UC Davis, but I wanted to definitely bring the Nebraska connection in. There's a lot of issues and discussions on corn and he comes from the corn belt.

So, here's Ken Cassman.

(Applause.)

DR. CASSMAN: Thanks, Anil. And why don't we all just kind of, you know, do some yoga here. I was looking out at --

(Laughter.)

DR. CASSMAN: -- about 100 catatonic faces. Mine included.

I think it's remarkable really that the organizers have brought together such a wide range of perspectives and expertise. We have -- well, we thank California Biomass Collaboration, we thank CARB and the other sponsors, but we have environmental advocacy groups here; we have government agencies, both at state and national levels; we have industry representing chemical industry, ag products industry, petroleum industry, biofuel industry.

We have consultants, perhaps some lobbyists, and we have faculty members and research scientists from a number of institutions.

My goal today, I mean this is a rare group, and the range of perspectives is incredible. And we're all talking together. So my goal is to say something that maddens each one of those groups today.

(Laughter.)

DR. CASSMAN: What I want to do is focus on the need to get corn ethanol right. Because I think what's happened is we're kind of missing the forest through the trees, in the fact that the only major biofuel that's going to be available and used in large quantity in the next five to ten years, and this is in large quantity, we're talking billions of gallons, is corn ethanol.

So if we don't get that one right, as we embark on this incredible process of trying to understand the environmental implications, we're really stepping off the diving board into a very deep pool that may have repercussions later we don't like.

And so we're talking then about both the actual -- what I'm going to talk about then in terms of getting it right is first that we -- and Bruce Dale made this point -- what are we trying to do a lifecycle assessment for. Backward looking at the way the corn ethanol industry used to be? How it is today, or forward looking?

And just to give you an example, 60 percent of current ethanol production capacity from corn comes from ethanol plants that were begun production since 2005. And in the next year and a half that value goes to 75 percent.

Now, my problem with the values being used in the current GREET model, as you'll see, is it's a backward-looking assessment. Because it's using values from these older plants, the 25 to 40 percent on that.

The second point, then, is that what I'll talk about are actual direct effects of fossil fuel emissions from production of corn ethanol.

And, again, we want to use values consistent with how the industry's performing today. And we can actually take measurements of each system. We can actually get real data, as opposed to you're hearing a lot about future biofuels, second generation biofuels. Those can only be hypothetical systems.

We'll take some data from a moderate scale, some data from a lab bench. We have no idea what the ultimate technology winners will be yet for many of these second generation biofuels.

So you're comparing apples and oranges when you say here's the value for corn ethanol system, here's a value for a switchgrass system. Because switchgrass system doesn't exist at a commercial scale.

But what we want to try to do, I think, in getting corn ethanol right is use the best available data for the existing biofuel fleet.

Now, the indirect effects people have covered well. I'm not going to go into it. But the main point to make here is that it's going to be one value that you apply to across the entire corn ethanol industry. It's not going to be specific to a specific type of plant, plant in a natural gas, wet distiller's grain plant in Iowa, for instance.

It's going to be -- because the indirect effect applies to the whole industry. And so we can develop software tools, not models, we all agree not models, but software tools that do lifecycle assessments for the direct effects.

And then when we come to agreement on what the indirect effect, it will be one default value applied across the entire industry regardless of type of ethanol plant.

So the biofuel energy system simulator software, these are things we were asked to cover. Its scope is corn ethanol, dry mill biorefineries. There are eight default scenarios, but it can be customized for certification of an individual ethanol plant. It gives a coproduct credit by the substitution method.

We don't cover wet mills; 18 percent of existing capacity of corn ethanol comes from wet mills, but that's crashing rapidly because all the new plants are essentially dry mills.

It assesses greenhouse gas emissions, energy, yield net energy and requirements for other resources like land, water, nitrogen. And it allows a default, again exogenous value, for soil, carbon sequestration, whatever. But that would have to be done outside of this software.

Does not assess land use change. Although it could, for direct land use change if you have the value that you can certify for carbon sequestration or loss in the system that produces that corn for the ethanol.

We use the most up-to-date data sources from USDA for crop production. Recent industry surveys for energy use. And more important, I think, an IPCC default emission parameters for nitrogen.

But more important, I think, is that it brings together -- it was an interdisciplinary effort that involved animal scientists because there has been a revolution in the last three years in the livestock feeding industry. Because now we have so much coproduct, distillers grains, and corn has been withdrawn from the feedstock supply, that three years ago the limiting factor in livestock feeds for cattle, especially, was protein.

And so soybean meal was the most important component of livestock diets. Corn was cheap; the energy source. Today corn is very rare or hard to come by and more expensive in livestock diets, but distillers grains, which are a protein-rich feed now, high in oil content, are very much accessible. So now energy is the limiting factor in livestock diets.

So it's very important to capture this revolution in livestock feeding in your assessment of the coproduct credit, which the BESS software does.

We're also working to expand it to switchgrass and stover.

Now, I mentioned it uses these updated estimates for direct-effect emissions. All key disciplines, engineers, agronomists, soil scientists, animal nutritionists input from stakeholder, particularly industry, professionals. Very user friendly. I'm going to go back and demonstrate it for you.

It can be used to estimate carbon offset credits for emissions trading for an individual facility and its feedstock supply, so that some day the ethanol plant can be considered the aggregator for any carbon benefits that accrue. And it can be used for compliance and certification consistent with any lifecycle standards, low carbon standards.

I imagine this is going to be available online, so these are the data sources we're using. But I want you to note they're much more recent than what the GREET model is typically using -- other models.

Because our goal is, again, try to get the snapshot of today's biofuel fleet. In particular, this shows the inputs of energy to biorefineries. GREET 2008 for wet mills is the dark bar on the left. The GREET 2008 is the dry mill configuration, average value they use for the U.S.

And then a recent Renewable Fuel Association's survey conducted last year; 22 ethanol plants representative across the U.S. We've done a study with the Nebraska Department of Environmental Quality that requires ethanol plants of a certain size to report their energy use as part of emissions compliance.

And so you see we have data from the Nebraska Department of Environmental Quality, nine plants. We did our own survey of six other plants in other parts of the midwest. That's the UNL-6 survey there.

Iowa also requires, in their Department

of Natural Resources, ethanol plants of a certain size to report their energy use. And that's the UNL-IDNR, nine plants recorded in 2004-2006.

And then a wet distillers grain set of plants; four plants, all the way on your right looking at the screen.

You can see huge differences in energy use and what you would choose to use, that's one of the key parameters of the lifecycle assessment, which is The amount of energy being used in the ethanol plant.

So these are the default values that are included in the model, but remember you can customize it for any configuration you like.

These are some of the input scenarios. It uses default values for crop production based upon the most recent USDA surveys in terms of both yields and inputs. Shows you some differences between the U.S. average there, Iowa average and Nebraska average.

We also have one scenario based upon actual production scale field trials we have where we try to optimize all production factors to get very high yields with very high efficiencies in those systems.

And so I want to go to the simulation mode right now. And they say I can do this. I need to stay awake, as well. So let me try. Can we shift it to the other computer?

(Pause.)

DR. CASSMAN: There we go. Because I think we can develop software tools that are not difficult, that are easy, that are user friendly and very intuitive. So you can download this model; there's been about 500 downloads. It has a very detailed user guide here. Wake up. Wake up. Even the computer's gone catatonic.

What I'd like to show you are two pages, just to show you some of the outputs. There's the complete documentation of the model.

So here's -- talk about transparency. I think if whatever we're using does not allow you quickly to come up with tables that show all inputs and outputs, it is very difficult to do, so that only a few people can do this, I think that's a transparency issue. Likewise with regard to input parameters.

So, if you don't have tables like, for instance, this, where you can see every input parameter that's used in the model, and obviously the justification for it. So there's the user's guide.

But it's the use of the model that's important. So here are the default scenarios. We'll run one that's the Nebraska natural gas; this is the dry distillers grain. It brings in all the default parameters; go to crop production, the ethanol biorefinery, the cattle feedlot. You compute your simulation and it gives output pages for crop production. These are all the inputs for total harvest area, grain requirement, water use, all the fertilizer and diesel, pesticide inputs. And it can plot them out in terms of absolute amounts, percent of the emissions from crop production, or percent of emissions from the total life cycle.

It shows a similar output page for biorefinery. Cattle feedlot.

Then it goes through a series of lifecycle analyses for material inputs, greenhouse gas emissions. And it shows each type of greenhouse gas and their emissions, and the total greenhouse warming potential over on the right. And a final net balance where it shows gasoline in the red bar, sources of emissions, the credit for coproduct, and then the final net effect.

And it gives a summary report that is very complete with regard to all of the performance parameters of the simulation, an emissions inventory, all your input settings and your internal hidden parameters that are used to make these calculations.

Then the point is that you can use it to compare. That was a natural gas, a Nebraska dry mill. You could look at a Nebraska coal ethanol plant. We actually have a coal ethanol plant in Nebraska. So it brings a whole different set of parameters for the coal plant. Simulates it, and allows you to compare.

So, right away one can see that in terms of lifecycle that emissions from the coal plant, in green here, has a lot more emissions than the natural gas alternative. And in terms of emissions reduction we've gone from 52 percent emissions reduction with the natural gas -- average distiller grain scenario in Nebraska to 22.

Note the numbers here. Talking about 52 percent reduction if you use these newer updated values for performance of corn ethanol systems.

Want to go back here and, for instance, show you how to customize. So let's say you've got an area, an ethanol plant that's able to draw corn and document that it's getting actually corn from producers that have much higher yields a ton, perhaps are higher. That they're doing slow testing. That they're using no-till. They can then get by with less nitrogen. They are able to have carbon sequestration here at about 200 kilograms per hectare per year, which is a modest amount.

And we're going to say that this is a California scenario. Save it. And it computes that, and you have your customized scenario. And you see here that, in comparison with our others. The point is you can get these scenarios and compare them both for a kind of a standard facility, or for a customized facility.

So what does it tell us then when we take these newer values of performance of corn ethanol systems that reflect how the majority of the industry is performing today, and as we build it out perhaps even it will build out even more efficiently.

Well, this is a summary of all the eight scenario defaults. And what you see here is that the typical ones are bold. I don't know if you can see them. They're typically natural gas, dry distillers grains or wet distillers grains.

And we're estimating emissions. And I think Stefan made an important comment. If GREET was parameterized the same way it would get these same numbers. The main difference is what you choose as inputs. We choose the more recent data on what we think how the industry's performing.

So, you see, we're up here at typically a Nebraska natural gas, wet distillers grain plant because we have lots of cattle. We don't dry much of our distillers grain. Sixty percent reduction in greenhouse gas emissions; 404 above -- 450,000 metric tons of carbon saved, direct effects, for a 100-million gallon plant per year.

So, when we compare then across, and this, I think, is very important, so the GREET model being used gets about a 24 percent reduction in greenhouse gas emissions relative to gasoline. The earlier EBAMM and interim model beacon is about the same level.

The scenario -- of the scenarios I showed you for the BESS software, the midwest regional average would be your number one there. It's 54 percent reduction of greenhouse gases. More than twofold greater than what may be used by EPA or California.

And I think the danger there is that you could say, well, let's low-ball it. Let's be conservative. Then producers, ethanol producers, could document that it's better than that, and everyone wins.

The problem is public perception. And the fact that policy is driven to a large extent by perception of whether corn ethanol or any biofuel industry is contributing to those goals for which we decided to subsidize it in the first place.

So, it's important. Does it contribute or does it not. And if you're setting these standards and you're saying, well, for the standards it doesn't matter so much. And they just document if it's different. No, it matters. It matters to national policy; it matters to the planet as we try to figure out this incredible challenge of meeting, and I think Don Smith did an excellent job of that, from Canada, of trying to meet food, fuel and fiber demand from a limited resource planet.

So the most sensitive parameters in this are crop yield, nitrogen, fertilizer and irrigation inputs in the crop production mode; conversion efficiency in the ethanol plant; and ethanol thermal energy use, the amount of energy it takes to make that conversion.

Of these, crop yield and nitrogen inputs and irrigation are, by far, the largest. Conversion yield is already very high in an ethanol plant. Maybe 91 percent theoretical efficiency. So that if we modify corn grain, get a little more starch, a little more amenable, yeah, it'll help, but it's at the margin from 91 percent, perhaps 95 percent. You're never going to get 100 percent.

Whereas, crop yield is much more important. So you can do an analysis across the country and look at the greenhouse gas intensity of a standard -- do you know how to get back on this -- so the standard ethanol plant, in this case a dry mill, natural-gas fired ethanol plant, located in different regions, based upon the crop production data, and electrical energy supply in that state -- there's data available for electrical grids for each state -- what you see is that certain states do have -- are advantaged because of soils and climate, yields, ability to produce with less inputs, than other states.

And so states like Texas, which require, because it's warmer temperatures, lower soil organic matter, lower soil -- supply, higher requirements for nitrogen, requirement for irrigation, Texas would have a relatively low carbon greenhouse gas mitigation potential from direct effects.

I don't want to go into direct effects. Everyone else did a great job. I will respond to my Brazilian colleague. Is Joel here? Joel. You know, this is a picture I took in 1997 from the contest-winning cornfield. This field won the National Corngrowers' Association yield contest. It has to be a production-scale field.

The yield was over 300 bushels per acre. The farmer used no more inputs than the average farmer in relation to yield. And it gives an ethanol yield of 7500 liters per hectare, if you can raise yields to this level.

And this is a plot of average yields, the lower straight lines, irrigated, rain-fed in

Nebraska, compared to those contest-winning yields in Nebraska in those same years.

And so you see we have a tremendous exploitable yield gap sitting there in the fields of our corn systems.

And the problem is that, how do we close those yield gaps. And it seems like we're getting the wrong message from policymakers that if we just genetically engineer a new higher yielding plant -- I quote here Bob Fraley, Chief Technology Officer, Monsanto, who goes around the world telling us that he's going to have drought-tolerant, nitrogen-efficient, high-yield potential corn. Quantum leaps now in a very short time.

And the problem is there's simply no scientific evidence to support it. Genetic engineering is going to be important, as is all, but it is going to be part of a continued trend of yield increases. There's no magic bullets out there. There's no science to support those magic bullets.

What is going to be is what I call an ecological intensification. And of which genetics is one tool in a very large toolbox. We're going to have to learn to produce crops nearer that genetic yield potential, while at the same time reducing the footprint of agriculture. Substantially improving nitrogen management, water management by honing the timing of planting, selection of maturity, plant populations, plant geometrical distribution, spatial application to the land, matching the crop to the land. And doing this all at very high yield levels.

And we've played around with this. It can be done, but what amazes me is at a time when we're the only biofuel system that's massively building out as corn ethanol, and no one seems to be talking about how to make it better.

We're looking way ahead to the second generation that may or may not get here. And, in part, it will get there to the extent that we can document corn ethanol is successful. Because it's going to be hard to convince the population at large that the check is in the mail if we fail on corn ethanol.

So I want to conclude at my one-minute mark, that corn ethanol will be first to test the newly developed life cycle low carbon fuel standard assessments. Substantial amounts of other biofuels are five to ten years away.

So accurate evaluation of direct effect emissions from corn is the foundation of the lifecycle process. These effects vary with ethanol by refinery type and corn feedstock supply.

Different reference, greenhouse gas emission values are needed for each major class of ethanol, plant, and perhaps by region. The best software provides the most up-to-date, scientifically sound estimate of corn ethanol, greenhouse gas emissions.

Up to date in the sense we think it's estimating how the current fleet is performing. And so -- GREET does so much more than corn ethanol. And it has to, because that's the mandate of the renewable fuel standard.

You saw Stefan's slide. It has to do so many different kinds of fuel. But it seems to me -- and that's great -- as those other fuels come online we'll have time to refine them, make them better.

Corn ethanol is here and now. I urge that those in charge of setting standards for corn ethanol, let's do this one right and better than the others, because it's applicable now and will shape public policy.

And so finally, I would say this transparency issue. And we really do, we've seen the posting from the CARB, the low carbon fuel standard working group, on the GREET model. We can't find -- as Stefan says, it shows you how calculations are made. The science behind it is not clear. The justification for selection of inputs and how they work, it's not there.

In contrast, we've spent a lot of time in constructing the BESS software to insure it's all in there. And I just urge those making the final decisions here, don't do anything until you really have it to where someone that knows a lot about the science of the system, like me and my colleagues, we can go into whatever you're doing and see how you've done it. And be convinced that it's reasonable.

Finally, we haven't talked anything about the next step, which is going to be certification and compliance. And so something like the BESS software is what we think is going to be needed to actually have available and easily used by professionals that can be certified, that are trained to make these certifications.

And with that I only want to say that we've had funding support from a number of agencies. We'd love to get some money from oil companies; haven't got it yet. And we've published a lot of this. Most of what I've shown you is published.

Thank you very much.

(Applause.)

MR. PRABHU: Let's allow one question, and then we can break for lunch. I hope Ken is here for the afternoon so people can ask him one-on-one questions.

Anybody? Just one question.

MS. JENKINS: Hi, Robin Jenkins with duPont. I'm curious to know if you know some of the ways that these dry grind plants are reducing their process energy to such cutting edge levels. The 54 percent savings is quite higher than I've modeled, myself, taking into account a typical dry grind, or what I think a dry grind is doing now.

DR. CASSMAN: Yeah. Of course, we'd have to go talk to them, but the newer plants are recycling energy and heat. They're using much less water, which must somehow be linked to other processes.

And I think that the plants that have been built -- and I'm not an engineer, so I can't give you a good answer, but these are data we've obtained from the plants, themselves. In our case, a survey of seven ethanol plants.

We're now working with one of the very very large ethanol producers that has eight or nine plants across the country. We're working to get even more data.

But I think the important point that I would make, only is that the plants that were built before 2005 were built at a time when there was no substantial investment in the corn ethanol industry.

And so you weren't attracting the top engineers and engineering firms, and there wasn't much competition. There was only one or two people out there doing it.

And I think since then what's happened is you've unleashed this incredible amount of creative energy and competition among major engineering firms. And so the plants that have been built since 2005, at a time when there's a tremendous amount of capital, capital at risk, those plants have been built with much better technology than the older fleet.

MR. PRABHU: Let's thank all our speakers again.

(Applause.)

MR. PRABHU: I guess this is from Martha. Martha, do you have any specifics for the break now?

MS. GILDART: One hour, if we can be back in the room at 1:45, so we have plenty of time for the panels in the afternoon. That's all.

MR. PRABHU: We meet back at 1:45 after lunch.

(Whereupon, the morning session of the Joint Forum was adjourned, to reconvene at 1:45 p.m., this same day.)

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AFTERNOON SESSION

1:59 p.m.

MR. COURTIS: I apologize that we had to cut short your lunch, but we are a bit late in time, and we have a very interesting panel of speakers. And we're going to try to continue the discussion on the lifecycle analysis part.

In the morning we had the first part of lifecycle analysis or lifecycle assessment component where you heard discussions about models that are out there. And the models can be used to do a detailed lifecycle analysis, take into consideration both energy issues, agricultural issues and issues associated with inputs and the processes that they use to produce different types of results.

We have a very exciting panel in the afternoon. And we're going to continue discussions on the more or less expansion of the discussion on the lifecycle analysis issues.

The first speaker in the afternoon is Jean Francois Larive. He is the CONCAWE Technical Coordinator, in charge of refinery technology and modeling for alternative fuels, oil pipelines and communications.

Francois is the CONCAWE focal point for the Joint European Well-to-Wheel Study and one of its principal authors. He is involved in all the CONCAWE activities on energy supply, refinery infrastructure issues, alternative energies and fuels.

He coordinates the CONCAWE work in relation with refineries issues, and the technical committee on biofuels certification, which was just formed by SEN, the European standardization body.

He was one of the advisors for the development of the greenhouse gas calculation methodology for the European community, for the U.K., renewable transport fuel standards, and is a member of the RSV expert panel on greenhouse gas lifecycle analysis.

Francois is a chemical engineer by training, and has been with Shell since 1974, where he held various positions in catalyst research and development, refinery technology, as well as economics, and scheduling in Europe, Far East and the Middle East.

Please join me in welcoming Jean Francois Larive.

(Applause.)

MR. LARIVE: Thank you very much. Good afternoon -- after lunch, but I have to talk to you about lifecycle analysis, so it's bound to keep you on your toes.

(Applause.)

MR. LARIVE: Anyway, I'll try to -- I won't bore you with any numbers or anything like this, but what I thought I would do is give you some thoughts, really, that have, you know, been born out of what we've been working on for quite a few years now on well-to-wheel analysis.

And really what is, I think, the important issues are in this sort of work, what has to be considered.

Before I do that, I'll just give you very briefly a sort of general view of what is going on in Europe on the LCA, the fuels LCA scene.

And I'll try to also sort of make a difference between why we do LCAs; we do LCAs for sort of looking in the future, or do we do it for regulatory purposes, which is what is slowly happening in Europe, and which will probably be happening also here pretty soon.

So, this year -- in Europe, a bit of historical background. It started, you know, there was some origin. There was interest in biofuels, of course, and other alternatives such CNG, in the late '90s. Wanted to understand the impact, et cetera, so I think everybody was driven by the same things.

Early work, I'm afraid I'm not mentioning on this Axel Friedrich early work in 1991, but you've heard about this yesterday. There was quite a bit of work done in various institute and academia, but mostly in Germany and Scandinavia, originally.

Some studies sponsored by governments, particularly in France, and in the U.K. to an extent. And most of these studies had limited scope. They were looking at one particular pathway or a limited number of alternatives.

The GM study that's -- first there was a GM study here that you probably have heard of, that was done a couple of years before. And the European GM study was pioneering in the sense that it was quite well-framed and wide-ranging.

And the study I've been involved in, that's what we call the JEC study for the JRCs, the -- Center of the European Commission. UCAR is the kind of technical arm of the European auto industry. Collaborative work and CONCAWE's the site for the oil industry.

We started working in the early 2000, and actually built on the GM study. We published our first version of the study in December 2003. And we tried to cover as much as we could. I'll cover a few slides on this in a few minutes.

Of course, I don't know whether people in Europe working on this, in Germany, the U.K., Holland, but again most of these are, they are looking at a limited number of pathways.

So, just a bit more detail on the JC study. I mentioned the three partners. We concentrated, and we still concentrate, on energy, greenhouse gases. We look at what we call viability of each fuel pathway, for lack of a better word. It's a bit of a mixture of, you know, how much we believe that such fuel could be produced; and to what extent it is practical.

And we did a little bit of cost analysis, certainly not the definition of cost analysis, but we tried to look at macro-economy costs. We're still working on it. We are working on version three at the moment, and we are committed to completion of version four in two or three years from now. It's used as reference by many people in the EU, partly because it has the bearing to exist, I believe.

I think I saw this morning something that looked suspiciously like this slide. I can assure you that this is the original.

(Laughter.)

MR. LARIVE: But I don't have a copyright on it, so that's fine. It's just to illustrate that we tried to be as comprehensive as we possibly could. One thing we haven't looked at, at least not in so many words, are battery electric vehicles. It's mostly because when we started battery electric vehicles were a bit of out of fashion. I think we will have to include them at a certain point.

Okay, so really the bulk of what I wanted to talk about is this, is what I think is relevant, is important to talk about when we look at lifecycle analysis for fuels.

I think the first one is really why are we doing this. Why are we doing this. Are we doing a particular academic study; are we doing a study that is going to be for corporate management guidance, or for government guidance. Or are we going to do something that is going to be used in support of binding legislation, i.e., that is going to actually cost people, cost money or represents money at a certain point.

And I think we have to keep that in mind; it's very important. Because what you have to put in, the sort of level of detail and complexity and transparency that you have to put in there can be quite different depending on what your actual objective is.

Scope. I think yes, it's completeness versus practicality and relevance, or materiality, if you want. There are a lot of things, and we've seen this morning several slides looking, trying to capture all the bits and pieces that you have to put in an LCA.

And you can easily get lost into details and spend a lot of time on certain things that, at the end of the day, are not particularly relevant. So I think it's important to be very early on aware of what the big ticket items are. In the -- or the uncertainties that are associated to the various parts.

We all know that N2O emissions can both contribute quite a lot to a lifecycle analysis of biofuels. But also that they are extremely uncertain. There are many reasons why they are uncertain. We could talk about this for the whole afternoon.

But, you know, if, depending what you're looking at and what sorts of data you have, they can be plus or minus 100 percent, plus or minus 200 percent. Or even sometimes with -- ranges.

So if you know that already, what's the point of spending a lot of time trying to figure out whether the transport that you take into account by truck should be 50 kilometers or 70 kilometers. It doesn't matter at all. So you don't have to, you know, spend a lot of time on that.

So, things like what I call minor agricultural inputs for biofuels like seeds, herbicides, et cetera. Okay, you have to put them in to be complete. But usually they are not that important.

Transport bits are not that important, even fairly long transport, maritime transport. But if you look at Eurotransporting, bringing in ethanol from Brazil to Europe, it's fairly minor. It's fairly minor. And this is not going to make or break your pathway.

Often the issue of the energy and the emissions embedded into the plant and -- et cetera, comes back. We have tried, we have looked at that on certain examples and every time we look at it, we can't make it count for more than 1, 2, 3 percent.

And somebody mentioned that in the context of fossil fuels, this oil, this morning. It's a site for oil. Of course, there is a lot of infrastructure for oil, but there is also a lot of megajoules coming out of that. And when you make a balance, really, it's not very important.

It's more important for vehicles. It can be more relevant for vehicles because simply the balance is slightly different. And you can go for vehicles, you can go to 10, maybe 15 percent. And also for vehicles there can be quite large differences between the types of vehicles. Whereas for fuels usually the order of magnitude tends to be the same for -- not only, it's not much, but it tends to be the same order of magnitude for pathways.

So, what impacts are to be covered. Energy, I think everybody looks at energy. Fossil energy, certainly, which addresses really the issue of how much fossil fuels are you actually saving.

We have also included in our analysis what we call total energy. We try to include in that the energy that is embedded in the biomass that we use. And a lot of people say, well, it's irrelevant, et cetera. But it's irrelevant, yes, in a way, but it's an indication of how efficiently you use actually the results.

And biomass is a finite resource, like every other resource. And we think it's an important measure. It doesn't replace the other one, it's complementary. But it's an important metric.

Greenhouse gases, obviously, maybe the question is which gas should you include. But obviously everybody looks at this.

Air pollutant, yes, but again in our view that's interesting, but this is, you know, the greenhouse gases and energy are universal things. They are global. So you can add CO2 being emitted here and CO2 being emitted there, and N_2O multiplied by something, and it makes sense.

Can you add particulate matters emitted somewhere in Brazil, plus particulate matter included, emitted somewhere on a ship, and particulate matter included emitted by a truck on the road in the United States, I think it doesn't make sense.

So, it can be interesting to maybe inventory, but what you do with inventory is another matter. Of course, there is also the issue that is dear to Mark Delucchi, I know, of the impact of -- on climate, which is very true issue. That we haven't taken into account, and I don't think many people have taken into account, being it is so difficult.

Okay, water sustainabilities, -- issues, this is the subject of this meeting. It is difficult to turn into numbers. And I think this is one of the challenges of all the sustainability criteria. How on earth do you turn this into numbers, into something that's measurable that people can judge.

The costs, yes, costs, everybody's interested also. But you have to ask yourself which costs, and the cost to whom. What is the -- what we have done in our cost analysis, we've said, well, we are looking at the cost to Europe, to EU, Inc. So kind of macroeconomic cost to Europe. That's a choice, that's a choice. Not the cost to a particular operator.

Geographical envelope; that's also important. Again, it's a compromise, because you want your analysis to be widely applicable and widely relevant. But by doing that you are almost certainly going to do some simplification, some averaging of reality.

This is particularly true, as we all know, I think, for agricultural parameters. These are very very local, yeah, almost to the level of the field, yeah.

And the same even can apply to how you treat for fossil fuels, natural gas, coal, et cetera, oil resources. They are different in terms of availability, et cetera, from one continent or one region to the other.

It's less problematic generally with the actual processes because these tend to be more kind of universal, yeah.

Timeframe, somebody talked about this

briefly this morning. Yes, it is an issue. You have to ask yourself how far ahead are you looking into; you want to have something which is sufficiently sort of representative of what is going to be, rather than the past. And I completely agree with the previous speaker on this.

The difficulty is how do you project yourself into the future. A lot of people love using learning curves. I don't like them because it is a kind of, you are sort of transposing past wisdom into the future; in fact, you don't know.

So what we try to do is try to use the best available data today. And data that, you know, might be half proven to be plausible in five or ten years. If you go much beyond ten years I think you are in the realm of science fiction.

You are anyway, I mean --

(Laughter.)

MR. LARIVE: Okay. The reference systems, yes, we all know this is essential. So for agriculture it's, the question is what would have been grown here if I hadn't done the biofuels.

For fossil fuels like natural gas or

coal, one important question is to ask yourself, if you say, you know, I'm going to put CNG in cars, the fact that I put CNG in cars, will that cause more natural gas to be produced in the world. Or will that simply cause the Chinese to build one or two more coal-powered plants rather than gas-powered plants. And that's a question that you cannot necessarily answer, but maybe you should look at both possibilities.

For the whole analysis, I think it's important also to realize that in all these things we don't start from a clean sheet of paper. We start from a basecase. And whether we like it or not, the basecase is fossil fuels. That's where we are, that's where we start from.

And in most cases we are considering scenarios where we anticipate or want to model a move from 100 percent fossil fuels to 90 percent fossil fuels, or 80 percent fossil fuel. So it's a kind of migration path. It's a migration path.

And therefore, when you look at the reference you should look at the reference in the sense that what will happen to my existing infrastructure if I introduce 20 percent of something else, rather than looking at averages.

And maybe I'll come back to that in a minute.

So the level of penetration also that you are anticipating, that you're trying to model, is also important.

So, what we try to say in all this, you should really look at a differential approach. What are the impact of the changes on the business-as-usual case. And you must have a business-as-usual case.

Byproducts. We all love this. So, how should these outputs, these other outputs, these bio-coproducts, and there are various definitions of it. How could that be allocated.

There are allocations -- so-called allocation methods by mass, by energy, by price, et cetera, which are really trying to split the cost between the various products.

A lot of people like them because they are straightforward. Fortunately there is no logical, this is accounting, this is not science. And so the results are transparent, but they are arbitrary. So there is a kind of a bit of a tradeoff there.

I think most people would say yes, substitution or system expansion is better. It seeks, in fact, to identify the benefits of coproducts, and then credit them to the desired main product.

So, it is trying to kind of simulate real life. So it must be better. But there are a lot of problems. What is the appropriate substitution scenarios. Usually there is no single answer. There are all sorts of possibilities. And the limit is your own imagination.

It may depend on region or special circumstances, et cetera. So what do you include, what do you not include. How far should you go, because substitution of something brings another substitution afterwards, so there's kind of domino effect there. And sometimes iteration loops. How far do you go. That's also a question.

And then there is this gearing effect. And I'll try to illustrate this with a simple ethanol plant. Cereal in, ethanol out, DDGS say to animal feed. And you have to provide power to this with say a natural gas power plant, and you get some surplus power to the grid.

So, you get the credit for the DDGS, fair enough, okay, substitution -- how to do it.

And you also get a credit for the surplus power if the surplus power that you make has a lower footprint than the outreach or the marginal, rather the marginal power from the grid. So that's all right.

However, if you build a bigger power plant you have a bigger surplus and you get a bigger credit. So the ethanol becomes better. You haven't done anything to it, but it becomes better.

So, that's the real problem. The way we have tried to solve it is by saying, ah, you can't claim any credit beyond the real needs of the plant which are expressed in heat. So, you need so much heat for the plant and you make electricity, and the surplus electricity that corresponds to that heat is what you get credit for. It's not as simple as that, but it's the principle.

Another thing is that you can say also, well, right, but is this credit even deserved as such as far as the ethanol is concerned, because somebody could have used the same natural gas and made electricity with it.

So, one way of dealing with it is to say well, you only give a credit for the fact that the ethanol plant has allowed you to take advantage of CHP. That's what we did in our study. I'm not saying that you should do that necessarily in all cases, but we thought it was a fair way of representing really what belongs to the biofuel.

Another thing, the impact of the selected method in substitution. You see this is from some of our data, 2005 data on one side, 2008 data on the other side.

You see the difference between animal feed and used as fuel for DDGS. On our previous data there was quite a big difference. Now both bars are lower, so we have more up-to-date data. But the difference is very small.

It's simply because we have decided that the marginal substitution which is soybean, some soymeal, has changed from the U.S. to Brazil. So you see the impact that that can have. And I'm not saying one is better than the other, but it depends very much on your assumptions.

Other thing here, the impact of the chosen method. So do you do allocation substitution, et cetera. Here you have the difference here. And you see that the differences in this case are not that big.

But what the allocation does, it tends to compress the differences because the coproducts then takes a proportional share rather than a fixed credit.

I have to go fast. One thing that is important here, you see that if you put, depending on the substitution or allocation, you can get uncertainty ranges which are completely different. And, of course, in substitution you get a very big one here because you've got the N2O emissions. And depending on what you base your N2O emissions on, this is IPCC, yeah, you get something that is a bit funny.

Okay, I'll probably just pass on this quickly. I just want to see the -- on the refinery. The important thing to realize on the refinery is that you cannot decide how much energy or greenhouse gas is associated with a gallon of gasoline. It is a false question.

It all depends on the scenario that you're looking at. And that's one of my criticisms of not GREET, but on the data that's on GREET. And that's everybody uses. These data are fixed. They assume that the refining system is a fixed system. It is a dynamic system.

Depending on what basecase you look at, and what end case you look at, your answer will be different. And this is something that we have done in a study that shows that the footprint of marginal gasoline in Europe can vary tremendously. It can even become negative if you reduce gasoline production in Europe too far, while keeping diesel production constant. You end up by using more energy with less gasoline. Because of the structure.

I don't have time to talk about land use. I'll just leave you with this one. The regulatory framework. When you have to go into a regulatory framework you need to try to be more practical, probably more simple.

So, your coproduct accounting, for instance, substitution can be done, but in some cases maybe allocation methods are acceptable.

I talked this morning about the use of default values. It's a practical way of putting a system on the rails.

And last thing is that this has all to do to go with a chain of custody system. And the chain of custody system is also to be thought about very carefully to make it both practical and reasonably economic.

So, how to find the best compromise between credibility, complexity and realism.

Sorry, Mr. Chairman, I was a bit too long.

(Applause.)

MR. COURTIS: Thanks very much for the excellent presentation of -- European approach into the lifecycle analysis. Thank you.

Our next -- maybe we'll have questions at the end of the session. I would like, also, to remind the speakers from the morning session, also the speakers from the afternoon session that we would appreciate if they -- would appreciate it if they are available so at the last session we plan, as it is scheduled, to have a moderated discussion of all the items that we discussed throughout the day on the lifecycle analysis.

So, we would like the speakers to join up front in a discussion about the issues that were discussed here today and answer questions possibly.

Our next speak is Sabrina Spatari. Sabrina is currently a post-doc research scholar with the Energy Resources Group at the University of California Berkeley. Her research concentrates on development and application of systems analysis methods for guiding decisionmaking. And currently she's applying these methods to study the biofuel production technologies.

She completed her PhD in civil engineering at the University of Toronto, in the area of sustainable transportation infrastructure, and obtained her masters degree in chemical engineering from the University of Michigan at Ann Arbor, where she worked at the Center for Sustainable Systems.

She has been actively involved in lifecycle analysis and FI research for more than ten years, and has worked in the -- demand consultant.

Sabrina, she's going to speak about lifecycle analysis of bioenergy and biomaterials. And please join me in welcome Sabrina.

(Applause.)

DR. SPATARI: Thank you very much. In fact, I am not talking so much about biomaterials because we didn't have time to change the program. I'm going to, instead, talk more about technological climate change and sustainability aspects of I say transportation fuels because, as we learned yesterday from Dan Kammen's talk, the transportation fuel supply is going to increasingly become more on the dirty side with the emergence of Albertan oil sands, for example, and coal-to-liquids technologies. And we have to think about technological climate change and sustainability aspects about those technologies, as well.

But today I'm going to focus on ethanol. And why ethanol. Ethanol, well, there is a vehicle stock on the market in North America that can run on 85 percent-by-volume of ethanol.

Today it's produced largely from corn grain using a starch-based technology and the coproducts are very important in insuring production economics.

And just last year the U.S. produced 7.8 billion gallons. This is hardly news with all of the talk of corn technology and all of the agronomists in the room.

But just a few statistics. This only represents 2 percent of energy in transportation roughly today. There are limits to the expansion of corn-based ethanol that even the corn growers association is willing to admit to. They project between 15 to 18 billion gallons before food prices are disrupted. And then there could be some other problems and issues that we might want to think about.

And then there are policy initiatives here in the U.S. to encourage biofuels. And beginning in 2022 this is going to move towards cellulosic second generation biofuels, which is going to be the focus of the work I'm going to talk about today.

Here in California you have a low carbon fuel standard, and this should potentially we see biofuels as a potential way of reducing the carbon intensity of fuels.

So when you look at the energy and environmental aspects of ethanol, this has, in fact, been the dominant thing studied in the literature. One of the most widely cited studies was the study from UC Berkeley in 2006 in Science, where they showed a significant reduction in petroleum use. So this is really energy security, addressing energy security.

And this is whether you're considering

corn ethanol or cellulosic ethanol, across most studies this thing holds. So you're addressing energy security, reduction in petroleum use, but only a moderate reduction in total fossil energy, and some also greenhouse gases from that study.

And then, you know, Searchinger, earlier this year, put into question the indirect land use effect. And so there's a big question mark or error bar -- question mark about how big that error bar is, related to corn ethanol.

And I know that the people at Berkeley in the department I'm working in are actively looking at this question using advanced economic models.

So, and then some work by Grooden Heywood at MIT; they call into question the potential reduction in greenhouse gases associated with corn due to coproduct allocation, because there are some different ways of allocating the coproducts.

Back to the paper in Science, they concluded that lignocellulosic, only lignocellulosic, ethanol offers large reductions in fossil energy and greenhouse gases, as well as large production volume.

They would probably preface that now to say, let's consider a subset of feedstocks that would qualify for sure. Definitely waste sources, agricultural residues.

So, now turning to the LCA literature on lignocellulosic ethanol, probably the most comprehensive that I've seen while I was studying this, was that by Sheehan at NREL where they looked at very, a comprehensive study of corn stover-based ethanol in the State of Iowa.

I developed a model using the same technology as Sheehan for Ontario, looking at switchgrass and corn stover, so this is a different climate, more northern climate, different yields. But really basically the same technology.

And when you move to other models that are out there, for example GREET, similar lots and lots of feedstocks, lots and lots of evaluation of fuel pathways. Really one technology is considered for conversion to the fuel.

So, some of the research gaps that I'm going to discuss today are that there are many many technologies emerging in labs at pilot scale for making second generation biofuels. And there's definitely variation in technological, as well as sustainability performance. And then the third aspect is uncertainty. So these are the three things I'm going to focus on as the talk progresses.

So, I've said earlier that one of the most largely studied aspect in LCA has been greenhouse gas accounting. But there is a burgeoning literature on other sustainability aspects.

And this figure here comes from work by researchers at UIC who look at, they compare greenhouse gas impacts, the global warming intensity of a variety of biobased products and fuels against eutrophication potentials. So this is the result of starving lakes of oxygen because of nitrogen runoff.

So on the Y axis you have a comparison of relative to gasoline, global warming potential per megajoule of fuel or product. And on the X axis you have eutrophication potential; it's measured in grams of NO3O per megajoule.

So, the more sustainable technology or products are closer to the origin. I'm going to focus on the circled product, which is corn-based ethanol.

In this figure they show that there's a moderate reduction in greenhouse gas emissions, while at the same time, quite a bit, a large eutrophication impact. So they're really comparing these two different metrics.

One of the things, of course, that they say that came up during this meeting yesterday, and this morning, is that that performance measure can certainly go down, decline along the X axis through measures like planting winter cover crops, corn-soybean rotations, and wetland buffers, just to name a few.

So, that's one sample from the literature that is really expanding beyond accounting for greenhouse gases.

Okay, so as part of a research paper I've been working on for the California Air Resources Board, through thinking about the low carbon fuel standard, we've been putting together, brainstorming some of the sustainability criteria that need to be considered for these low carbon fuels.

And this here I'm referring specifically to biofuels. And I've divided them among ecological and socioeconomic. If you look at this list, it's a pretty big list, and it really spans the social sciences and the sciences, if you want to really address the important issues in developing any kind of fuel system.

And, you know, we just pored over the literature from a variety of sources, from academia, NGOs, and government sources around the world that are considering the sustainability aspects related to fuels.

And it's important to note that thinking about these we need to consider them as direct, so along the fuel production chain, as well as indirect, so those market-mediated effects.

Just to give you a little bit of detail, we've talked about this a little bit. This figure shows the effects of indirect market-mediated effects. Within the box you have the direct related impacts. So corn is used for ethanol. Corn is planted instead of soybeans, so this sequence of events calls changes price dynamics. So soybean prices rise.

Potentially soybeans are planted on forest land. Maybe there is a displacement of forest dwellers. And there are so on and so forth effects. That's one possible sequence of outcomes through this market mediated effect.

In terms of determining the indirect land use component, people are using -- researchers are using general equilibrium models to estimate that. But this is really just the first step.

Then we have to quantify this very intangible sustainability measure. And many of them that I listed in the previous slide. So, back to this list of sustainability issues.

In addition we need to consider these from regional, national and global scales because they, in fact, operate on different levels depending on the sustainability risk.

So, I'm going to take an easy way out now, instead of -- I see, you can do it more than one way -- and talk about greenhouse gas emissions, what has been most studied by LCA modelers. And I'm going to give some more, a closeup case study of a second generation biofuel pathway.

So this figure here shows the different feedstocks and technology platforms for making bioenergy. We have agriculture and also forest.

I'm going to focus on the agricultural side, because this is closer, further along in technological development.

And I'm going to focus on the sugar platform route, specifically lignocellulosic ethanol. Looking at a couple of feedstocks and technologies that convert this feedstock to ethanol using enzymatic hydrolysis and fermentation. So using advanced biotechnology.

Just wanted to say that none of these technologies are at commercial scale, though we know that some are emerging at demonstration scale.

And before moving on I want to highlight a few key points, some of the key challenges for research and development in developing these types of advanced fuels. One of them, probably the most -- the largest of the challenges is overcoming the recalcitrance of the cellulosic feedstock.

There's some papers in Science last year that discussed some of the technological barriers to moving forward and research needs for advancing this technology. Mainly improving enzyme performance; improving the specific activity, for example, of the protein, the enzyme. And these would then reduce enzyme cost. And in addition to enzyme cost, we would want to reduce the treatment chemical costs. All of these together would improve yield and improve cost performance.

In spite of that, improvements in performance, there's still variation and uncertainty in any kind of model.

So this figure shows the LCA model that I'm going to describe. The first two boxes show the feedstock production and the ethanol conversion. These, together, comprise the fuel cycle. And then vehicle operation would make this a well-to-wheel model.

In any kind of model you would inventory all inputs and outputs, including fertilizers, herbicides, nutrients, enzymes and the energy associated with any operations like harvesting equipment.

I'm going to focus on two feedstocks, corn stover and switchgrass, and two technologies, although I looked at several others. Two pretreatment technologies, dilute acid and ammonia fiber explosion developed by Bruce Dale.

So this here is a very over-simplified diagram of what this ethanol conversion facility would look like. The feedstock is sent to a pretreatment system that releases the hemicellulose sugars and prepares this otherwise recalcitrant cellulose fiber for enzymatic hydrolysis.

All residual components of the feedstock are separated and sent to a boiler for energy recovery to produce the coproduct, electricity. And so you have the ethanol as the main product, the electricity as the coproduct.

In the near term it's likely that enzymes would be purchased from an outside facility, but in the longer term the vision is to incorporate this into production onsite, institute production. One possibility is through consolidated bioprocessing. And this is a technology under development by Leland at Dartmouth.

So, this is what you do with all of the uncertain input variables. You feed them, these random variables, into your material balance function; and you generate a set of stochastic results. This is the Monte Carlo simulation approach to estimating metrics.

So this figure shows my results from

this stochastic estimate. And so the results are shown over a 95 percent confidence interval, and interquartile range.

And what that tells you is that 50 percent -- you've got a 50 percent confidence that the, in this case, the metric the ethanol yield, lies within that range shown in the box.

This, in contrast to the point estimates shown above the 95 percent -- the box plot that I'm illustrating there, which were estimated using single-point estimates of a certain composition and an optimized yield.

You can do the same for greenhouse gas emissions. You can, you know, generate another metric through this model. And in this case I'm including electricity coproducts, an electricity coproduct credit, which is why you have negative greenhouse gas emissions per liter of fuel produced.

And so this figure really compares the two processes, comparing their efficiency; also including considering the performance of the electricity coproduct.

So what I'm going to do next is I'm going to take one of these point estimates and compare it to some literature.

So this figure here shows, this is only in the ethanol conversion stage, and it's an inventory of input chemicals and enzymes. The results shown to the far left are a few models that I put together, point estimates, again. And then the ones to the far right are, in fact, the EUCAR results from the CONCAWE report.

And notice how they're almost identical. That's because we used similar, the same sources for -- at least in the case of the NREL -- process, exactly the same data. So we get the same results.

I want to contrast this with the two very high estimates from this NR CAN estimate of either switchgrass or wood-derived ethanol via simultaneous saccharification and co-fermentation technology.

So the authors there assume a really -- or they had a really high estimate of greenhouse gas emissions associated with enzymes. And so it's kind of curious why such an outlier.

The reason behind that, if you look at their input variables, they assume an enzyme that's available on the market today which is not really the enzyme that would go into making cellulosic ethanol. It's really an enzyme that is used to treat the surface of fabrics.

And they also assume different greenhouse gas emissions per gram of enzyme. And so this is the rationale behind this very large answer.

So, the point I make here is that results really depend on input variable. That one result from NR-CAN took into account a really high enzyme loading that wouldn't necessarily be economic to run such a plant. And the point I'm making is that you get really different results depending on the input variables.

In the case of enzymes, they are a specialty product, only a few decades old. High in production costs, and the engineering behind developing those enzymes is still evolving.

So, the point is that there's a need for making plausible, probability distributions for all significant variables in an LCA. And it's important to update your results with new -- as new information comes in.

So the results I showed you were from Bruce Dale's studies from a few years ago. Maybe, you know, he's probably made a lot of advances. He's reduced the ammonia loadings since then, and has achieved better yield. So Basian techniques, in fact, become really useful for updating these kinds of models.

So now I'm going to come back to the sustainability metrics and think about putting out some questions on how do we go about evaluating sustainability.

And so this is just -- I let my imagination go wild, my own and my colleagues, who helped me work on this paper. So we threw out some options for estimating or evaluating sustainability.

One way would be to take a purely qualitative approach, looking at best practices. Yesterday, Steven Kaffka gave us a lot of examples of really improved agricultural techniques that would reduce water loading, would reduce overall fertilizer input. And these would have really good impacts on -- they would reduce ecological risks associated with the agricultural system. So that might be just a truly qualitative approach.

Another option might be to estimate some sort of scale or sustainability metric. Here you might -- so here you would take a more quantified approach. You would formalize a few set of important metrics and then quantify them. And maybe convert them all to one unit of measure, the S unit of measure.

For example, you could use the social benefit cost analysis approach. So you would convert, say, hectares of biodiversity loss in this system with some sort of transfer coefficient X to units of sustainability.

You could take a more normative approach using a ranking or ordering system whereby you use a biodiversity at one level and cultural diversity at another level. That would be another approach to measuring sustainability.

Another approach, the binary system evaluation approach. This is what Dan Kammen described yesterday as the zero tolerance approach. Maybe you say, this technology here or this feedstock is acceptable and that one is not.

Again, more of a decision, binary decision.

Another option might be to define a vector of mixed sustainability criteria, and you might take a more, sort of a public health approach and define threshold levels that are appropriate for each sustainability criteria.

And then the fifth one that I came up with were combinations of all of the above. Maybe take the best approaches for each.

As I come through this exhaustive list I realize sustainability is very -- it's difficult to define in many cases; it's hard to measure; it's going to be very hard to evaluate for fuels. And it's really important.

So, that's one of the challenges ahead when it comes to evaluating sustainable -- I wrote calculating sustainability, but, you know, maybe that's even the wrong word. It's the engineer in me wanting to formalize everything.

So, compare -- let's compare the treatment of uncertainty across sustainability criteria, relative to what I just described for, you know, scaler approaches or a vector of single-point estimates of sustainability.

You know, we, as scientists, like to have a 95 percent confidence interval before making a decision, because you can get radically different results, as I showed with the technology models.

But we're hardly close to estimating

uncertainty for sustainability, and it's really really important. So, what do we do. We sometimes have conflicting sustainability criteria in any given product or process or activity.

So I'm still thinking about this, and I ask the question, I throw it out there to you. Maybe a qualitative evaluation approach is really best for now. I was definitely encouraged to hear Steven Kaffka's presentation yesterday where he outlined irrigation, planting crops in -- saline-resistant crops, or crops that can take residual nutrients from the soil. I'm encouraged by those kinds of practices. And maybe they're the kinds of approaches that are necessary for making biofeedstocks, or a biorefinery future more sustainable.

So, that's it. Thank you for listening.

(Applause.)

MR. COURTIS: Thank you, Sabrina. Because I think we are running a little bit behind schedule, it might be a good idea to keep notes for your questions, and then we'll respond to questions at the end of the session. Appreciate that.

Our next speaker is Paul Wieringa. He's

going to give us a presentation and try to summarize the policy, energy policy and climate change approach that has been taken by British Columbia.

Paul is the Executive Director of the Alternative Energy Branch at the Ministry of Energy, Mines and Petroleum Resources.

He's responsible for energy efficiency and conservation, bioenergy and new technologies within the electricity and alternative energy, as the Executive Director with the British Columbia Ministry of Energy, Mines and Petroleum Resources.

Paul was part of a team that developed the 207 energy plan, a vision for clean energy -- particularly the oil and gas component of that. The activities of his branch include the responsibility for greenhouse gas mitigation for the oil and gas, mining and electricity sectors. The -- and low carbon fuels energy efficiency conservation programs, bioenergy and innovative clean energy technology policies and funding.

In 1990 Paul joined the Ministry of Energy, Mines and Petroleum Resources, and he has had various policy and managerial positions within the Ministry, and the Ministry of Finance and

Crown Agency Secretariat.

In 2002 he returned to the Ministry of Energy and Mines as Director of electricity policy and focused on developing and implementing the provinces 2002 energy plan.

Paul holds a master of economics from the University of Groningen at the Netherlands. Please join me in welcoming Paul.

(Applause.)

MR. WIERINGA: Well, thank you very much. This first slide sets out a little bit on the climate action target that the province has set out for itself. You'll see there that greenhouse gas emissions have been increasing for the last number of years. And the idea is to get a 33 percent reduction of 2007 levels.

And so you'll see that's a substantial reduction there. If you look at it as a business-as-usual case, it's almost about a 45 percent reduction. So it's a substantial reduction.

And government is trying to take a number of actions to reduce that, of which low carbon fuel standard and renewable fuel standard is one of them.

In 2007 set out an energy plan. I like

to characterize this as there's some things that we've really got to worry about when we're doing all this LCA work, and then there's some things that have already been decided. So we don't have to worry about that internally.

So, one of the things that's been decided within British Columbia is on electricity. If you do have a coal-fired plant you must carbon capture and sequester the CO_2 coming off of that. There's legislation that's being passed this week that will require that. So there's one of the things that if you do have a facility in British Columbia, we don't have to worry about the emissions from coal.

The second thing is if you're going to put any new fossil fuel generation in British Columbia right now, you have to offset all those emissions. So, again, in this LCA there's another thing that's been taken care of.

And for the existing, we've got about four plants right now that are out there, for the existing plants, they have to be all offset by the year 2016. So, again, past 2016 on the electricity side, and this LCA work, that's sort of been decided.

So in the accounting -- I was going to say modeling, but I'm just catching myself -- in the accounting that makes it fairly easy.

On the upstream oil and gas side in this plan there's a requirement to reduce flaring. In five years 50 percent of routine flaring has to be eliminated; within ten years all routine flaring. And so there's just been some guidelines put out, and we estimate that those will result in about a 43 percent reduction.

This is somewhat of a busy slide, and I hope you can see most of this. And I put it up based on what Axel was telling us yesterday at lunch. Where he was basically saying, why are you worrying about this 2 or 3 percent in fuel; why aren't you worrying about trying to reduce the resistance of tires.

And so you'll see on this, we're doing a whole suite of things in all sectors to reduce greenhouse gas emissions. It's everything from on the waste side, we've got legislation in place right now that you'll have to do something with that landfill gas, capture it. You either have to flare it, or you have to generate electricity with it.

Agriculture. You'll see there's quite a bit of anaerobic digesters, improved fertilizer application, bioenergy. There's a whole suite of things there. And then also something on the fossil fuel side, cap-and-trade. I'll get into that a little later because I think when we're doing some of our LCA work we're going to have to link in what's happening in some of these other sectors.

As of July 1 we're also putting in a carbon tax in place. And so the carbon tax is $10 a ton. And it goes up $5 every year thereafter. I calculated this in cents-per-liter, so it's about 2.4 cents. So the international audience will understand that. I think it's around 7 or 8 cents per U.S. gallon. Whatever it is, just multiply by 3.6, and that's what you get in your U.S. gallon.

So you'll see prices will start to move up as a result of this. It's trying to introduce it gradually. The diesel one is slightly higher. And for natural gas, as well. So you're seeing about, the way prices are in British Columbia right now, this is about a 2 to 3 percent increase on gasoline. And it keeps moving up to about a 5 to 6 percent increase.

On natural gas it's starting off at about a 5 percent increase, and will move up to almost 15 percent. So, it's -- and on coal, coal prices, a long-term contract is hovering right now around $70. Spot market sometimes you'll see around 300. But you see it's going up substantially.

The nice thing is our income taxes are being reduced, by the way, and so are our corporate capital taxes. So this is a true tax-shifting measure.

As I mentioned there are some of these linkages that we're going to have to deal with, so we've got this western climate initiative. It was launched in 2007. We're anticipating that some of this work is supposed to be done, I've got on here August 2008. That might be a little bit optimistic, but I think on some of the things that we're going to see are going to have an impact, certainly on the biofuels and biomass.

This reads as a who's who and who produces greenhouse gas emissions in British Columbia. And it reads as a who's who of who's in the oil and gas industry. Someone was telling me you could move a little cursor around here; I'm not sure how that works.

But you'll see up in the Fort Nelson and Fort St. John area, that is where most of our natural gas comes from; 75 percent of our natural gas is exported.

The other ones that you see there, that reads as a who's who of who's in the pulp and paper industry. If you look at that, and that's where most of the biomass is now being consumed. We are now starting to see natural gas consumption reduced dramatically at all these pulp and paper mills. And they are using biomass instead.

And that biomass is used primarily in generating electricity. And so it will compete quite heavily with anything on the biofuels side.

On gasoline. We're seeing our gasoline consumption is fairly constant on a per-capita basis. It is not moving. And we are also seeing in the urban areas it is quite a bit less than in the rural areas, primarily because of forestry, mining and oil and gas activity. That tends to occur in the rural areas.

And so, again, when we're looking at this lifecycle analysis, we're starting to estimate that we're not going to see much in the way of increase, perhaps even a decrease on a per-capita basis.

The same thing for diesel. Diesel is also fairly constant. And, again, even though we're seeing more activity in the oil and gas side, it's almost being offset in the forestry side.

You heard earlier this morning that Canada is coming out with some standards for renewable fuels and British Columbia we have the same thing for gasoline. We're going to have a 5 percent renewable content by 2010. We estimate that that's around 243 million liters that's going to have to be required. Most of that we anticipate is going to be imported in the short term.

We're also doing the same thing on diesel and we're running ahead of where Canada's going on that. Canada has 2 percent by 2012. We're going to require 5 percent by 2010.

And just to put this into some of the difficulties we're going to face, up in the more northern areas where it gets down to minus -40 degrees, it's more difficult to put in, say, 5 percent biodiesel.

There are some tests that are occurring right now where 2 percent is still feasible. And it's working at minus -40 degrees. So this is going to be an average throughout the province of 5 percent. We're anticipating that they're going to have a much higher percentage in the southern areas of the province.

On low carbon fuel standard we signed an MOU, along with the Province of Ontario, with California we'd follow what they're doing. However, there are some differences.

Our major difference is probably our starting point. We use most primarily gasoline and diesel that comes from Alberta, but 75 percent of our consumption is imported. Most of that is coming from synthetic crude, and most of it's coming from oil sands.

So our pathway -- our starting point is going to be quite a bit different. We're thinking of using 2010 as our starting point rather than 2006/2007. And part of that is to insure that that 5 percent of ethanol and 5 percent of biodiesel is included in our starting point.

We may use something different in the

way of pathway model. The same thing on our credits and on our resources. Resources, we are primarily hydroelectric. About 90 percent of our electricity is derived from hydroelectricity. And biomass, and some small amounts of natural gas. Our starting point is going to be quite a bit different.

The same thing on natural gas. We have an awful lot of natural gas. We export about 75 percent of it. We've got less in the way of transportation losses and things like that coming down. So in that calculation we're probably going to have some differences with California.

And then on renewables, as I mentioned, we have an awful lot of biomass. And we also have, up in the northeastern part, primarily wheat that's grown. And that wheat could be a candidate for ethanol.

We are competing, however, with other jurisdictions that have production incentives. So we are seeing that there is, from a farmer's perspective, some incentive to move that grain elsewhere and have it converted into ethanol, and imported back into British Columbia as ethanol.

So those are some of our challenges that we're facing on that.

We're doing the same thing as California, having an average fuel carbon intensity. We're looking at default values. We have legislation in place that has basically three categories. We'll use an average one for fuel. You can also do it by component. Or you can supply us with information on what your actual value is.

Our point of regulation is going to be at the wholesale market. And that's primarily because that's where we also happen to collect our taxes. And so, from an accounting perspective, it's a fairly easy thing to do that.

On compliance we're using primarily economic instruments. And for our renewable fuels and for the low carbon fuel. On the renewable fuel it's just going to be you give us a report at the end of the year. If you're out of compliance you tell us how many liters. You multiply that by what the compliance penalty will be and send us a check.

So it's a fairly easy thing to do. It's somewhat like your income taxes. You calculate your income tax; what do you owe; you pay. We're thinking right now of having somewhere between 20 and 30 cents per liter as our compliance fee.

On these lifecycle stages you've probably seen some of this. We're going to be doing somewhat similar, looking at all the inputs, looking at what's happening in the system boundary, and then what the outputs are. So I won't deal with that, you've probably seen it enough times.

On the analytical tools you've heard an awful lot about GREET. We've also got something in Canada that's called GHGenius. There are a lot of similarities. It uses some of the same seed code. The nice thing about it, though, is it has an awful lot of specific factors that are specific to Canada.

So this gives you some background on this. Since I'm trying to catch up on some time here, I'll go through this quickly here.

You'll see all kinds of results can be done. And I'll just move through this. There are a lot of new pathways that have been introduced in this GHGenius. There's a lot of documentation associated with it.

Little bit on the scope here. And as I

mentioned, some of this has already been dealt with nicely for me because of other policy decisions that have been made. I think we're still going to have to do an awful lot of work around some of the land use changes and some of the stuff around feedstock and fertilizer.

The manufacturing one, I think that we're seeing so many new plants coming onstream with new characteristics, a lot of that's all going to have to be updated.

The other nice thing about this, though, is that it uses an awful lot of fairly standard sources. So we're using statistics Canada data, industry reports. And major industries have already been reporting on what their greenhouse gas emissions have been. So we can use that data and use it quite nicely in our evaluation, as well.

And then, as I mentioned, most of the ethanol and probably biodiesel, in the first years are going to be coming from outside of British Columbia. It's also nice ways of using some of those existing studies that are out there.

When it comes to data, it uses public data. We tend to have a preference for that. And even though it uses industry averages rather than plant-specific data, it can be tailored to use some of that plant-specific data in the future.

And it's a dynamic model in the sense that it is iterative, and it tries to solve those circular references. And it uses common units.

There's been a lot of talk about do you just do backtracking, or do you also look into the future. And when you start looking into the future you make some estimates. So this one, it will go to 2050, and the farther out that you get I like the term here, science fiction. I was at least happy that you used the word science, rather than just pure fiction.

(Laughter.)

MR. WIERINGA: Although I have been getting lots of complaints about it just being pure fiction. So it does do some of that. And it also takes into account some of the forecasts that people are using.

So the National Energy Board, which is our main regulator of the upstream oil and gas sector, similar to FERC, it does a forecast. So it will plug in those forecasts into the model, as ell. So it's probably a little more science than just pure fiction, although we had a lot of debates with our colleagues at the national level as to actually what's going to happen on the national level.

As well, the results are calculated at each stage of that life cycle. And it can also calculate what's happening not only in Canada, but the U.S., Mexico, and then also some of the areas in North America, as well.

And the nice thing is we are hoping that it will analyze some of our provincial pathways, as well. We're trying to do some thing with our colleagues in Ontario so that we don't have to reinvent the wheel.

I think I heard numerous times, now that we've got one accounting tool, wouldn't it be nice if they were all linked and all used in the same way.

So, the GHGenius is quite large. It's got about 200,000 cells. It's free, it's downloadable, all those wonderful things. So in comparison with all the other models here, it's got probably more pathways. And for us the nice thing is it's got Canadian data that we can use and that we can link into it. So that's somewhat important to us. And it's fairly easy to make some changes to pathways.

You see on the top line there, everything looks like a nail, dot, dot, dot. So I think one of our concerns is that whatever accounting that we use, and whatever model that we use, that's all it is. It's a way of accounting.

And I think you've heard today there's ways of shifting numbers around. And I'm an economist by training, and for me it's dollars talk. And most people are concerned, are they paying or are they getting money out of this. That seems to be the major emphasis. Everybody in industry that comes to talk to me, that's the first thing that they want to talk about.

As well, this is a tool, it doesn't give us all the answers yet. What it often does, though, it gives us some information that can inform us on what we would like to look.

So, not only on where those dollars are moving, but it might give us some indication what kind of policy tools we should put in place to change some things.

I thought I'd just deal with a few things that are of issue to us in British

Columbia. You've seen an awful lot about the oil sands. Most of the crude that we're getting is coming from that.

The thing that we have noticed, however, is that the carbon intensity is declining in oil sands. In other words, they are coming up with new technology that is reducing the greenhouse gas amount per unit of crude.

The other thing that I think we're really wrestling with is when we come out with default values are we going to use maximum, minimum, average or mean. And we've got a real internal debate around that. And it depends on which side you're on. In this accounting, where do you want to be.

And then on the electricity stack I mentioned what we've got here in British Columbia. We're going to be down at net zero. Our concern is that when we're looking at some of the biofuels coming into the province, are we going to be using similar processes that are used in California. Are you going to use a supply stack or marginal one. And we haven't wrestled on that one.

Part of that is also with WCI. We're going to be calculating emissions from electricity that's going to be imported into the province and exported. And we'd like to have some kind of consistency on how we're going to deal with that.

Other thing is we would like to see more renewables grown in British Columbia and used. Right now, up in the northeastern part of British Columbia there's only a population of 65,000 people living up there. It's primarily oil and gas, some forestry and agriculture; an awful lot of agriculture up there.

But 30 percent of the land up in the northeastern part, which is plains, is fallow right now. Prices have been too low over the last number of years for farmers to grow anything. Canola is seen as somewhat of a bright spot for most of our farmers. And so they're quite anxious to grow more canola.

Again, we haven't got any processing facilities, so we're seeing some of this canola may end up leaving the province.

On the forestry side we're seeing a bit of a downturn in the forestry sector. And so there is less biomass that is being taken out of the forest and brought to mills right now. There's a lot that's being left.

Some of that could be utilized. I think some of the folks here probably know that we've got something called mountain pine beetle. It is devastating the forests and most of the interior of British Columbia. About 80 percent of the lodgepole pine is going to be infected and it will die. And it will have very little use.

Right now most of the people that have those licenses to cut that, they're very interested in using this for electric generation. Electric generation is nice; you usually have a 15- to 20-year contract. There's a lot of certainty.

On the biofuels side nobody's giving you a 15- or 20-year contract. I think we heard this morning if you can get a six-month future that's really great.

The other thing is on productivity gains on land utilization. We have right now, we're working on a policy to have a no-net-zero deforestation. In other words, if you have land that is being forested you can't take it out without replacing it somewhere else.

And we're looking at more on the basis of the amount of biomass per hectare. So we know on the coastal areas there is more biomass per hectare that's grown than, say, way up close to where the treeline is.

So if you cut a hectare up close to the treeline you will not necessarily have to replace one hectare in the southern area. But if it's the other way around you have to replace much more.

And then there's much talk about the relationship between food and fuel, but we're also trying to figure out should we be taking into some account the relationship of fuel and its impact on food.

So we know that the more fuel that we use it will have an impact on food. So that's one of the internal debates that we're having, as well.

And then a lot of it is around this fuel grade versus food grade. Much of what we're seeing up in the province, the ethanol that would be produced would not be food grade as a source of the biomass, either if it's wheat, or if it's canola, or if it's some of the forestry.

So, we're very much interested in cellulosic ethanol, second generation. And then also using that waste products that we've got.

We've got three producers that are very much interested in using some of the waste primarily around tallow to make biodiesel out of that.

And that's -- I was trying to catch up with five minutes here. So that ends it.

On this lifecycle analysis, we're at the starting point in many cases of what you're doing. We're trying to take some of the best points of what other jurisdictions are doing.

On the biomass one, on the forestry side, I think we're fairly well developed on that side. We're starting more around the ethanol and the oil seeds.

Thank you.

(Applause.)

MR. COURTIS: Thanks. That was a great presentation, a great overview of the programs.

Our next speaker is -- he's going to talk about lifecycle -- municipal solid waste -- Keith Weitz. Mr. Weitz is an environmental scientist at RTI International's environmental engineering group.

He specializes in sustainable environmental solutions by helping public and private clients achieve environmental goals through interdisciplinary research, interactive tools and conceptual frameworks and analytical methods.

Keith's work areas include municipal waste, solid waste management, global climate change and integrated technology assessment, as well as lifecycle assessment.

Keith holds a masters of economic management from Duke University, and a BA in economics and business administration from Augustana College.

Please join me in welcoming Keith.

(Applause.)

MR. WEITZ: Thank you. And I get the somewhat dubious honor of not only being the last presentation of the day, but also I get to talk about garbage, --

(Laughter.)

MR. WEITZ: -- which is great. For those of you who haven't heard of RTI or me, I'm on the east coast in North Carolina at RTI. We're non for profit research organization. We do a lot of different things there. I'm in an environmental sciences group.

And actually, my first project at RTI

back 16 years ago was a lifecycle assessment project. I was then writing guidelines for first generation methodology development for lifecycle inventory, lifecycle data quality and impact assessment. So since then I somehow have gotten into this garbage track.

And part of the reason we're here talking about garbage today is the organic fraction. It's a source of biomass and there's a number of issues about the management of that, of bio-organic or biogenic fraction.

And there was actually an NPR show last year that raised an interesting question about global warming, and well, what should I do with my banana peel after I eat my banana if I'm concerned about global warming.

And there's a number of different options we could take to manage that banana peel. Some of the conventional ones are put it in a landfill. We could compost it in our backyard, or at a dedicated municipal compost facility.

Or my last thing there I have in quotes, waste to energy. And I have it in quotes because I'm using that as sort of an umbrella term, not only what we talk about as sort of mass burn combustors, but also some of these emerging new technologies. And technologies that have been used a long time like anaerobic digestion and some of the newer technologies for managing waste, gasification, hydrolysis, plasma, et cetera.

But this also raises an interesting question in general, and provides a pretty useful construct for trying to bend your brain around some of these issues.

And if I'm concerned about global warming, the answer might be one thing. But what if I'm also concerned about cost, or about energy consumption or conservation or sustainability.

For those of you who aren't familiar with municipal solid waste, I threw together a couple quick pointers. And these aren't necessarily scientific, these are just layman pointers.

First of all, there's a lot of it generated, and a lot of it's disposed even after it's generated. There's a figure there on U.S. waste generation from the USEPA's Office of Solid Waste.

And, you know, we're roughly about 275 to 300 million metric tons of waste per year. If we look at the biogenic fraction of that, it's at least 50 percent. So we have a lot of waste, we have a lot of organic waste.

The challenge of waste that's different from dealing with grains, grasses or canes is that it's a heterogeneous mix of a bunch of different things. Some of those things we like. Some of those things we don't like. But they're all mixed together. It creates challenges for using it for feedstock for specific operations.

Waste has a Btu value. I put perhaps on the order of 3000 to 5000 Btus per pound on average. And it's depending on your perception, it's a local burden or perhaps a resource.

And finally, my six-year-old daughter taught me this one. It stinks. And funny thing, we had to take some stuff to the landfill, so I thought that was a good opportunity to show the kids where their garbage goes. And that was the one comment I got from them.

In California we have about 40 million tons of organics are currently disposed statewide. And the breakdown of that organic mix is as follows: We got about 70 percent of carbon-based organics; about 30 percent is readily compostable material; 21 percent paper; and 15 percent food.

We're developing some regional characterizations for those organics. But this also gets into the heterogeneous mix of things. And we have, you know, a good 75 percent almost of organic-based material. There's about 25 percent inorganics.

But you'll notice a lot of that material is neither recyclable or particularly good for energy recovery.

So what I'm going to get into a little bit is talk about the lifecycle concept as it applies to waste management. We've heard a lot of it applied to biofuels, and in general. And talk about waste management options. I split them into two groups for this talk. Energy producers and energy savers or conservers.

The producers would be landfill, particularly landfill gas to energy, and waste energy options. Energy savers would be recycling and composting. And then get into a summary of what the lifecycle benefits are for different operations.

I think we've heard all this ad nauseam today. I won't go into it any further. But when we're applying the same concepts of lifecycle assessment to analyze solid waste management systems, what we're talking about is we have a starting quantity and composition of waste materials. And how do we best manage that to meet our objectives, whatever those are.

And we have a suite of options for doing that. Some of those options recover materials; some of those options create products; some of those options generate energy.

And like any other lifecycle assessment, our process boundaries track all the inputs and outputs, products, byproducts of each activity in that system.

And so if we're looking at greenhouse gases, for example, this would be our boundaries for what's included, what's excluded in terms of greenhouse gas emissions. And this is from EPA's Office of Solid Waste, their greenhouse gas sources and sinks from solid waste management; and also it's what their basis for their WARM model is.

Getting into landfills. Landfills are obviously designed and operated according to federal regulations. There's different types of landfills. There's the conventional landfills and there's bioreactor landfills, which are landfills where they recirculate leachate or other liquids to enhance the biodegradation and enhance gas production.

And there's different options for managing the gas that's produced. Landfills can be a significant source of greenhouse gas emissions from the organic fraction that's disposed of in them. And the gas can either be vented, it can be collected, and of that collected portion it can be flared, converted back to CO_2, or collected and utilized for energy recovery.

Landfill leachate treatment and collection. It can either occur onsite or offsite. These are all activities that require energy, that require materials, and thus are all part of the lifecycle inventory for a landfill or any other operation.

So all these activities get accounted for. The materials that go into the leachate collection system, the energy consumed to haul or process that leachate, et cetera.

On the gas management side, again gas can either be flared or used in an energy recovery system. If we're using it for energy recovery one of the key aspects here is what is it offsetting. What is our grid. And I'll get into that in a minute, but when we talk about the general burdens and benefits, as I said, you're going to consume energy, produce emissions, but you're also possibly recovering energy from that. And possibly storing some carbon long term in the landfill.

Landfill gas collection efficiency is a touchy subject and an important subject because it's a highly significant variable. Landfill gas contains about 50 percent methane, and it's a potent greenhouse gas. And landfills are a significant source of greenhouse gases in the waste management system, and in general.

And gas collection and control can greatly reduce that methane generation and overall carbon emission footprint.

So the assumed gas collection efficiency can have a significant impact on the carbon emission results. And you can see here on the left I have a landfill case where gas is vented. And then the two bars after that, the one in the middle is one where gas is flared and converted to

CO2. And the one on the right is where it's used for energy recovery.

And you see here that the big stepdown is when you can control gas, period. You get a little benefit from the additional energy recovery and utility sector offsets. But, really the big step is just controlling the gas in the first place.

Waste-to-energy systems. I like this diagram from Japan. They devised all these cute little fireball figures as the Japanese like to do. Thermal systems, we have our conventional mass burn systems. We also have more of the emerging technology suite, the mass burn, gasification, pyrolysis, plasma arc treatment.

In the nonthermal, anaerobic digestion, fermentation or hydrolysis.

I'm going to focus here on the mass burn technology, mainly because that's the technology that's well established and proven technology for handling municipal solid waste. The other technologies are, by and large, operating at a venture pilot scale and not commercial yet. But they have the same sort of benefits in general, which we'll get into here in a little bit.

Just like a landfill or any other operation they have air, water, pollution control systems. These systems require energy to operate and they have lifecycle burdens to operate. If we have to produce a line for the scrubber system, that's included in the lifecycle burdens.

The new and emerging technologies, as I mentioned, the cost and environmental performance of these technologies isn't as certain at this point. There's a few technologies here in California and other states that are ramping up to test facilities. And hopefully when we have a better understanding of how those facilities relate in terms of cost, energy recovery and emissions we can better integrate those into our systems.

So not only do we have energy associated with the operation of the facility, if we have residual streams those have to get transported somewhere and managed. But we also have benefits. The benefits are one, we're diverting waste from landfills where it otherwise might produce methane. We have energy production that offsets energy production on the utility sector grid.

Possibly some metals recycling. And revenue from the sale of both that energy and recyclable material.

Now, if we look at the net total energy balance for waste energy and landfill operations on a lifecycle basis, you'll see that the waste energy operation does a much better job of extracting energy out of waste, which is what we would expect.

If we look at it on a carbon basis we get a similar picture. And looking at the components that go into that waste energy carbon balance, we have the waste energy plant, itself, which is producing greenhouse gas emissions. And those are largely from the combustion of plastics, of other greenhouse gases associated with material inputs such as lime and other air pollution control materials.

We have a big electricity offset, and we have a smaller ferrous offset for the piece of ferrous metal that's recovered out of the ash. There's really nothing that happens on the ash landfill. And I didn't even bother to include transportation because that's also a fairly insignificant piece. So all that gives us a net total negative for this piece.

Now, the size of that electricity offset bar really dictates whether that net total is a negative or a positive. And that bar size depends on what we're offsetting on the utility sector.

If we're offsetting coal-based grid mix, then we're going to have larger greenhouse gas offsets than if we were offsetting a natural gas or mix of a grid mix that had fossil and nuclear or hydro fuels on it.

So that grid mix of fuels in the lifecycle assessment is very significant. Much more significant than really what's going on in the waste management stream, period.

Recycling. There's different types we could do. We could have just mixed garbage going to a plant and materials separated out. Or more efficiently we can have some level of household separation so we put out our recyclables in a bin. And that way we get a more efficient system on the back end.

They can be highly manual operations or highly automated operations. Revenues, markets for these materials fluctuate pretty widely.

Similar burdens to everything else. We have to collect the material; we have to process it; we have the energy and emissions associated with all that. We also get the benefits of recycling. Those would include diversion from landfills, conservation of energy in diversion resources, revenue from the sale of recyclables, and possibly some forest carbon sequestration with paper recycling.

Composting. Compostings can be designed to take organics only, or mixed with MSW. By and large the prevalent option is organics only. And like recycling, they can be highly labor intensive or highly automated processes. And have markets that are highly region.

Similar with recycling, we have the same burdens. On the benefit side, it's a little more sketchy in terms of quantifying some of these benefits. They're a little more difficult to get at. Again, we can divert waste and organics from the landfill.

I put two items in red there, the potential for offset of other products and soil carbon storage. Those are two areas we're actually working with the California Waste Board at the moment to try to get a better handle on, specifically in California. There's been work that's been done on a national basis as part of the USEPA's WARM model. The question is how applicable is that to California.

There were some pretty broad assumptions that were made in that model. We're trying to get a better handle on if compost product is being used, what kind of other products is it offsetting. Fertilizers, pesticides, herbicides? What sort of water reduction benefits are there. And put some more hard numbers to this.

Now, same thing with soil carbon storage. We have the potential to have some carbon storage associated with composting.

So, summary of the lifecycle tradeoffs. Landfills and waste energy are -- mass burn waste energy in particular, are well established options that have been accepted and proven. They have pollution control requirements and can recover significant amounts of energy from waste through landfill gas-to-energy or waste-to-energy system.

Recycling and composting typically require separate collection and can save significant energy by offsetting upstream production activities, upstream production of materials.

Landfills have generally been the cheapest option in the states, but this, again, is highly regional variable. Waste-to-energy has typically been the most expensive option. And recycling and composting have fallen in between.

Waste-to-energy is most efficient at producing energy, while recycling is the most efficient at saving energy.

Waste-to-energy, recycling and composting all avoid methane generation. And material and energy recovery create very significant upstream benefits.

So, back to our NPR question. The answer that was given was actually that backyard composting would be the best. But all options are pretty good in this case.

And really when it gets down to it, answers are typically site-specific, based on what facility constraints, other constraints are in the region; and also depending on values. What is my value to the minimum cost way to manage that banana peel, or is it the way that minimizes greenhouse gases. Or are they not mutually exclusive goals.

Am I concerned about local impacts

versus global impacts. And this leads us to think about other organics and inorganic materials in the waste.

And some take-home thoughts. Municipal solid waste can provide feedstock for bioenergy production. Perhaps it's more challenging in its use due to its heterogeneous nature.

All these management options cost money, consume energy and create environmental burdens. Sometimes I think there's a thought about composting and recycling that somehow you magically put it in your bin and it saves the planet. But the reality is we have to spend energy, money and create emissions by processing that material and transporting it.

Waste management options can have significant energy-related benefits. And, again, back to the energy savings options recycling and composting versus the energy production options landfill gas-to-energy and waste-to-energy.

And a good question, which I don't know the answer to, is where is the tipping point between those two options, savings and production.

It would be material-specific, it would be site-specific, and it would really depend on a lot of different factors.

Energy savings and production from waste can also produce significant savings for greenhouse gases, in general. Of course, this depends on our grid mix that we're offsetting or other fuels or products that we're offsetting. But the general trend that we usually see is when we're saving or producing significant amounts of energy, we're also doing good in terms of greenhouse gas balance.

And source reduction perhaps is a win/win option. Again, because those upstream pieces of the lifecycle are so significant that if we don't produce as much stuff in the first place, and don't have to dispose and manage it, those significant savings on both the upstream and downstream then are quite large.

And with that I'll wrap it up. If you have any questions about solid waste management and lifecycle issues you can go to our website that we're building. There's a lot of documentation on there. Or you can contact me.

Thank you.

(Applause.)

MR. COURTIS: I think we have about five

minutes for questions, and let's open the questions forum.

MR. MILLER: My name is Scott Miller, I write the bioconversion blog and the biowaste blog and the biostock blog. I also represent a company called Price Biostock Services, which produces 14 million tons of woodchips per year for the paper and pulp industry.

First comment, Keith, you're on the side of the angels. We need a waste-to-energy solution, particularly in the State of California, and the city I live in, Los Angeles.

Second, I want to say something to, is it Paul from British Columbia. I spoke up in Vancouver in the region of the Pine Mountain beetles, and I was talking about the wildfires in California, which have been the worst ever.

And the whole country is suffering through six of the seven worst fire seasons in the last 50 years. So, it's an upward trend. Talk about a hockey stick, the wildfires in California are a hockey stick.

But let's get to the bug infestations. You had a chart up there, it was a chart of the greenhouse gas emissions. And it didn't mention anything about the bug infestations.

When you have bugs, obviously they're decaying wood, it's creating a lot of greenhouse gases. We have the same kind of blinders in this state about wildfires. Wildfires' smoke, that's visible greenhouse gases. But also the decay afterwards is greenhouse gases.

So I appreciate your talking about the forest products industry. I'm just wondering if you can explain to me why greenhouse gases weren't in your pie chart, because I can't ask anybody from CARB, they're no longer here today.

Thank you very much.

MR. WIERINGA: Yeah, thanks. And if you've ever gone, flown over British Columbia you will see vast tracks that have this orange-reddish hue. And believe me it is not a nice thing to see, unless that's your favorite color.

The reason why we haven't put it in is we're using data that's been put out by Environment Canada. And Environment Canada does not include it. And part of the reason why Environment Canada does not include it is that they're following the international protocol how to calculate this.

And the calculation is that biomass, over time, is not supposed to have -- it does not have a net impact. And so I think that they're using about a 50- to 60-year cycle for that.

But what we are seeing is we are seeing some productivity increases on some of the hectares in some areas. At the other side we're also seeing all this pine beetle wood, and it's all decaying. The idea that the government has right now, we'd like to see it harvested fairly quickly and replanted fairly quickly.

You need to get around year 15, year 20 that should back up again. So they take a bit of a longer view on that.

MR. COURTIS: Any other questions?

MR. NICHOLSON: I'm Bill Nicholson; I'm currently an energy consultant, but I spent 32 years in the forest products industry and involved with cogeneration.

I wanted to ask our European friend about the limitation that you were putting on the electricity and making observation about the amount that you could count. And made the observation that if you limit it to the heat that the plant uses, there is a wide variation in the amount of electricity I can generate.

You know, your restriction is something of a restriction, but it isn't a whole lot.

MR. LARIVE: It is not perfect, yeah. And maybe without much time to explain things in details, but I mean it's quite obvious that if you build a plant that has a big cogeneration, and produces surplus electricity beyond the heat that you need, and you happen to be -- this electricity happen to have a footprint better than the grid, you are saving greenhouse gases. And as a plant you could be given this.

But when you do the LCA in order to try to figure out the value, you know, in general of ethanol produced in that way, you can't allow this amount because you have to put a limit somewhere.

That's always the difficulty with these things. Because we are trying to, when you do -- the way the people want to see the result of an LCA is grams of CO2 per megajoule or per gallon of something, of ethanol.

And because you are doing this, because you have to bring everything back to a unit of production of the biofuel, you have all these problems. Yo don't have these problems in real life, if you look at a plant, because then you have a real thing that you compare with other real things.

The other thing is that you need the heat. There is no single relationship between heat and power in terms of CHP, for instance. So you have to make an assumption.

MR. BLISHKE: Good afternoon. Jeorg Blishke with Metcalf and Eddy. I have a question for Keith. Have you considered in your analysis also source separation of organics, for instance source separation that is already pursued and actually quite successfully practiced in the City of Toronto where anaerobic digestion is used. And from my perspective, anaerobic digestion is a beneficial approach as you preserve the organic matter, and this could also be not only extract the energy component of it, but you can afterwards composting of the digested residue, you can not only add nutrient value to the soil, but also sequester the carbon.

MR. WEITZ: Yeah, this is always a contentious issue, is how do we get the materials out of the waste. And as I mentioned, there's two ways to do that. It's either to have source separation upfront at the households; or to have back-end at the municipal level or some other level, have processing of the waste to extract the fraction that you want.

And it's just a transfer of burden and cost from one place to another.

If we're talking, you know, sending out a separate truck stream to collect the organic fraction, then we also have to look at what are the fuel requirements of that and associated costs, the greenhouse gas emissions, et cetera.

On the back end you're absolutely right. There are technologies such as anaerobic digestion where we can recover energy, and also the leftover residues and maybe apply those to soil if they're of high enough quality. And get some benefit on the back end, as well. And we do track all that, so, yeah.

MR. COURTIS: Maybe would allow two more questions because I think we are about, probably about ten minutes over time. Thank you.

MR. WASON: Hi, my name is Bill Wason; I'm with CO2Star. This is directed at the gentleman from CONCAWE.

There's two aspects to this question

because they're sort of the two biggest gaps that I see in lifecycle analysis. And because you're one of the few organizations that actually does well-to-wheel, I'm kind of curious how you've dealt with this.

The biggest one, when you look at the magnitude of these numbers, this is why I bring these things up, and there are two examples that I can give. The first is a comparison on GTL between a Swedish study where they looked at the ISO recommendation coming out of the refinery baseline numbers, that that suggested that there be economic rank in the allocation of refinery emissions.

Now, it never got out of the committee because the oil industry killed it at a committee level. But, that recommendation was used in the lifecycle analysis, and when they did that with comparing GTL, they came up with a 35 percent positive. And when TIAC did it with GTL, they came up with a 20 percent negative.

So there was a 55 percent difference between the two studies. And it was mostly to do with this petroleum baseline.

The second part that people tend to miss is that you do kilojoules per kilogram, or kilojoules per liter, okay, for the fuel and you usually equate it at 100 percent use level. So, if you have biodiesel you have 8 percent energy loss, or if you have ethanol you have a 30 percent energy loss at B-100.

But when -- 99 percent of the fuel is used at a low blend, and when you use it at a low blend, the efficiency numbers are very different. In fact, you can gain an efficiency. In fact, a Canadian researcher got 3 percent -- 1 to 3 percent efficiency gains from a 2 percent biodiesel because ultra low sulfur diesel came in and had all these lubricity losses.

So I'm kind of curious how -- I know your current models don't deal with this, but you're coming up with new models, how you deal with these huge data gaps that are missing from the current models.

Because if you just duplicate the old petroleum baselines are okay, or the well-to-wheel analysis doesn't look at the common use, then you miss huge chunks of carbon.

MR. LARIVE: I'm not quite sure I followed your first reasoning. I can't really see how you could just by, probably what you mean, fiddling with refinery numbers go between minus-20 and plus-25, because a refinery number anyway, refineries use in Europe about 7 percent of the energy they produce.

So even if you sort of multiplied that by 2, or decided there was nothing that would have made that much difference.

Having said that, I'm not sure what Swedish study you refer to. But, if you make accusations here, there have been some fiddling and that the oil industry has blocked something, then you might as well make sure you substantiate that. I don't really -- I'm not here to respond to this sort of question.

Now, your second question is about the improvement or the difference in efficiency of various fuels in terms of the number of megajoules per kilometer. So far we have taken the view, and that's not CONCAWE on its own, that's also EUCAR, the car industry, we have taken the view that a megajoule is a megajoule.

And therefore that's within a certain technology. If you take diesel and whether you put biodiesel in it, or whether you put GTL or you put normal diesel in, the efficiency will be the same.

I know that there are a lot of people who do not necessarily agree with this. There are a lot of studies that say different things. We took the view that so far we haven't seen any convincing scientific evidence one way or another. And therefore, we have kept it that way.

Now, people can always take our result and say, well, you know, I would like to give another 10 percent benefit to ethanol or to something because I believe it is that way. It's not difficult to do. We haven't done it. And we have said clearly that we haven't done it, and why we haven't done it.

MR. COURTIS: Thank you. I think it's about time to limit the questions, and then there will be an opportunity at the panel after we get together again in about ten minutes, for more questions to be asked.

I'd like to again thank the speakers today and --

(Applause.)

(Brief recess.)

MR. ADDY: That's good. All right, so

we're going to start this session. This panel discussion arises, I think, from the need to measure sustainability performance in a standard setting environment, I think for a number of reasons, the least of which is the possible certification of bioenergy and transportation fuels in a possible regulatory environment.

My name is McKinley Addy; I'm the Program Manager at the Energy Commission. I was responsible for overseeing the full fuel cycle analysis work for the State Fuels Plan. And will be working with several of my colleagues at the agency to do some sustainability framing for a big funding program that the Energy Commission is going to be managing.

We are about to start another iteration of the full fuel cycle analysis work through a contract that the Energy Commission is about to let to several contractors. We will also be characterizing sustainability in the transportation energy sector on a full fuel cycle basis as the authorizing legislation directs the Energy Commission.

And as you can see from the assembled group here, I've got this unwieldy task of guiding a conversation about a topic that many people aren't clear about, several disagree on, and most people know very little about.

How does one account for these multiple views and factors in the treatment of sustainability in lifecycle assessment, especially where there is a desire and a need to measure sustainability.

And the approach is going to be to draw from the conversations this morning, the presentations that were made. I'll ask a few questions of the panel members, and then we'll open up the conversation to the rest of you if you have questions.

But before that, as a way of review, you can put up this slide. Okay. I can see here. So as a way of review, several presentations from yesterday and some time today looked at the definition of sustainability with a view towards modeling, measurement and standards.

There was some discussions about constraints. And all of this is happening in several policy contexts. Why is this important? California is looking at setting a low carbon fuel standard. The Energy Commission has responsibility, as well as the Air Resources Board, for administering a $200 billion-a-year program over the next eight years.

That program requires some sustainability accountability, if you like. You heard about the ISO 2007 program. Then there's AB-32. There may be others.

Your discussions about the limitations in assessing sustainability I appreciated -- Sabrina's, is that -- yes -- presentation. She tried to take a crack at some of the issues in measuring sustainability.

There is the issue of consistency in using the results. One of the very important objectives of the Energy Commission and the Air Resources Board in dealing with the question of sustainability is to insure some consistency in the application of what definitions, what standards, what measurements we come up with across the different programs.

There are also some discussion about research gaps and I think this panel is going to be looking at some of the questions relating to some future research -- can you just -- down for me, please, I don't have to deal with that.

This is an example of where sustainability occurs in a legislative context. That's going to be guiding the Energy Commission in what we do and how we treat sustainability.

Next slide. If you're going to talk about sustainability in a regulatory framework or a program administration framework, what are the things that you're going to measure.

And yesterday Danielle mentioned some of these different factors. Sabrina mentioned several of these. And a question that arises is on what basis will you measure these factors and apply them in a regulatory framework or a program administration framework. Another question is, is everything measurable.

Next slide. A suggested measurement framework, which I think Sabrina attempted to present to us, could define a sustainability function, and that function could be such that it accounted for the factors or indicators of sustainability as the EPA prefers to cal them. One could assign units or use analogous units.

There may be some common units that lend to easy combination or there may be separate units which requires separate treatment and the setting of performance thresholds.

Out of this definition could arise a system of sustainability equations with results that then can be modeled on a lifecycle basis, or a sustainability index that can also be modeled. One could also use units from some established sectors. I think Danielle Fugere of the Friends of the Earth mentioned that, as well.

Next slide. Okay, which bring me into my assembled group of people here. And my first question to them is what do you see as the key research questions for assessing sustainability within an LCA framework.

Anyone of you can comment. And, by the way, we have to pass the mike among the group of you because we have only two.

Go right ahead.

MR. LARIVE: Just maybe a short thought. Turning principles, somebody yesterday had a very good kind of a framework, sort of starting with principles and to criteria and to, what was it, indicators.

I think turning principles into indicators, because whatever you do, if you stay at the level of principles then everybody would be happy in talking about it, et cetera. It's not going to do anything.

You've got to turn things into things that you can measure, that you can verify, that you can audit, and that people can see on a piece of paper that you've done it or you haven't done it.

So, as long as you stay at the level of the principles, and even at the criteria, you haven't done anything.

MR. ADDY: Anybody else on the panel? Stefan? No? I gave them an assignment this morning. Some of them just got the assignment about ten minutes ago, so they're reading it -- yes.

DR. SPATARI: So I think I agree definitely, and I sort of thought and thought, and lots of my collaborators thought and thought about how to quantify sustainability.

And I think in putting together the list of criteria or risks that we need to consider, there will always remain some intangibles. And so I think we'll always be left with a semi-quantitative, semi-qualitative.

Maybe some other agree or disagree.

DR. DALE: Okay, I'm going to add something. I think if you can measure it and quantify it, that it's a fit subject for LCA. If you can't, it's not. This doesn't mean it's not important, it's just not a subject for LCA. You can deal with other policy metrics, but it isn't LCA.

DR. CASSMAN: And following up on that there's LCAs on real systems, and LCAs on hypothetical systems. And they're qualitatively different.

MR. ADDY: Robin, sorry for calling on you, but in the work that duPont is doing, you mentioned this morning that there is an interest at the corporate level to consider or do things sustainably.

In some of the LCA work you've done are you somehow able to characterize sustainability impacts in the LCA framework?

MS. JENKINS: Do you mean sustainability impacts beyond the quantifiable typical --

MR. ADDY: Either beyond the quantifiable typical factors or indicators, or even with the existing factors, the known ones.

MS. JENKINS: Yeah, as I showed this

morning, we had, at least within the ICBR, we identified five top criteria: greenhouse gas emissions; fossil energy use; water use, also a quantifiable metric, sustainability metric; land use, I believe was in there; soil, soil health, erosion, all of those being quantifiable metrics that we use to compare different process options and compare benchmarks with.

We also have talked about, though, the metrics that are more qualitative like biodiversity. That's one that I struggle with. How do we measure the effect on biodiversity when we remove specialty crop residue from the cornfield. How am I affecting biodiversity and how can we measure that. Or is it more a qualitative case-by-case, farm-by-farm analysis. I'm not sure that we know how to do that yet.

MR. ADDY: All right. Going to the next question. Remembering that the lifecycle assessment framework includes looking at the different steps that involve production, transport, the processing, storage, transport in the final use of the fuel, does measuring sustainability lend itself to the general steps of the LCA framework? Again, production, extraction, transportation, processing, storage.

MR. LARIVE: I think if we are talking about LCAs as we know and love them, i.e., trying to figure out what is the footprint of a gallon of ethanol, in my view it doesn't really fit because I think it's going to be very difficult to pin down, you know, all these whatever, sustainability criteria, all the ones we have seen and we have talked about, to pin them down to a particular liter of finished product or gallon or megajoule.

You know, the European Commission, as you have heard yesterday, has a warm feeling because they have included in their directive some limitations on the type of land that you can use to grow biofuels.

To me it's a complete delusion because, of course, yeah, people will not grow biofuel on this land, yeah. They will grow something else on the land that are not kosher.

So as long as you only apply this to biofuels and not to the whole of agriculture, forestry or anything else, you haven't really done anything.

MR. WEITZ: Maybe I'll play a little bit of a devil's advocate here and throw out the idea that, you know, we're talking about assessing sustainability within an LCA framework, and perhaps that's not the right order. Maybe it's how does LCA contribute to a sustainability framework.

LCA is good for what it does, which is comparisons of two different systems. But it's fundamentally different from maybe a sustainability assessment where we're looking at bigger things.

For example, LCA is not a risk assessment. It can't tell us what the changes in the ecosystem are going to be. And that seems to be like perhaps a key element of a sustainability assessment.

Similarly, cost and economics typically hasn't been part of the LCA framework. So how do we integrate that. Sustainability is perhaps, you know, a broader umbrella that LCA can play a piece in, but not necessarily sustainability within an LCA.

Just throwing that out there.

MR. ADDY: Ken.

DR. CASSMAN: I think if we look at another goal, I mean the low carbon fuel standard at one level, it's to reduce the carbon footprint of a fuel supply in a state like California or a country or a region EU.

But the other end, there's benefits, particularly in the biophysical dimensions of sustainability to have the industry be incentivized to improve its footprint as it evolves.

And so having the ability to do certification on individual facilities and their associated feedstock incentivizes, provides motivation and justification and reward to, for instance, I think the ethanol plant or future biorefinery plants. Let's look at the big picture. They can be aggregators. They can aggregate value that society wishes to confer for certain environmental goals.

So, soil carbon sequestration, greenhouse gas mitigation, water quality issues, a whole range of things. And they're all linked through this connection between energy and crop production.

And so I think, at that level, don't lose sight of the whole reason you're setting low carbon fuel standards is to move industries, and particularly in this case, biofuel industry, in the direction of lowering its carbon footprint.

DR. DALE: Actually, you know, regarding your comment about the devil's advocate, I agree completely. I think LCA, as a useful tool, kept within the balance of where it's able to contribute.

I mean a knife is good for cutting. A hammer is not very good for cutting. So, use the knife for cutting, and use the hammer for measuring things. And use LCA for what it's good for, that is that you can quantify systems whose boundaries you can draw comparison you can make. And don't try to use it for things for which it's not very good.

I don't have any disagreement at all. In fact, I heartily endorse that point of view.

MR. ADDY: So, let me -- you want to say something? Go right ahead.

MS. JENKINS: Yeah, just to reiterate. I think what I mentioned the sustainability criteria metrics that we held so highly, only a few of those really used LCA as the tool. Measuring processed water use is just looking at the process, looking at the net water that we're taking from the well. There's nothing LCA about that.

What I think LCA has done beyond, enabling us to calculate total well-to-wheel greenhouse gas emissions, or total well-to-wheel fossil energy use is to help us understand the importance of looking at the entire system and not discounting where our feedstock is coming from. And knowing the importance of capturing the burden of all of the processes along the entire value chain. I think that's another benefit that the tool has brought us.

And also the importance of soil health and the measuring of the nitrogen cycle and the carbon cycle at the agronomic level, understanding those aspects. Or also at the field level that aren't all the way through an LCA yet, but are a part of sustainability, along with erosion and really looking at sustainable agriculture, you really don't have to use LCA as a tool to get to those sustainability criteria, also.

MR. ADDY: So the issue is a perspective that will probably help us step back from the conventional understanding of lifecycle assessment, is it possible that those who propose to look at sustainability factors in a lifecycle content simply mean that we should look at, for example, the water use impacts from the production of the feedstock, through the transport of the feedstock, and processing of the feedstock, so that if you're not using one of these conventional tools like GREET or GHGenious or the LEM, but again expanding that thinking about lifecycle.

Go ahead, and then Sabrina.

MR. LARIVE: You can put anything you want in the lifecycle, you know, in the LCA framework. It's a matter of defining what's your boundary in terms of what you include, what you don't include. So if you want to take it water, you take water.

At the same -- LCA is useful to aggregate in a systematic manner, things that are similar, of a similar nature, and occur in different places of a chain.

But I think, you know, some people may disagree, but generally speaking the sustainability issues that we're talking about here have a lot to do with agriculture, or say growing things on land. And not a lot to do with the rest of the chain.

What the rest of the chain has to do with is greenhouse gases, it's energy and maybe water. But child labor and all this, I mean, and whatever else, this is really a lot to do with the way the land is used and all this sort of issues and things like that.

So, from that point of view the whole LCA framework is less required, maybe because we are talking about only one part of the system. And you don't need to add up the sustainability of growing, plus the sustainability of transport, plus the sustainability of making the stuff. In the sense of sustainability criteria, as we want to describe them.

MR. ADDY: Sabrina.

DR. SPATARI: I definitely agree with what Robin said. In some cases for certain metrics like water, it really doesn't make sense to think about it in a lifecycle sense. You might think about it over the lifecycle at different stages, but when we're talking about sustainable water use at the crop production stage, you wouldn't sum that across because that's maybe a region-specific metric, or crop-specific metric.

And so when I was generating that list

that I put up earlier in my presentation on sustainability metrics I wasn't necessarily restricting it, this falls within LCA.

We thought about, in our project, sustainability metrics related to biofuels, and those that are relevant for, say, the oilsands in Alberta. And when looking at oilsands operations, it actually -- LCA approaches very well into those kinds of systems because you're dealing with something like greenhouse gas emissions; a supply chain where you can use economic input/output effects or models to look at, you know, these massive projects that are very well contained in an area.

And you can sum them across the lifecycle or the production cycle and they make sense to be aggregate like that. Not the case when it comes to water.

So I was working with a student at Berkeley who knows a lot more about water than I do. And he came up with a set of metrics that would be relevant for water and agriculture. So the acrefoot of water per acre applied to, you know, a growing set of crops.

So, yeah, so I agree with a lot of what

was said earlier. LCA, sometimes it's much more obvious that the LCA kind of approach can feed directly into a sustainability kind of framework. But often you have to sort of think about these socioeconomic criteria that don't really fit in.

MR. ADDY: So a -- oh, okay. There's a mike, go ahead, John.

MR. SHEARS: Yeah, John Shears. Just because water has come up, and we're in California, for ag roughly two-thirds of the water that's used in the state goes to ag. And if you look at the energy footprint of water in California, close to a quarter of the energy use from the grid goes for water use. A quarter of the energy goes to moving that water around.

So, you know, given that we're talking about energy as sort of the critical issue in the greenhouse gas footprint, I just wanted to put that point on it, since we raised it.

DR. SPATARI: I'd like to respond to that, too. Yeah, I agree. In this case you have this water/energy nexus. And it's really region-specific. It's not a lifecycle metric. The two are connected, but they really are region-specific. No? You can disagree.

MR. ADDY: If you want to speak, please come to the mike.

MR. SHEARS: Okay, as someone who sort of did a lot of initial work on looking at implications of climate change in California, three-quarters of the water falls on the north part of the state. Most of that water goes through the delta, through the State Water Project and the Central Valley Project, which is a federal and state.

I mean, through the huge infrastructure, it's going to southern California, Los Angeles, but a lot of that water that's going down is going to the San Joaquin Valley.

So, really, when we're talking about this, we're talking about a very limited region within the California context, when we raise this issue, so. You know, within the broader context it's a statewide thing.

But I think we can -- you can actually, within the California context, you can get a pretty good handle on how to allocate, attribute those numbers.

DR. DALE: Yeah, I think what Sabrina was trying to say that in spite of what it appears, California is really a very small place after all.

(Laughter.)

DR. DALE: It really is just a region of the world, even of the United States.

(Parties speaking simultaneously.)

DR. CASSMAN: The other thing is the amazing plasticity of water use and agriculture. I mean if you don't use it in agriculture, what -- are you going to let it run out to sea? I doubt it. I think it has other uses.

And the point is those other uses are much less plastic than agriculture. When you have droughts, agriculture can survive through several years and cut back water by 50 percent. If it's going to industry or houses, it's very less plastic.

MR. ADDY: Before you speak, let me just make this comment. I understand there is a wealth of -- no, there's a tsunami of desire for people to ask some questions. If you have a question I encourage you to please come up to the mike and ask your question of the panel.

Go ahead.

MR. SHEEHY: I think that water does, I

think you could make a pretty convincing argument that water does fit within the LCA context. And I don't understand why you would separate it, why you would say it's regional when, for instance, in models you separate ethanol plants that operate in the midwest when their corn is corn is coming from the midwest versus Brazilian sugarcane. You're already looking at different regions already.

So in these LCA models you would want to actually incorporate water. And then you would also want to compare it to water intensity and hydrogen production, electricity production. They've actually done studies on this now, the water intensity that would happen from an increased plugged-in hydrogen economy.

So you'd need to generate more electricity. When you generate electricity you need to actually cool the generators. So you actually have increased water. So you're going to have increased water use in that part of that fuel.

So you have to take it -- you do want to consider the water use of biofuels because you want to compare it to oil. You need water to extract oil. Enhanced oil recovery uses a lot of water. Processing oil takes a lot of water.

You want to look at increased electricity as an alternative fuel, hydrogen. So, I mean, these are -- I think you do want it to fit into the LCA context because you might compare favorably against some of those other fuels, too. That's one thing about biofuels that you should consider. I don't think it will, but you at least want to consider it.

And there's two types of water consumption, also. You also need to consider that. Is that you have evaporation versus water consumption, which you haven't distinguished between. You also need to distinguish between those, also.

MR. ADDY: Thank you. Ken, let me just get somebody else from the audience.

MR. KLINE: Okay.

MR. ADDY: Anybody else? Come up. Ask your question.

MS. OPAL: My question's about land use changes. So if you guys want to stay on the topic of this one, you can go first.

MR. KLINE: You want me to go first?

MS. OPAL: Mine's about land use; I'm

totally changing -- okay, we're changing topics.

Charlotte Opal, Roundtable on Sustainable Biofuels. My question is for the speakers from the morning and those who didn't get to show their slides on land use change.

Keith -- or Kevin, sorry, I understand that at the margins ag is not the main driver for the land that people are really concerned about, which is the high carbon stocks and the high conservation value areas, the conversion.

I understand it's a much more complicated household level driver that does the land use changes, not just the ag.

But, do you think that there is no causal link between agriculture expansion into these and conversion of these areas?

And if you think there is a link, how would you tease out how much of that is the fault of agriculture, and specifically biofuels?

And then everyone else can also -- if you understood the question -- talk about it.

MR. KLINE: It's a good question. I think that if you were able to look at very specific bounded areas you might try to evaluate all the different factors and the elements that they contribute to a land use change process.

In fact, that's what the study that I referenced, the Geistand Lambin tried to do. And they couldn't easily describe the complex process of land use change globally, but at localized levels they could find more predominate factors, and they even found clusters of factors working together.

And sometimes crop markets were within the cluster that was predominate in a given locality. But it certainly wasn't a singular force, there was no singular force.

And it also is fairly clear that to put causation, given the amount of land that is already cleared and under-utilized, a relatively small area, relative to that already cleared and under-utilized land is at least questionable.

And I guess my real point is that you need to look at land use and compare real land use that's happening to the land use under future alternative. And if the land use is not sustainable before, and now we're making it more sustainable, then I think that's an improvement.

If the land use is clearly sustainable before, and moving away from that, then that's not an improvement. You can do that -- bound it, but we just heard that British Columbia has 30 percent of their land fallow. They've got cattle, technology, infrastructure; they've got everything they need to put that in production, but the markets haven't been there.

And the places we're talking about, the percentages that you might call fallow, the percentages of land available are just, they're much bigger, they're huge, they're huge areas. And to try to say that new land is being cleared from biofuel crops, I guess my simple answer is I would say there's no direct causation that you could link to that.

But I think there's actually stronger argument to say that if I have no biofuel market in the United States, we're reducing deforestation. And some of the costs right now are being attributed to biofuels for indirect change should actually be considered as a benefit under direct impacts in other countries.

I think there's more evidence towards that than the other argument.

MR. ADDY: Anybody else on the panel want to comment on that?

DR. DALE: I'd actually like to add a comment there. The fundamental argument of the indirect land use is that, or among them, is that it's a bad thing for agricultural prices to rise, the price of agricultural commodities to rise. Because that will encourage agriculture.

And, gee, you know, --

(Laughter.)

DR. DALE: -- I have a hard time getting my head around that. I really do.

Besides that, the policy, intended or not, of the United States, and to some degree the European Union, for decades has been to destroy agricultural communities around the world by exploiting subsidized commodities, okay.

If you studied that issue, you have to face it, that's the case. Are we still trying to keep those poor people poor, now, in the name of some environmentalist and some misguided approach? Now I'm speaking very frankly to you.

I just have real intellectual and moral problems with the idea that the agricultural communities have to be kept forever to serve some perverted higher good of lowering greenhouse gases.

Okay, that's what I think. I'm happy to argue it with anybody, but that's what it looks like to me.

MR. ADDY: Thank you. Any other question from the audience, and then I'll throw a question at the panel.

DR. KAFFKA: I want to kind of keep it on this focus, but also make it more specific to our discussion here at this meeting.

I think it would be a great loss if we let this panel disassemble without addressing this issue from the perspective of what we need in California.

Yesterday, Dr. Kammen, in one of his slides, was talking about greenhouse gas benefits from particularly crop production. And then said that it was completely swamped out if the land use change was included.

And there is discussion in policy circles that no crop production whatsoever can be considered sustainable because of the land use change issue.

So I would like the panel to comment on that as a possible guideline for California, that principle. Because it is at least in discussion.

MR. ADDY: Panel members? Who'd like to go first?

MR. SPEAKER: Do you want to vote, Steve?

(Laughter.)

MR. ADDY: Can you pass the mike to Stefan, please.

MR. UNNASCH: I feel constrained by the question list, but this is partially jumping to the market mitigated question, and also the, you know, is it appropriate to grow crops.

But, you know, the genie's been let out of the bottle with the market-mitigated analysis of land use change. And I think we need to understand even more what this analysis is about.

First people have to get clear that the reason we're doing the market-mitigated analysis is because it's really cool. You can run a model that will turn on supply and demand factors. You can figure out how much this and that is going on all over the world. That's not really the reason we're doing it.

The reason we're doing it is because the model of switching from corn-corn-soy, to corn-corn-corn, putting the soy in Brazil and putting the -- displacing some land is too simplistic. That's why the market-mitigated approach is being applied.

So, you know, you brought it up in the context of sustainability. I think there has to be a reason to do the market-mitigated approach because you can apply it to everything. You can apply it to the price elasticity of gasoline. Is natural gas use causing more coal to be used.

But back to the biofuels and, you know, there's many more cropping systems that need to be understood. There's, you know, the cover crops. There's a lot of complexity with how some of these biofuels could be grown, and I'm not sure they're all captured in, you know, the current market-mitigated analysis that's going on.

And rather than, you know, throwing out the market-mitigated, you know, there's one side that says, well, we don't even want to look at this market-mitigated stuff. It's a bunch of voodoo economics. And the other side says, well, a simple sample calculation shows it's, you know, 500 grams per megajoule.

I think there's a lot of understanding of what the input assumptions are, and why, you know, what the meaning of the market-mitigated factors are. And trying to tease all those out and understand what some of these sensitivities are, to, you know, maybe more environmentally crop systems and some of the benefits that might not be captured in it yet.

But, don't apply it to sustainability until you have a reason.

MR. ADDY: Any other panel members in response to Steve's question? Here.

DR. CASSMAN: I've been an agronomist for 30 years now. And as an agronomist your main goal in life is to improve crop productivity. And, of course, protect the environment.

But during 28 of those 30 years I have watched the real inflation adjustment value of the thing I'm trying to produce and help produce, decrease in value. To the point where if you're really concerned with poverty alleviation, human nutrition, there was no hope if it continued along that path anywhere in subSaharan Africa, anywhere there was an impoverished country with a large majority of that population dependent on agriculture.

And so here, all of a sudden, you've had a chance to elevate the value of the basic industry upon which the majority of humans depend upon.

Now there's challenges, but I can only tell you that the continuation of a trend of decreasing prices and commodities was not sustainable. And I think now we have a chance, with this reevaluation of agriculture, to invest in sustainable practices because it's simply worth more.

And one thing that's really left out of the previous analysis-like search is when you raise the value of agriculture there are hundreds of millions of hectares of land that are farmed at subsistence level, where carbon in soils has been degraded to the lowest possible level.

And the only hope to reverse that is to have a higher value agriculture so farmers can afford to invest in technologies that can start to conserve and rebuild and regenerate those systems.

DR. DALE: By the by, when you do that, when you increase the yield with agriculture, you're going to increase the soil carbon capture, also. Those soils are depleted; they've been run down. You start applying good seeds, better cultivation factors, fertilizer, you are going to build up soil carbon. There's absolutely no question about that.

And by the way, getting millions of people a better life. I don't see why this is so hard to get, I really don't. I don't see why we make a god out of greenhouse gas.

MR. KLINE: Just following right on that, you increase soil carbon, you increase intensity in yields, and you reduce pressure to clear new land -- you stabilize that frontier.

And there's so much land in this condition that's available, it's just mind-boggling. But when you're out there and you see it burning, twice a year sometimes, three times a year, and you see those fires going down and into the roots of what once was forest, it's frightening. And it's not happening because of a crop attacking, because of all these other conditions. It's hard to convey to people that live in the United States what this process is like. I know. I'm frustrated because I can't find the words sometimes. But it's really different than how people visualize it here.

It's not this closed circuit that you

can do in a general equilibrium model. It's zero sum, it's not like that.

MR. ADDY: Go ahead.

MR. HERWICK: Yeah, you've got a whole line of folks here that want to ask questions.

MR. ADDY: Let me just -- before you ask your question, let me just see how many more people have questions to ask. Ooohhh -- okay. Let me suggest this. If you can be as succinct as you can in asking your question. And ask the panel members to be as succinct as they can in responding, we will try to get as many more questions and answers in here.

And then I've got a couple I want to ask the panel before I bring this to a close.

MR. HERWICK: Okay, I'm Gary Herwick with Transportation Fuels Consulting. I have a question here that has to do with the incorporation of the land use change -- of a land use change debt into the regulatory process of the low carbon fuel standard or the renewable fuel standard.

You know, we've heard over the last couple of days -- I'm not a lifecycle expert, by the way -- so I'll say that right away -- coming up here, but what I've heard so far is that certainly we need to include the impacts of land use change as a debt on, you know, on the top of biofuels.

How we do that is a question. Direct land use change, perhaps, is pretty well known, so I've heard. But there's a great deal of uncertainty surrounding indirect land use change. There seems to be, from what I've heard, a lack of data, a lack of data supporting it. There seems to be perhaps impacts of some factors that we haven't even included yet, societal and policy drivers that would change the use of land that are totally independent of biofuels or crops.

MR. ADDY: -- got a question?

MR. HERWICK: It's coming.

MR. ADDY: Please.

MR. HERWICK: Okay, it's coming. So there's a great deal of uncertainty, so there's a, you know, there's a wide amount of variation in the assessment of that.

And it strikes me, someone said, one of our speakers said that it's important to get it right. Well, if there's such a degree of uncertainty around it, don't we risk some unintended consequences of putting in something that has that degree of uncertainty into a regulatory process.

And could we, in fact, end up discouraging the production or the development of some biofuels that could be helpful down the road?

MR. ADDY: Thank you. So, is there a risk in including indirect emissions that have uncertainty associate with it in a regulatory framework? Anybody wants to try and answer that question?

MR. UNNASCH: Sabrina, would Michael Harris say that zero is not the best guess? So, I mean, that's -- and from what I've heard today, it could be -- who says it's a negative number, it could be a positive number.

But I think the come back is that zero is not a good guess and work is underway to try to come up with a reasonable bracketing.

MR. ADDY: Please.

MR. MATTESON: Gary Matteson, Matteson and Associates. It seems that yesterday we spent a fair amount of time trying to define principles. I'm not sure we came up with a consensus, but I think we came pretty darn close.

And today we're now talking about measurements, or standards of practices. And I think there seems to be a bent towards trying to make them absolute, where possibly they should be both absolute and relative.

I think your comments were along the lines that they could be both, some of them absolute and some of them relative.

There will be technology, I'm sure, and reorganizations of these industries so that they will start to achieve these standards that we're going to put forth.

My question to you is can we come up with a consensus of what these standards should be so that we could pass it on to the group which is going to be discussing certification tomorrow?

MR. ADDY: Analysts? Did you get the question? You didn't get the question. Okay. Let's see if I can reframe the question.

There is an interest in moving all of these measurements and discussion of principles towards the setting of standards. And perhaps criteria that will allow the use of bioenergy in economy. Do we think that we're moving towards that direction? I think.

Go ahead.

DR. SPATARI: I'm not sure we're moving in that direction, but it's certainly been proposed, and it's been used in different industries before -- they have green certification standards, and they are not free of problems. There are leakage issues, but maybe it's 80 percent of the time more sustainable than not.

MR. KLINE: My impression is that there's been a lot of progress made and I think Charlotte Opal was here, and this effort at the, actually many levels, sustainable soy, sustainable sugar, sustainable biofuels in general, coming up with principles and criteria. And now working towards indicators.

I think there's a lo t of really good progress. And, again, it's really exciting that this is happening, that biofuels has raised the attention of the world to what has been a historically important issue that hasn't received this attention.

How do we use land towards sustainability. How do we really improve -- and so I think we're making a lot of progress in the basic concepts of what is more sustainable land use in a simple table like Steve Kaffka presented yesterday afternoon, are pretty widely accepted. And those can be measured.

MR. ADDY: Thank you. Another question? Please, a short question.

MR. WASON: Okay, but I'll try and explain myself better this time.

MR. ADDY: If it's not short, forgive me, I'll exercise my moderator's privilege and sort of cut it off.

MR. WASON: Okay. This question has to do with the fact that there is, right now, a perception in the public that there's a link between biofuels and land use change right or wrong.

I'm not going to go into why it might be wrong, but that begs then, as a question, is that -- if you're getting blamed for cutting a rainforest and it has 300 tons, and you're wanting to exclude certain biofuels because of that supposed link, right or wrong, then the question becomes does a fuel standard then allow you to introduce the idea of preserving that rainforest and gaining that 300 tons? And would various markets then open themselves up?

Because right now, for example, you have very strong restrictions on import of ethanol, even though it has very good lifecycle carbon balances for sugarcane in Brazil.

So, I guess it's a question about whether or not you see a low carbon fuel standard having the flexibility in order to get land use change to work right.

Because right now the pile of paper that you're generating from having to do the audit trails for the U.K. costs the industry a billion dollars, 2 billion dollars that you could use to buy rainforests in Brazil or whatever.

MR. ADDY: Thank you, I think we got the question. You want to answer it? It's a political question. How about I do this? Are you going to attend a low carbon fuel standard working group meeting? Good, I'll pass that question on to them.

Who's next?

MR. VELASCO: So many questions, so I'll only try to ask one, and then try to grab maybe some of you.

I'm just reminded by, trying to remember the incident when President Bush was asked, I think, around the reelection campaign, about all these problems. And he just said, it's hard. You know.

And I feel your pain, to use Bill Clinton's words, to try to figure this stuff out. It's hard.

I will just ask one thing from you, and then ask a question of you, very quickly.

First, before you complete any of this stuff, kick the tires, kick the dirt and all the places you're trying to measure. Don't do like some people in Science Magazine -- I won't say his name, starts with an S -- who went to Brazil after he drafted his paper. Please don't do that.

Second one, and I'm not saying just go to Brazil, go elsewhere, too. There's some other beautiful places to visit.

The other one is really kind of a funny question that I'm sort of always struggle to ask, but I think it's just a fair, to try to get the discussion going even more. What happens with my friends in the corn ethanol industry in the U.S. when, in the model, where this year they actually plant less corn. Does this mean that they grew some Amazon. Because in the old model when they plant more corn we pushed soybean into the Amazon. And guess what, supposedly it's the corn guys' fault.

I'm not here to judge whether it is or not. But in the model, if you take your model in reverse, you're not going to give, you know, the renewable fuel association credit for this.

The reality is we're planting more soybean in Brazil regardless of whether there's more or less corn in the U.S.

And I just sort of push that just because these models start getting so complicated. And it's easy to write the headline of the Washington Post or the New York Times. But it's impossible to try to tell the farmer down in Brazil you should do this, not do that. Or tell the farmer in Iowa to do the same.

The question is how do we get this model implemented in a way that regular, you know, farmers and others can use? Forget the policymaker. I know they won't be able to use it.

MR. ADDY: Quick response.

DR. DALE: I think that direct land use change has a reasonable chance of being implemented on the local level, and can actually provide good guidance.

I think indirect land use change is lifetime employment for a whole herd of researchers.

(Laughter.)

DR. DALE: And I think you'd better count on having your budgets, to do this, increased by about tenfold, because that's what it's going to take to do the analysis if you do indirect stuff, and do a good job of analyzing not only indirect effect of biofuels, but indirect effects of petroleum fuels.

I'm serious, again, I'm serious. This is lifetime guaranteed employment for researchers like myself. I don't think it's particularly useful or productive.

I do think going after direct land use has a reasonable chance of providing useful guidance to develop more sustainable practices.

MR. ADDY: One other comment and then Danielle.

DR. SMITH: But if indirect land use can make a big difference, then what is the alternative? You just ignore it? Ignore the fact that because it's difficult to measure and assess that you should make no attempt at it?

That seems to me to leave the policyfolks without an adequate set of cards.

MR. ADDY: Let's get Keith, and then I think I will -- the comment that I've heard in a low carbon fuel standard workshop about -- well, go ahead.

MR. KLINE: It's not ignoring it; it's whether you try to put it in LCA. Different things are at different scales, and operating with different drivers. And so we definitely want to try to address, I think, as a civilization the protection of biodiversity, protection of cultures, the protection of tropical forests and ecosystem services all around the world.

And land use, if you really focus on land use, and proper land use, part of that is working within a landscape where those areas that are biologically important, that are providing key ecological services, riparian areas and any farm, you go all the way up to the watershed, those areas should be zoned for protection. And you try to make sure that the rules are in place and the capacity is in place to make that happen. The incentives have to be right.

And I think that the certification process and the issue of sustainability gives us a tool to help move in that direction. We're not going to solve the problems of the world overnight, but we can move in a positive direction.

MR. ADDY: Thank you --

MR. KLINE: We're not going to ignore them --

MR. ADDY: Thank you. Just some quick comment. The Air Resources Board in some of the low carbon fuel standard workshop has expressed their strong desire to deal with indirect emissions associated with values change. So, that's on the table. And I don't think California's going to ignore that.

Danielle.

MS. FUGERE: I have a lot of questions but I'll keep it short. I have two short ones that are kind of related, which is how can you correlate the existence of fallow land with lack of impacts?

Because BC has 30 percent fallow land right now, but you see the Brazilian rainforest being cleared. So, I'm -- and shouldn't we measure what's actually happening as opposed to just assuming that the fallow land would be used?

And similarly, can you assume that increased ag prices are going to benefit the poorest people? Or is it going to simply benefit agribusiness, as it's done in the past?

So I would jus say we shouldn't just make those assumptions, but is there something to back those up?

MR. KLINE: I agree we shouldn't just make the assumptions. I think that's the problem we're in because people just made some assumptions. And I think it's definitely worthwhile to review more carefully what's going on.

Again, if you look at the trends, projected, it's not just that they're going to grow soybeans anyway in Brazil. But they've been increasing at a very steady and very rapid rate in Brazil, and they're basically on track.

But even those trends can change and have blips based on weather and infrastructure and breakdowns and different institutional circumstances.

I think that biofuels are an incredible

opportunity to help achieve this better equity for the small farmers if we do it right. And it's such an opportunity we'd be crazy to pass it up.

So, yeah, sometimes increased prices don't always trickle down or get to everyone we want. That is reality. But, in general, the comments that have been made, I've seen not only have we -- we, the developed nations with subsidies -- put a lot of food in these countries, we put so much in it that it just sits and rots.

I've been -- the U.S. Agency for International Development has actually spent fairly large sums of money in several countries to dispose of food we've donated that's rotting in countries that have starving people. I mean, it's just -- there's a lot of things going on out there we need to review and analyze how we can move things in this positive direction.

DR. CASSMAN: And just quick on that. You're so right. Higher prices are necessary but not sufficient. My point only was that the way the trend -- the 50-year time trend of decreasing value of agriculture was the most unsustainable trend on earth.

But now we have an opportunity. And

it's only an inroad that we have to take advantage of.

DR. DALE: Can I make one more comment? I promise --

MR. ADDY: Yes, please, go ahead.

DR. DALE: -- I'll be direct and hopefully pretty brief.

I overstated to make a point, okay. Obviously, if you're directed by the people that we serve, to measure or to try to estimate indirect, of course you have to do it. The Congress says do it, of course, you have to do it. The California State Legislature says it, of course, you have to do it.

What I ask is that while this is happening that reasonable comparisons be made. And that the quality of the data, I mean if we're going to base important decisions on these kinds of calculations, then let's have some idea of how reliable they are. And why should that be controversial?

So, what I would say is let's really look at the output of these models and let's see what the uncertainty is in the numbers that they give us. That ought not to be too hard.

And if it can't be done, then let's let us know that. If it only gets one number, and there's no uncertainty with it, then I have my own conclusion, as a lab scientist, of what that number means. It means not very much.

Every single measurement I've ever made in my life has an uncertainty associated with it. I assume that those numbers have uncertainty associated with them. If they don't, then I'm pretty skeptical about whether the rest of it has any value.

So, let's see what the uncertainty is. Take it out. One model feeds another. One calculator, set of calculators, feeds another. And then take it that last step that I didn't get any pushback from anyone that either Searchinger or Fergione had looked at the management of the land post-conversion, okay. Nobody's done that.

I show you data based on our own work, those biofuel carbon -- been recovered rather quickly, depending on how you manage the land post-conversion.

And let's just work through the numbers and see what they tell us.

MR. ADDY: Thank you, Bruce. Any other

questions from the audience?

Yes, please come up. By the way, the Conference Manager has told me that I could go another ten minutes, but I'll take five minutes of questions and answers from the audience and the panel. And then I have two questions I would ask.

MR. VELASCO: Since we have a little more time and I got no answer on one of my questions, --

(Laughter.)

MR. VELASCO: -- I'll go for others. One, in terms of trade, I mean, you know, why should there not be the calculation of subsidies and trade distortions in these models? Because it seems to me, for example right now, the way, you know, our trade policy -- I mean if we're putting everything up there, you know, on the wall, let's just include the big one, which is right now if we're exporting ethanol from Brazil, in order to get into the U.S., guess what. We need to go through CBI, Caribbean Basin Initiative, to dehydrate. Otherwise we pay a huge tariff.

And there's an economic incentive to do that, because even though it costs us 30 cents a gallon, it's less than the 60 cents a gallon we're going to pay on entry.

Guess what. The dehydration is done with fossil fuels, because Caribbean countries don't have enough energy.

So what happened? The carbon footprint of the fuel that's coming into the U.S. is higher for Brazil just because we're having to go there.

Now, you say, well, that's so little it's irrelevant. I mean if we're going into details, you know, of this granularity, let's include this as well.

And along these lines I've sort of asked the question of along this, you know, there's some social components that go counter to some of the other things you're asking for here.

Example: You're talking about, I think I saw one slide, net employment being a positive. Well, actually it's the case in Brazil by mechanically harvesting the cane, which is something we need to do for environmental reasons and for others, is actually driving employment down.

Now, that's actually, I think, from the environmental community, some would say good. Others would say, well, that's bad. We lost

200,000 jobs in Brazil. Again, what do we tell the farmer in Brazil, what should he do. Because that's what -- you know, so we're being constantly asked.

And if your model's going to do anything, it's going to be to direct people to act a little better elsewhere.

So, if you can answer any of those questions, I'd be very appreciative.

MR. ADDY: Okay. Did you tease out the question?

(Laughter.)

MR. ADDY: You did? Could you answer the question, Stefan, please.

MR. UNNASCH: Yeah, add it to the to-do list of the general equilibrium model. They can predict jobs as well as dollar impacts.

But that might be a good sustainability metric to pop out of these models. I mean, it might not be accurate, but --

MR. VELASCO: But what's better? Technology or jobs?

MR. ADDY: Okay. All right, thank you. Please. Is there another question in the audience as he comes up? Okay. Go ahead.

MR. SIMS: Thank you. Ralph Sims from the International Energy Agency. And we just reviewed some of these lifecycle analyses, and it's going to be reported in conjunction with UNIP and OECD. And it's all a total confusing mess.

(Laughter.)

(Applause.)

MR. SIMS: If I was a policymaker, what would I make of it? And it's just -- it's reading in the media, as well as getting advice. And Bruce's comment, we're all going to get career jobs in this for decades, we haven't got time. I'm also involved with the IPCC, and we all know the messages about that, as well.

We haven't got the time. What's the message for the policymakers today, the key message for the policymakers today? And it can't be, give us more R&D, or whatever. What's the key message that the panelists would give to our current policymakers, not just OECD, not just United States, but in Ghana where they're now thinking of sugarcane ethanol, or whatever, as well? Thanks.

MR. ADDY: Thank you. That's a direct question.

(Laughter.)

MR. ADDY: Panelists? Here, Keith.

MR. KLINE: I'd answer there are several recommendations, but one very astute one is I think we can do a lot better at integrating our foreign assistance and foreign policy with our domestic policy when it comes to energy.

And we do provide a lot of foreign assistance, and it's totally independent of our trade policy, which is so independent of our domestic energy policy.

And if we started looking at it more strategically, and as you brought those together, we could probably do something in Ghana and in Central America and in several places that is going to be, as I tried to point out in my presentation, a win/win/win. Win/win for energy security; win/win for food security; and win/win for development.

DR. CASSMAN: Bottomline from my view. Biofuels have been the only thing that has raised the value of agriculture, giving the chance for half of the world's population to rise out of poverty.

Because there are some biofuels that are on the shelf ready to go and expanding rapidly, make sure we get the lifecycle assessment right for those. Spend much less time on hypothetical ones.

And, again from my view, when you do that, corn ethanol is not so bad. And make sure you don't mix and match a value that's so uncertain that the range of uncertainty around it is larger than that value plus the value from the direct effects.

Don't mix and match things that are so qualitatively different that it can change the whole course of your assessment with significant policy implications that eventually could be the wrong ones.

MR. ADDY: To the panelists, this is an important question that California will be considering an important factor.

Do you have any thoughts about how environmental justice issues might be characterized or considered or included in a sustainability evaluation of fuels?

DR. DALE: Yep. Give poor people a chance to grow a lot of fuels and make some money so that they can at least afford to inoculate their children and have a decent life.

MR. ADDY: Okay. Keith, first, then John.

DR. DALE: I am single minded, yes, that's true.

(Laughter.)

MR. KLINE: I think that some issues are more process-related than the typical kind of criteria-related.

A lot of the environmental justice issue, where I see it, is about having stakeholder participation and a little bit of control over decisions that affect them.

And so if the process is done right, with their participation, I think that would be how you would address that issue.

MR. ADDY: And the last question from John.

MR. SHEARS: Yeah, it's not so much a question as an observation. And that is, you know, we're talking about all of these issues within the context of biofuels. And I agree with Keith that, you know, it's helped elevate a lot of these issues.

But we are living in a climate-constrained world here. And this same conversation eventually is going to be applied to food production.

So I just want us to be cognizant of the fact that while there seems to be this philosophical difference between is it okay for food, but it's not okay for biofuels.

We're going to be coming and butting our heads up against some of these same issues as we try and figure out how to, you know, manage this whole rigmarole around climate, when we start looking more closely at aspects of food.

So, just wanted to add that observation to the conversation.

MR. ADDY: Thank you. And just to close this out, I'd like to get your attention back into the question of this session, which is how to best assess sustainability within the framework of lifecycle assessment, taking into account short-, medium- and long-term research strategies.

A couple of things came out of this conversation. One of them is that sustainability should be looked at, but perhaps in a contributory fashion and not necessarily in the conventional way that lifecycle analysis or assessment have been done.

And we probably want to expand our thinking and understanding of lifecycle as it applies to sustainability.

There was an interest in modeling some of the economic effects related to biofuels production.

Last comment is that although we focus on biofuels in talking about sustainability, sustainability also applies to the consideration of the other alternative fuels.

And I'd like to thank the panel members for gathering so closely together around the table.

Diana.

MS. SCHWYZER: Thanks, McKinley. I'm Diana Schwyzer from the Energy Commission, as well. And I'll be very brief.

Just first of all, a quick announcement. If anybody is missing their sunglasses, Rivo brand.

MS. SPEAKER: (inaudible).

MS. SCHWYZER: Okay, I'll give them to you, Sharon, and you can give them to him.

And beyond that I'd like to thank our

panel again, and audience, for participating in this discussion.

(Applause.)

MS. SCHWYZER: Yeah, really interesting issues came up here in the lifecycle assessment, sustainability, land use change.

I know at the Energy Commission we do take the potential indirect land use change impacts very seriously. And we've been closely following the work, the academic work, and the debates on these topics.

And we're looking forward to the results of the current studies going on at UC Berkeley for ARB, as well as the contract that we're initiating that McKinley mentioned, and all the other work that's going on on this topic around the world. I just wanted to add that.

And now tomorrow we have a great lineup of speakers on certification, industry practices.

And finally, a wrap-up of what all this means for state policies, especially the low carbon fuel standard, AB-118, and AB-32, our big climate change policy.

So, please note that we start at 8:15 tomorrow, not 8:30. So, look forward to seeing you all bright and early in the morning.

Thanks a lot.

(Whereupon, at 5:23 p.m., the second day of the California Biomass Collaborative Joint Annual Forum was adjourned, to reconvene at 8:15 a.m., Friday, May 30, 2008, at this same location.)

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CERTIFICATE OF REPORTER

I, PETER PETTY, an Electronic Reporter, do hereby certify that I am a disinterested person herein; that I recorded the foregoing California Biomass Collaborative Fourth Annual Forum; that it was thereafter transcribed into typewriting.

I further certify that I am not of counsel or attorney for any of the parties to said forum, nor in any way interested in outcome of said forum.

IN WITNESS WHEREOF, I have hereunto set my hand this 4th day of July, 2008.