TETRA
Moderator: Dana Warn
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DANA WARN: Welcome to the second West Coast Webinar of a three part series on climate change, waste prevention, recovery and disposal organized by the Environmental Protection Agency Region 9 and 10 offices. We are happy to have you participating.

This Webinar will cover compost and landfill issues. Before I introduce today's speakers, let me turn the line over to (Tommie Jean) from Tetra Tech to go over some of the call logistics.

TOMMIE JEAN (ph), TETRA TECH: Thanks, Dana (ph).

TOMMIE JEAN: Welcome to everyone. Thank you for joining us today. This is a recorded session. During the session slides will be moved for you and, your lines will be muted. If you can't see the presentation or, if you would just like to download them to have, I'll send an e-mail – or, an URL out so that you can click there and download the presentation yourself.

If you have questions, the only way to ask them is to type them into the chat box. If you look at the right hand side of your screen, you'll see a chat box there. That's where you can type in technical questions you might have about this technology or, any issues you're having. You may also ask questions about the content of the presentation.

At the end of each presentation, we have five or 10 minutes set aside for questions. And, we'll read them aloud over the phone and, the speakers will answer them live. At the very end of the Webinar we'll also have five or 10 minutes set aside for additional questions. So, if you think of something for an earlier speaker, please don't hesitate to type it in at any time. If we don't respond to one of your questions on line today, we'll try to e-mail you a response later.

You might note that there's a raise your hand feature. Unfortunately, we can't respond to those. So, please don't use the raise your hand feature. All you need to do is use the chat feature to talk to us.

We also like to get some feedback from you on these climate change sessions. At the end of the Webinar today a pop up window will display asking you about four different questions. How effective was this? The contents and technology? We'd love to get your quick responses. They'll probably only take you one or two minutes to answer them. In addition, we'll send you an e-mail later with a more thorough survey so you type in comments if you have additional ones.

And, that does it for me. For technology remember to use the chat feature on the right hand side. And, Dana (ph), I'll hand it back over to you to introduce our speakers.

DANA: Thanks Tommie Jean (ph). Today will we have four great speakers. We're going to hear more about the greenhouse gas implications of landfills and composting.

As I mentioned, this is a second in our series of three Webinars. The first session provided an introduction to climate change and materials management and covered some background material for this session. If you were not able to join us for our session, the materials are available on our Web site for you to download at your convenience.

Our first speaker today will be Stephanie Young. Stephanie Young is a waste management engineer for the Waste Compliance and Mitigation Program of the California Integrated Waste Management Board. She has 14 years of experience in the solid waste management field and, is currently responsible for facilitating the climate action team's recycling and waste management subgroup, managing projects under the California integrated waste management board's climate change landfill methane capture strategy and, providing technical engineering assistance to both internal programs and external agencies. She will provide us with an overview of the connection between climate change and landfills.

Following Stephanie (ph), we'll hear from Sally Brown and Brenda Smyth (ph). They will be covering the connection between compost, organics and greenhouse gases. Sally Brown (ph) is a research associate professor at the University of Washington College of Forest Resources. She is a member of the National Academy of Science Standing Committee on Soil Science, is on the Chicago Climate Exchange Committee to develop a protocol for methane avoidance from landfill diversion and, has a monthly column in BioCycle on greenhouse gases.

Brenda Smyth is currently a division chief for the California Integrated Waste Management Board in charge of the state wide technical and analytical resources division that works on projects related to organics, green building and conversion technologies, climate change, extended producer responsibility, tires and special waste. She has 24 years of experience in both the public and private sectors.

Finally, we will hear from Gary Liss who will cover Zero Waste activities and their connection to climate change. Gary Liss has over 35 years of experience in the solid waste and recycling field and was a founder and past president of the National Recycling Coalition and, was solid waste manager of the City of San Jose, California. He has documented zero waste businesses, developed zero waste business principals, helped the Salt Lake City Olympics and the world summit on sustainable development in Johannesburg achieve zero waste and helped organize zero in on zero waste business conferences.

All of these speakers' full bios are available on our Web site if you'd like to read more about their experience.

We will pause and answer questions briefly after Stephanie Young's presentation, after Sally Brown and Brenda Smyth's combined presentation, and after the presentation from Gary Liss. We will also have time for questions at the end of this session. We know this is a long Webinar. We don't have any breaks planned but, we will be posting a full transcript and audio file of the Webinar including the question and answer sessions to our Web site. So, if you need to step away for a few minutes you can catch up on any content you miss.

Thank you very much for participating, let's get started.

STEPHANIE YOUNG, WASTE COMPLIANCE AND MITIGATION PROGRAM OF THE CALIFORNIA INTEGRATED WASTE MANAGEMENT: (INAUDIBLE)

Thank you Dana (ph). Let me see. I've got control. So, I'm letting – I'm just letting the disclaimer sit up there for a little bit. And then, I shall move on to the start of my presentation.
So, good afternoon, everyone. And, welcome to the Webinar.

Today I've been asked to talk about landfills and how they affect climate change. Primarily the emissions landfills gas and, most importantly, it's methane component.

So, understanding emissions from landfills is an important element to understanding the relative benefits of certain waste recovery and erosion activities such as composting, where methane avoidance can be a significant (INAUDIBLE).

So, on this slide, this is where I'd like to kind of go over today. I will first discuss some basics of the (INAUDIBLE) behind landfill emissions. Talk a little bit about how these emissions can be controlled. And, end with examples of California's efforts related to landfill emissions. So, just to warn you, I will be speaking more from a technical point of view. Because my primary duty at the waste board is to provide technical engineering assistance to the clean up (INAUDIBLE). So, my experience in general has been the field (INAUDIBLE) or, project manager that coordinates, organizes and executes large scale engineering projects at landfills from concept stage through permitting, budgeting, contracting, construction, start up and, ongoing maintenance. So, just to give you an idea of my point of view, I'm just one of those people that actually gets done – gets things done in the field. So, let's begin and talk a little bit about landfills.

So, on slide number four right now. So, why are landfills being targeted? Well, landfills produce methane, a very potent greenhouse gas. So, according to California Energy Commission's 2005 consultants report title Research Roadmap for the Greenhouse Gas Inventory Methods, landfills are the largest source of anthropogenic methane emissions in California. In EPA's in 2008 report titled Inventory of U.S. Greenhouse Gas Emissions and Sinks from 1990 through 2006, the EPA stated that landfills accounted for approximately 23 percent of the total U.S. anthropogenic methane emissions in 2006. Which is the second largest contribution of any methane (INAUDIBLE) in the United States. The first be enteric fermentation (INAUDIBLE). So, however – and, however, more recently the California Air (INAUDIBLE) Board completed their emission inventory where emissions from landfills were estimated at 5.62 million metric tons of carbon dioxide equivalent in 2006 and, 6.26 in 1990. So, essentially, the landfill industry as met the 1990 goals today.

So, why is methane a potent greenhouse gas. Methane absorbs terrestrial, meaning as coming from the earth, infrared radiation. Otherwise known as heat, that would otherwise escape the (INAUDIBLE). In addition to being able to trap heat, it has a global warming potential 21 times that of carbon dioxide. Meaning that it's 21 times more powerful at warming the atmosphere than carbon dioxide. However, it has a chemical lifetime in the atmosphere of about 12 years. Which is relatively short. Thereby, it – thereby, making it a great candidate for mitigation efforts over the near term.

So, just to mention though, that methane is not only a potent greenhouse gas, it also has several potential threats to the public health and environment. It is potentially explosive in volume (INAUDIBLE) five to 15 percent methane and air. It is an axphytiant in confined spaces, which means it displaces the air we breath. And, it's odorous, toxic and contains ozone (INAUDIBLE) otherwise known as volatile organic compound or, VOCs.

So, moving on to the next slide. How do the landfill produce it's methane? Well, it's actually a very complex analytic biological process. So after being put into the landfill, the biogenic waste such as the paper, food scraps and yard trimmings, is initially digested by air aerobic bacterial. After the oxygen has been depleted, the remaining waste is available for consumption by anaerobic bacteria which can break down the organic matter into substances such as cellulose, amino acids and sugars. These substances are further broken down through fermentation into gasses, a short changed – chain organic compound that form the sub strength for the growth of methanogenic bacteria. Methane producing anaerobic bacteria can put these fermentation products into stabilized organic materials and natural gas consisting of approximately 50 percent carbon dioxide and 50 percent methane. By volume and some other little subsection to volatile compounds in our (INAUDIBLE). However the methanogens do depend on how much waste is there, what types of waste, preferably organic decomposable types, how much moisture exists, the climate which kind of relates back to the moisture and barometric pressures. And, how old the waste is. So, all these factors help determine how much and how long this process of making methane will occur. Significant methane production typically begins one or two years after waste disposal in a landfill. And, may last from 10 to 50 years. Sometimes longer depending on where this landfill is.

Next slide. OK. Oh, oh. Oh, went too far.

OK, it's taking. OK. OK, great.

So, this graph is in practically every textbook or guidance document that talks about landfills and landfill generation. So, I thought I'd put it up here and share it with you today. So basically it shows how the composition of landfill gas changes over time with how the early list and free fatty acid volumes are consumed over time. The time scale's not really (INAUDIBLE) and, it's different for every site depending on the conditions mentioned in my previous slide.

So, just to go over the phases a little bit, you'll see over the top – if I could get a pointer here. Oh, there it go. So, these are the phases, one, two, three, four and five of the landfill gas composition by volume. Cellulose fatty acid over time.

So, phase one is when the biological decomposition occurs under aerobic conditions. The primary byproduct of this is carbon dioxide. And phase two is when all the oxygen present is completely consumed and the analytic bacteria begin to grow. Phase three is a stage when acid, such as acidic, lactic and formic acids start to develop after they are converted by the anaerobic bacteria. In this stage the ph starts to drop due to all the acids and, carbon dioxide and hydrogen are the primary byproducts. In phase four, is when a second group of micro-organisms, or the methanogens (ph) convert the acetic gas and hydrogen gas to methane and carbon dioxide. This creates a more ph neutral environment for the methanogenic (ph) bacteria to establish itself. Methane and carbon dioxide are the primary byproducts in this stage. And then, lastly, phase five is when after most of the readily available biodegradable organic material has been converted to methane and carbon dioxide, (INAUDIBLE) action begins to slow down and it's further retarded if not enough moisture is present.

I'll move on to the next slide which should be slide seven.

So, what happens to all the methane that is produced? So, this slide kind of shows the different methane pathways. So, it is either emitted into the atmosphere – let's see if I can get the pointer out of here. Emitted into the atmosphere. It is oxidized in the soil zone. Or, it could be recovered and flared, which is burned off, or converted into electric – electricity, or metho gas to energy.

So, notching here because the reception it's e rather insignificant is methane that laterally migrates from the waste mass. Or, methane that is stored in the waste mass. And, this is not to be confused with carbon storage material. My focus is actually the methane that kind of is retained in the waste mass during this process. And, carbon storage would be 30 minute topic on it's own which I do not have time to cover today. But.

So, climate change efforts emissions is of most concern. Methane not captured which is not naturally oxidized and substances are removed by controls and released to the atmosphere as fugitive emissions. The current methods for capturing methane and other pollutant emissions from landfills have been subject to intense scrutiny. The major concern is that the estimate makes assumptions which do not take into account all relevant factors that can have an influence on actual emissions. Methane emissions difficult estimated with high degree of uncertainty by modeled and by direct measurement. Which I will talk more about in greater detail, later.

Also, (INAUDIBLE) in California, increasing – there's an increasing chain of organic waste stream that is (INAUDIBLE) from landfills and is composted. These composting facilities are managed in (INAUDIBLE) and, reduce methane production which Brenda and Sally will talk more about later.

Now, I'll move on to the more technical part of the presentation. So, how are these methane factories determined? Since emissions are what we're concerned with, I'll work my way backwards, beginning with the methane recovered to what oxidized and generated in (INAUDIBLE) what's fully emitted.

So, start with how we can determine how much methane is actually recovered from our landfill. There are two ways. The direct measurement and, indirect calculations.

So, the direct measurements. This is where methane is recovered by an active system of vertical wells or horizontal collectors. The recovery is directly quantified by mass store measurement. The methane recovered is directly calculated from measured flow rates and, the methane concentration. Which, are typically taken at the main header line from the entire system to the actual collection and control device which could be the flare or the energy recovery system.

So, assuming that the methane concentration is constant between measurements, you can multiply the two and actually get a direct measurement of what is actually being recovered. But, indirectly, say that your landfill doesn't have a landfill gas collection system, then another method of calculating potential recovery is to use a landfill gas generation estimation model such as the Environmental Protection Agency Landfill Gas Emissions Model, also known Land Gen. And, the Intergovernmental Panel on Climate Change or, IPCC's first order decay model or, you can hire a consultant that has good proprietary models which, for the most part, in my experience, has been same models, the IPCC or the Land Gen, but they use site specific data to calibrate them. Then, using an assumed collection efficiency, meaning the percent at what a comprehensive system is capable of capturing, the amount recovered is simply the multiplication of the collection efficiency and the model's estimated generation rate in standard cubic feet per minute. This method is typically used when designing the system, especially to (INAUDIBLE) the blower of our (INAUDIBLE) control device systems.

Next is methane oxidation. And, we should be on slide nine right now for those of you who are not following on the Webinar cast.

So, microbial methane oxidation is carried out by methanotrophic (ph) bacteria or, methanotropes (ph), which is not to be confused with some methanogenes (ph) that create methane as discussed earlier. These methanotrobes (ph) possess a specific enzyme which allows them to oxidize methane to methanol, which is then further degraded to carbon dioxide. So, previous to field (INAUDIBLE) that a significant portion of the methane present in the cover is oxidized by endogenous methanotropes (ph) and (INAUDIBLE) between ten to 100 percent. And, in some cases it was shown that the methanotropes (ph) even consumed atmospheric methane for dumping in a negative flux.

And how we change that, there's some atmospheric methane that's in the atmosphere and some methanotropes (ph) were not using enough methane from the landfill flow will actually suck in methane from the atmosphere and treat it. That's why there's a negative flux.

So, what affects this is the effectiveness of the cover and it's thickness, physical properties, moisture content and temperature. The oxidation rate also relates the amount of methane being released to the landfill surface. So, if there's no methane, there's no methanotropes.

So, the two techniques are the direct technique is to have the new diminished studies to measure oxidation it's called the stable column isotope technique. Concerns a preferential oxidation of the elemental carbon 12 over the elemental carbon 13 in methane by the methanotropes, it is possible to determine the oxidized fashion by quantifying the change in carbon 13 of methane between the (INAUDIBLE) surface. So anaerobic zone gas can be collected from recover headers and wells or, probe center directly into (INAUDIBLE). Or a gas reflecting methane oxidation was collected either in a static flux chamber or, through upwind or down wind air sampling along selected (INAUDIBLE). So, I've included a link to a paper by Borgess (ph) and Champton (ph) (INAUDIBLE) regarding this technique if you'd like to learn more.

So, they indirectly it has been well established that landfill cover sills provide poor measure of oxidation of fugitive metho as it travels to the landfill surface and methanotropic micronisms are present in most soils.

So, our fit together, in this slide, which kind of shows all the different studies that are out there and breaks down what the results were. The methane oxidation and maximum rate. And the faction of the methane that they showed to have been oxidized by these different cover soils or, biofilters. And, this actual table was done by a consultant as part of an exercise. So, a guidance document on reducing landfill methanes that I will talk more about later. So, I thought it would be helpful for you to have this. Move on to the next slide.

So, let's move on to the methane generatim. There are many direct for measurement methods for this part. And, actually, I only know of one company that has developed a direct measurement landfill gas exhumation method. And, that company is Hydrogeal (ph) Chem Incorporated. But, there're a probably a few others. Others (INAUDIBLE) direct measurement have to do with the generation models and determining parts of the specific values for the (INAUDIBLE). I'll go into greater detail about those areas in the (INAUDIBLE) section.

The barrel pneumatic method consists of accurate measuring and analysis of the (INAUDIBLE) in the landfills and natural variations in barometric pressure. The method is based on gas oil principals and independent estimates on the gas probability of the cover, refuse and surrounding soil. I haven't seen this in action, myself. But, I provided a link for more information if you'd like to learn more.

So, since there aren't many direct methods, the method intervation (ph) can be indirectly estimated using either actual landfill gas system recovery data and, an assumed collection efficiency to calculate what is generated to kind of divide the two. However, the most widely used indirect method is use the first order decay model.

So, the first order decay model is based on a first order reaction. Where the amount of product is always proportional to the amount of reactive material. Which means that the year in the waste material was deposited in the landfill is irrelevant to the amount of methane generated each year. It is only the total mass of decomposing material currently in the site that matters. And, also it's age.

The two most predominant first order decay models are the landfill gas emissions model, otherwise the Land Gem developed by ET and the Inter-government Panel on Climate Change Model or it's shortened as IPCC.

The Land Gen can be used to estimate total landfill gas and methane generation as well as emissions of carbon dioxide, non-methane organic compounds and individual air pollutants from landfills. Land Gen primarily uses defaults from model inputs based on empharical (ph) data from the United States landfills. Primarily decay value, which is the methane generation rate. And, the L mott (ph) value which is the potential methane generation capacity. The methane generation rate, decay rate, determines the rate at which the methane is generated from the waste in the landfill. The higher the value of decay, the faster the methane generation rate increases and it decays over time. So, it generates really fast and then, it slows down. So, you get most of the generation out in the first few years.

The value of decay is primarily a function of four factors. The moisture content of the waste mass. The availability of the nutrients of micro organisms that breakdown the meth – break down the waste to form methane and carbon dioxide. The ph of the waste mass. And, the temperature of the waste mass.

Now, the potential methane generation capacity or, the L mott (ph) value depends only on the type and composition of waste placed in the landfill. The higher the cellulose content of the waste, which is the degradable part, the higher the value of L mott (ph). Field test data can also be used in place of the model default when available. But, it can be cost intensive to perform. The IPCC model purposely expound decay and L mott (ph) values are allowing inputs of actual waste composition and landfill conditions. So using inputs from model then calculates decay and L mott (ph) values that are appropriate for the landfill that are used in this model. But, please note that there are many uncertainties associated with the special or a decay model. It's (INAUDIBLE) difficulty for the methodology is that (INAUDIBLE) waste a positive in the landfill is required. And, though, specifically, the type of degradable material – for example, yard clippings to trees, to food, all require. These data are required, ideally, on a yearly basis and are not readily available. And, in California we do have waste characterization studies that have California specific values that is to be probably better used for farming purposes, not necessarily measurement. So, let's methane a lettered (ph), which would be slide 12.

Finally, I'll talk a bit on methane emissions from landfills. Methane emissions are a function of several factors including the total amounts of municipal solid waste in landfills, broken down annually, the characteristics of landfills receiving waste. Such as the composition of waste in place, size, climate, (INAUDIBLE) and (INAUDIBLE) systems and, amount of methane that is recovered and either flared or used for energy purposes. And, the amount of methane oxidized in landfills and in cover soils instead of being released into the atmosphere. Next slide.

So, there are many different techniques of direct measurement of landfill emissions. As seen in the following slide. However, there are many pros and cons. With the biggest (INAUDIBLE) issue evolving around determined actual flux of methane from the area of the landfill and mass produce coordinator today. I've provided the table key but, will not go into much detail on each one. I will however talk about the two that are currently being researched, the flux chamber method and the optical remote (INAUDIBLE) or, radio (INAUDIBLE) mapping. And, I've (INAUDIBLE) a slide provided where I got the tables from just in case you'd like to research it more.

So, the first table. You can move on. This is the first part of the table that kind of describes the methods. Gives the description. Has advantages and disadvantages and, overall opinion. This is the document that California Energy Commission put together when determining their research goals for climate change back in – I believe it was 2005, 2008. So, this is the first one. And, to the second (INAUDIBLE). Here it is, 2005.

So the methane emitted part. The two methods of direct emissions monitoring is the flux chambers and, the optical remote sensing radial plume. And, for those of you that like to use just a little bit more about, I provide some more information. The first one's the EPA User's Guide on Emissions Isolation (INAUDIBLE) Chamber. And, the second one is actual PowerPoint presentation done by Miss Susan Thornbaugh(ph) of the EPA on her optical remote sensing and radial plume for mapping. There you go.

So, this slide kind of shows photos of a landfill in California where both techniques were being used. On the left is the flux chamber. And, on the right is kind of like a (INAUDIBLE) view of the radio (INAUDIBLE) mapping and optical remote (INAUDIBLE).

So, the flux chambers are used to determine of subject compounds emitted from land or the quick surfaces. The flux chamber is set up to include a known surface area. It is introduced to the chamber to mix with emissions and transport them to the collection device. The chamber should be designed to create a best mixing and sampling conditions without altering the emissions of gases at the surface. The samples collected are used to determine the actual flux of (INAUDIBLE) at the surface in micrograms per square meter per minute. But note, due to the configuration and size of the flux chamber, it would be difficult to install it around well penetrations. So, on the left side here we have the flux chamber being installed on the surface. And, they have to insure that there's a tight seal between the cover soil and the actual flux chamber, itself. And, on the top one, is the cover, which has a mixing component and a (INAUDIBLE) component. So, as you can see it's kind of hard to put it up against a well penetration which would be on the upper right hand side. So, in this situation the site for study (INAUDIBLE) placed flux chambers out to get an idea of what that look of flux might be from this certain penetration.

Now the optical remote sensing with radial plume was developed at the University of Washington. And, in 1999 researches from the U.S. EPA Air Pollution Prevention and Control Division of the National Risk Management Usage Laboratory and arcadists began work investigating and capturing emissions from area sources using this method. The radial plume mapping method uses a simple configuration of non-overlapping radial plume geometry to map the concentration distributions in the (INAUDIBLE).

So, basically what happens is these two little devices, one is a vertical radial plume mapping device and, the other one is a horizontal one. So, there's a set of deflectors that set up horizontally along the surface. And, also some deflectors are actually set up on the (INAUDIBLE). And, they set the – they send the laser beams to these deflectors and composition data across the plane. So, it's horizontally and vertically.

So the – so, using the – they actually have software. So, using the optimization algorithms in the software to tap into it's concentration data, it's converted into spatially distributed concentration maps. (INAUDIBLE) locations of the emissions and (INAUDIBLE). And, the vertical radial plume mapping configuration consists of several optical beam paths deployed down wind from a area source. So, incorporating the wind information, the flux of the plane can be directly calculated leading to a direct measurement based estimation of an emission rate from the upwind air wind source. But, I want to note that the study is currently underway. So, that's actually (INAUDIBLE) to how to compare or not at least. I thought this was a pretty nice dramatic of a flux chamber.

So, I want to note that measuring emissions directly is very difficult. One problem is that our landfill surface emissions are extremely heterogeneous spatially. According to some studies, the heterogeneity of landfill emission is best integrated by a large scale, direct measurement techniques, set add to total measurement for entire surface area can be (INAUDIBLE). And, according to others this problem can be overcome by using multiple measurements using a simpler technique as the chamber method. Some (INAUDIBLE) have found a good agreement, about less than 10 percent difference, between chamber and (INAUDIBLE). And, argue that if properly done both methods are reliable.

Other researchers argue that static chambers can hardly be trusted for making more than small scale estimates of landfill gas emissions because it kind of takes enough (INAUDIBLE) surface area the chamber itself, anyway. But most researches, even those who found agreement between chamber reading (INAUDIBLE) and crew methods, were never possible because of their simplicity. So, Borgess (ph) in a communication in 2004 notes that the failure to account for the heterogeneity of emissions or, the failure to cover the hot spots of emissions, resulted in factor or four difference between chamber and chaser methods. And, a large sampling (INAUDIBLE) are extremely laborious because of the number of samples needed and the resulting large amount of data which result in chambers not being accepted or large scale flux measurements. So, it's clear that if the chamber methods are to be used it is best that researchers utilize methods that account and (INAUDIBLE) for any distortions that this method may create as a result of spatial heterogeneity.

So, on to slide 19 where continuous methane emissions. So, since there is quite a bit of uncertainty when trying to directly determine actual air emissions from an entire landfill surface, many have relied on the old indirect method of using the first or, the decay model, to estimate the amount of methane generated. From that, if a landfill does not have a system in place, the amount emitted would simply be the amount generated, minus what is oxidized. But if a landfill has a comprehensive gas collection system, EPA identifies that 75 percent of a default caution efficiency to use with technology gives many people heartburn. The amount emitted would then be the amount generated, minus the amount collected or controlled, minus the amount oxidized.

So, I want to go (INAUDIBLE) the 75 percent collection efficiency a little bit further on this slide. So, natural gas collection efficiency is the amount of (INAUDIBLE) gas as collected in the system compared to the amount generated. As mentioned, there's quite a bit controversy around the 75 percent collection efficiency value. A study was done by the Los Angeles County Sanitation District where they found their systems to be 100 percent efficient in collecting the gas. In other studies show between 85 percent to 99 percent, especially the systems that are compliant with the Federal (INAUDIBLE) regulations, specifically the new (INAUDIBLE) performance standard where emission guidelines rule with the (INAUDIBLE) of MSPSET, (INAUDIBLE) collection efficiencies higher than 75 percent or, landfills must meet stringent surface emissions performance standards. But on the other hand, (INAUDIBLE) collection efficiencies are for those landfills that are not regulated under federal rules but, do have systems in place for other reasons such as water quality degradation or, gas migration control. However, with any method, estimating methane emission can be problematic due to the high spatial variability of emissions. So, no one surface is alike. And, heterogeneity of air mass (INAUDIBLE) rates and variations of landfill and a climate. So, until consensus or near consensus could be obtained on how the collection efficiency can be determined or, tested in a site specific manner, it appears as though we're stuck with the 75 percent default.

Next one, which is slide 20.

So, how can we control what emissions do escape from the landfill? First of all, one could keep the degradable stuff out of it in the first place. Such gleaner food material, shrubs and bushes, trees, anything else organic. The gleaner food material can be composted, the paper could be recycled and, other remainder composite organics anaerobically digested, which is an emerging technology. In some marks they'll even segregate organically into dedicated landfill cells so they can control the decomposition either aerobically or anaerobically with highly designed capture systems. The rest are considered engineered operational control centered, installing recovery systems before regulations require, changing the landfill gases from design, operating and maintaining their existing systems differently, increasing monitoring to be able to detect leaks better or, changing the way they build their landfills in the first place, such as a bio-reactor. An owner or operator may often elect to install a bio cover to oxidate methane as conditions allow. A more comprehensive discussion on each of these items is provided in the California (INAUDIBLE) with Management Publication 300-08-001. Don't bother writing that down, it's in another slide. I provided that. And, it's titled Technology and Management Practices for Reducing Greenhouse Gases from Landfills. And, it may be downloaded from their Web site.

So, what are some of the things California (INAUDIBLE) is doing. Well, these are just a few examples of the projects currently underway. And, by no means, is this an exhaustive list. So, we're on slide 21 right now.

So the Climate Action Team which was created by the Environmental Protection Agency in response to Governor Schwarzenegger's executive order S-3-05 identified a strategy for increasing landfill methane capture to reduce methane emissions by 2020. The landfill methane capture strategy includes three core components. The first is to install (INAUDIBLE) control systems in landfills currently without control systems. Second, is to maximize landfill methane capturing systems (INAUDIBLE) for optimizing landfill design operation, closure, post closure practices. And, the third is to increase recovery of landfill gas for use in bio mass renewable energy source to replace energy from non-renewable fossil fuel functions.

So, under the first one, the California Air Researchers Board is currently developing a control measure that will reduce landfill meth – excuse me, methane emissions by requiring control systems where systems not currently required. And, performance standards for maximum control. They hope to achieve one million metric tons of carbon dioxide equivalent of emissions reductions from this measure.

Under the second one, and, there are several activities going on. The first is the waste board retained SES engineers to develop the (INAUDIBLE) document to help landfill operators and regulators evaluate potential actions to achieve additional greenhouse gas emission reductions from landfills. The one what are already currently occurring with existing landfill practices and, on the slide is the link that I promised to that particular guidance document.

The second one is the Waste Board also has a project to research the long term performance and maintenance of green material to oxidize from the landfill sources. This is anticipates a wide spread use of the smaller landfill that may not be able to meet the performance standard set by ARB. And, this operation would require fresh, green material that chipper and equipment to (INAUDIBLE) over the surface. So, pretty simple. And, the study is expected to be completed in 2010.

And, the last one there. There's a lot of ongoing research on how to at these emissions portion of the equation. The California Energy Commission is funding a project a solid (INAUDIBLE) sound and practical detailed landfill methane emissions model and, inventory methodology to account variation across landfill type specific characteristics, climate and oxidation covering soils. They plan to collect two years of field data and outland for the different climate regions throughout California using flex chambers to obtain emission factors and radial plume mapping at one landfill to provide additional fields of validation. Waste management is also doing their own research on the radial plume mapping which they plant to share the information with the California Energy Commission's project team. And then, the Los Angeles County Sanitation District has already a paper on how they recommend their landfill owner to determine their collection efficiency.

(INAUDIBLE)

OK. And lastly, but no small effort is the last one.

To recover landfill gas to produce energy has been increasingly hard in California due to the stringent air regulations. So, project both demonstration or research are focused on not only demonstrating the technology, such a liquefied natural gas. But, working to find answers to existing technologies to comply with regulations. (INAUDIBLE) were the California Energy Commission's public interest energy research program is trying to do.

So, the California Public Utilities Commission or, SPUC is also trying to even go beyond that by extending the recent assembly bill of 1959 which currently only provides funding for renewable technologies at water and waste water treatment facilities. They plan to extend their funding to all types of facilities that produce renewable energy.

And, not on this slide but, I would like to add a little bit about how landfills are being handled on the carbon trading market. The California Climate Action Registry developed a landfill project for reporting protocol which was accepted by the board in November, 2007. An eligible project is the installation of a landfill gas control system for capturing and combusting methane gas that meets all performance criteria and exceeds all regulatory (INAUDIBLE) including local state and federal. And, also commences operation on or after January 1st, 2001. But, not may landfills, if any, will be able to meet the requirement of (INAUDIBLE) protocol due to the pending A – Air (INAUDIBLE) regulations and the stricter rules that apply to all regulatory agencies, not just the Federal, unlike the Chicago Climate Exchange. And, under the Chicago Climate Exchange, entities and individuals in the waste management sector can participate by registering their (INAUDIBLE) which (INAUDIBLE) the emission credits owned by (INAUDIBLE) projects that sequester, destroy or visibly screen off gas emissions. Their (INAUDIBLE) landfills, although not required to collect methane by law per the NSPS. And, methane (INAUDIBLE) projects put into service on or after January 1st, 1999 may qualify.

So, that actually concludes my presentation. I appreciate you listening. And, we'll try to answer any questions that you have. Thank you.

TOMMIE JEAN: Thank you so much, Stephanie. We did have a few questions come in and I want to let people know that they can go ahead and keep on typing in questions. But, let me give you a few right now.

You we're talking about methane capture? Has there been any data on methane capture for alternative daily cover produced from yard debris?

STEPHANIE YOUNG: Not that I know of. Let's see. So, that's actually study looking at ADC on top of – I'm trying to think. That might be difficult because ADC is put on daily and the next day someone comes in and they put a new layer of trash and then, another ADC. So, in order to study that on a daily basis might be difficult. But, I don't know of any actual studies that target ADC. I can look into that further.

TOMMIE JEAN: OK. That would be great.

A couple more questions. You were talking about direct measurement techniques. Is there any information on if measurements differ from each method or, are the fairly similar.

STEPHANIE YOUNG: Depends on which direct measurement. So, let's see, because like for the methane emissions there's the flux chamber and, there's the optical plume mapping. And, those are the ones that are actually being studies more now than all the others in the C (INAUDIBLE) document. And, some studies have shown agreement and, some studies have shown you know four times different. And, right now, this is what the California Energy Commission is doing with their study and, Waste Management is actually doing. So, that – those studies are actually underway. And, those comparisons are not yet available. But, there are some studies already out there that do try to compare the two. And.

TOMMIE JEAN: OK.

STEPHANIE YOUNG: And, they vary. They vary from being close to very far apart.

TOMMIE JEAN: All right. Let's see. So, we also have a couple questions about the multiplier for methane. So, and this, I think, specifically, (INAUDIBLE) view on number four. You were saying the (INAUDIBLE) lifetime in the atmosphere is 12 years, so the – (INAUDIBLE) referring to this stop trashing the planet report, and it suggest using a 20 year multiplier for methane resulting in 72 times CO_2 equivalent. Not, the 21 times CO_2 equivalent. Can you talk about that at all?

STEPHANIE YOUNG: Well, not too familiar with that report. I've seen in various other reports that the chemical lifetime is between 10 and 12 years. I haven't seen the higher one, that's why I used 12 years. So, I'm sorry, I won't be able to really give you a nice answer on that one.

TOMMIE JEAN: OK.

STEPHANIE YOUNG: Yes.

TOMMIE JEAN: (INAUDIBLE) like will be that of different documents, and so.

TOMMIE JEAN: OK.

STEPHANIE YOUNG: Yes.

TOMMIE JEAN: And, let's see, we have time for just a couple more.

Are flaring systems able to collect and capture more methane than landfill gas to energy recovery systems?

STEPHANIE YOUNG: Well, they – most the time they use in conjunction. So, they both use the same collection system which is the series of wells or horizontal collectors, they're actually inside the waste itself. So, they use the same kind of components of it. And, the energy recover of a flare is just the control device. So a landfill operator owner can choose to use one or the other. But, most of them that have an energy recovery component do have a back up flare. Because, sometimes the landfill generates more meth – more landfill gas than an energy recovery device can handle. So, they have both.

So, I don't know if one does better than the other. Because there's the flare can actually destroy (INAUDIBLE) construction of methane can destroy over 99 percent of the methane in the flare because of the high temperature. And, the energy recovery device can destroy – it depends if they – there's different kind of engines and, some can destroy 90 percent, some can destroy upwards of 95 percent. But then, if you think about the big picture, it's an energy recovery device. So, it's actually avoiding you know fossil fuel emission by you know converting those to energy. So, it may actually emit a little bit more, but it's also doing a great climate (INAUDIBLE) benefit by avoiding emissions of flare. I hope that answers your question.

TOMMIE JEAN: OK. Great.

A couple more here. I know we're throwing a lot of questions at you.

Do the UAPPA for (INAUDIBLE) Council Integrated Waste Management Board recognize a bio cover as reducing fugitive methane from landfills? And, if so, does the landfill have to measure how much is oxidized or, is there like a default value given?

STEPHANIE YOUNG: You know, that's what we're trying to get out. Because the table I showed shows many, many studies out there. They show that if (INAUDIBLE) certain things you will get this amount of oxidation. But, hasn't been applied. So, that's why the Waste Board is actually funding a study to actually look at that. And, come up with actual applied algorithms or, models that an owner operator can use by plugging in certain parameters to get it's actual oxidation rate from – depending on the material that you use, the climate that you're in, what landfill that you're – you know, what landfill situation you have and, what cover materials you already have in place, we'll be able to get that.

But, as for defaults right now, I know that EPA uses a default of 10 percent, to be conservative. Although their studies have shown between 10 and 50 percent. And, more recently studies have shown greater than 50 percent, even, at that. So, but as for an actual model that could be applied and (INAUDIBLE), they actually (INAUDIBLE) these oxidized numbers backed up with data, like how you take that data, in order to put it into the model. But, you get defensible results. That's the Waste Board is working on right now.

TOMMIE JEAN: OK. Great. Maybe we have time for just one more.

So, can you – are there any examples of co-location to use methane for energy production for other renewable energy production like bio diesel coke?

STEPHANIE YOUNG: There are landfills – there is a landfill out there is attempting to convert their landfill gas to liquefied natural gas, which is a vehicle fuel. And, the Waste Board has actually awarded grant projects to Gas Technology, Inc. or to (INAUDIBLE) Steel Project in connection Waste Management and (INAUDIBLE) DOC at their Altamonte landfill to convert landfill gas to liquefied natural gas. And the Altamonte landfill also has, in addition to them attempting to use (INAUDIBLE), they have a flare. And, they actually have energy recovery on site. It's just that their producing so much that they want to be able to use that landfill gas for some other benefit rather than for (INAUDIBLE).

TOMMIE JEAN: OK. All right. Well, that's all the time for questions right now so we can move on to the next presentation. But, keep sending in your questions and we'll see if we can answer more at the end.

So, our next presenter is Sally Brown. And, Sally, when you're ready the floor is yours.

SALLY BROWN, RESEARCH ASSOCIATE PROFESSOR, UNIVERSITY OF WASHINGTON COLLEGE OF FOREST RESOURCES: You mean I can talk and get people to sleep very quickly?

(INAUDIBLE).

And, I'm going to split this with Brenda. And, hopefully there'll be a very clear, very organized transition. And, everybody will understand why we switch where we do and then, we switch back. So.

So, the title is Climate Change or Organics Compost Issues. And, what I've done with this presentation is try and go over the whole process that both Brenda and I have been a part of. Trying to develop on methane avoidance protocol for the Chicago Climate Exchange, focused on composting. Diverting materials from landfills, getting methane avoidance credits and, then associated potential benefits or credit with composting. And, so do I forward or, do you guys forward, I don't remember.

TOMMIE JEAN: You forward unless you would like some help.

SALLY BROWN (ph): No, I just press the forward and, nothing is happening. So, if somebody could forward to number 25, that would be great.

TOMMIE JEAN: No, problem. Here you go.

SALLY BROWN (ph): OK. I don't mean to be so challenged.

TOMMIE JEAN: (INAUDIBLE) some (INAUDIBLE). There we go.

SALLY BROWN (ph): OK. I'm still not forwarding here, but I …

TOMMIE JEAN: So, I have you on slide number 25? So, just let me know when you're ready to (INAUDIBLE).

SALLY BROWN (ph): I'm almost there. Come on computer. Yes. OK. Here we go.

So, here's the logical breakdown of the presentation. So, what do you do? What happens with organics. And, we're looking at what happens under anaerobic conditions and, I'm going to be providing a much less sophisticated of an understanding of what happens in a landfill than we just heard. And, my apologies for that. But, so, an uncontrolled decomposition of organics in land fills versus then we transition to Brenda, when you have a controlled anaerobic digestion, which is what happens when you specifically dedicate a digester to decomposed material, without the presence of oxygen. From there we go to, OK, what happens then if we introduce oxygen into this system, take the material out of the landfill, put it in an aerobic pile, like a compost pile? And so, what happens to organics as they decompose in a compost system. And, finally what happens when you then take that compost and put it into a soil system. So, looking at degradation and, factors, benefits, associated by products of degradation in a range of environments. So, if we go to the next one, number 26.

And, it's coming a little faster this time. By the way, the 21 time factor for methane is based on a hundred year time frame. So, if you were shorten it to a 20 year time frame, which a lot of people have suggested because methane only persists in the atmosphere for nine to 12 years, then you would get a CO2 equivalence factor of 72, I believe. And, that's where that comes from. And, a lot of people, because there's some urgency about reducing CO2 in the atmosphere as quickly as possible, a lot of people have targeted methane because it only persists in the atmosphere for a very short time. And, if you look at it's global warming potential on a shorter time frame, it's much more potent on a shorter time frame than over the hundred year time frame. So, that's a way to transition to that.

Anyway, next slide is what life is like in a sanitary landfill. And, here what I want to describe here is something that I've been – was told recently in a meeting by Jean Bogner. Jean Bogner is the first author of the IPCC chapter on waste. She's a consultant out of Chicago that knows an awful lot more than I do about landfills. And, there's a discussion in the IPCC documentation on landfills about climate temperature effects on rate of degradation materials in a landfill.

But, IPCC is writing stuff up for the world as a whole. And, the world as a whole does not sanitary landfills like we generally do in the U.S. and many other developed countries. So, what happens in a landfill versus what in an open dump is Molalie (ph) are two different things.

And, if you look in a sanitary landfill, what some of the data suggests is, to a certain extent, the landfill makes it's own climate. Here's a graph from a study that was done in a sanitary landfill in France. There's another study out looking at landfills in Germany. And, basically what you see is when you put the landfill into a sanitary cell, compact the material and, put a cover over the material, it starts heating up. And, it'll stay pretty warm for an extended period of time. And so, in the landfill here, at least, it's always t-shirt weather. If you'll – I don't think anybody want to live in a landfill. But, if you choose to do so, don't pack your sweater. Here, the temperature is in centigrade. And, what you can see is that within 20 days after depositing waste into an active cell in a landfill, temperature goes up to about 40 degrees C, stays generally between 35 and 40 degrees C for the first hundred and 60 days that the material is in the landfill. This is during a period when it's not springtime in Paris. The ambient temperature outside of the landfill in the beginning is under 10 C and, only after about a hundred days does it get over about 20 degrees C. So, it's much warmer in the landfill than it is outside, summertime in the landfill. And then, if you go to the next slide, which is number 27. And, this is working much better and I really appreciate your willingness to do this.

So, it's hot in there. And, not only is it hot in there, it's hard to breathe. How quickly does oxygen get depleted? This is another graph from the same study. And, you can see a precipitous drop in oxygen concentrations. Oxygen is the dark solid line with the little triangle there. And, you see that the oxygen starts out OK, it's times zero. And, before you get to five days, the oxygen is way down. It stays pretty low and then drop precipitously for what little less than a drop there is, for it to drop, to about zero at day 100.

What you can also see is that methane to increase. Starting at day 20, you have some measurement of methane. Day – when the cover goes on, it's in the middle of an increase, and that increase starts topping out at day 100 and, stays pretty stable from there. So, hard to breathe, hot in there and, how wet is it?

Depending on where you are, standing in that landfill, hopefully you haven't been overly compacted in the landfill, it's wet. It's not as wet as you would ideally like for anaerobic decomposition. But, it's a moisture that varies. So, if you're standing in the middle of those banana peels that are squished, it's very wet. By those crushed newspapers, you're a little drier. And, you can see the moisture percentage in the landfill is 160 to 310 grams of water per kilogram of space. So, it's certainly wetter than you're going to find in Tucson. I wish I could hear people groaning with these bad jokes, but if I could have the next slide.

(INAUDIBLE)

OK. Now, when you have these damp and wet conditions, these are great conditions for certain things to decompose and not very good conditions for other things to decompose. A lot of the studies that you see in the graph that we saw earlier on decomposition, focus on cellulose and handy cellulose. These are compounds common in paper. And, here you see a pizza box. This is our – where I live, this is our food waste, the yard waste joint collection bin. And so, this is an actual slice of recycled materials going to compost in the Seattle area. The food waste, you're not going to find a high cellulose component. You're going to find more carbohydrates. You're going to find more sugars. All those potatoes and French fries that you didn't eat. Fats, oils and grease. You're going to find chemical compounds that are more readily degradable. You'll also find a high moisture content and a high nutrient content in your food scraps. Paper will be too dry and too high in carbon to decompose very quickly on it's own. So one of the things in the Chicago Climate Exchange group that we had was first of all what is it like inside the landfill and then, how do individual things pave within the landfill. Within the EPA you see a degradation rate given waste as whole. Within the IPCC literature you see different decay rate constants for different components of solid waste. What we focused on within the CCX subgroup was different decay rates and the material that's highly pugestible (ph) that's going to start bringing down right away, things like municipal bio (INAUDIBLE), certain components of yard trimmings, yard waste and food scraps. These were identified, everybody agreed that these were all materials that would degrade very quickly on their own. OK, so next.

(INAUDIBLE).

OK. When you have an anaerobic decomposition, we talked – we heard earlier about menting (ph) formations. But, what can also happen when you have anaerobic decomposition and, here it's more when there's very, very limited oxygen, not completely absent of oxygen but, very limited oxygen. Also, realize that conditions in landfills are often assumed to be pretty uniformed. But, you're going to be fairly (INAUDIBLE) if you didn't have hotter spots. These hot spots will migrate. Wear spots, there'll be preferential areas. The flow of moisture. You're going to have zones with some oxygen and, zones with no oxygen. So, don't think about a landfill as this modelific (ph) key of anaerobic conditions. Think of it as an area with some variation.

Anyway, in the parts, we have organic nitrogen. And, you have little to no oxygen. You have the potential for that organic nitrogen to eventually de-nitrify (ph), turn back to nitrogen gas and, if this disreacts (ph) and doesn't happen with 100 percent efficiency, has a formation of nitrous oxide. Nitrous oxide is something that you can form when you high nitrogen containing material with a lot of carbon into there for the micro's to eat. The deal with nitrous oxide is, it's close to 300 times as potent as CO2 as a greenhouse gas. OK. So, these are the two things we're concerned about both in a landfill as well as in a compost pile. And, we can go to the next one.

OK. Here, when you remove the (INAUDIBLE) materials, then the highly putensible (ph) materials that we've talked about. And, once we set the stage for what life is like in landfill, you have the potential to generate greenhouse gas credits. By taking steps that will make methane and, here we're only dealing with methane although nitrous oxide might be a factor. When you're taking things out of the landfill, can you get credits for taking them out and having them decompose aerobically. And, here on the CCX subcommittee we use this as basis how many credits you would get. It's a very long and ugly looking equation which is from a clean development mechanism protocol. Clean development mechanism is the UN arm that works with the IPCC to develop protocols for specific project activities to get people credits. So, even though this a very long and ugly equation, what you can – OK, I'm. OK. What you can do is ignore a lot of these initials and sigmas and, even E bases and, focus on S, that first S is – which is stands for the methane collection efficiency in a landfill. And then, the second that we dealt with in the group was the K. That first order to K constant. How fast is stuff going to go away? So, if you go to the next slide.

OK. This is my own understanding gas collection efficiency at a landfill. And, this is basically what a large number of people within the group had agreed on. EPA has their default of 75 percent. But, that is over the entire life of a landfill. That's an average value over the life of a landfill. IPCC has 40, 50 percent as their default value over the life. Now, what the actual efficiency is, is most likely zero. Before the gas collection systems are in place, when waste is in place. And, for the majority of landfills in the U.S., there is no gas collection system immediately in place as waste is being deposited into a cell. The EPA regs specify that a two to five year period which – from when waste begins to be deposited and, when gas collection has to be put into place. So, what we agreed as a group was that before you have a gas collection system, there will be zero gas collection efficiency. Now, you may think that that sounds pretty obvious, but let me tell you, we had several hours of discussion on these conference calls about this. And, this was a major consents and victory that we all agreed that if you're not collecting gas, you're not collecting it at zero efficiency.

Next point is when you're still accepting waste materials into the landfill, have a collection system in place, how efficient is it then. We had limited consensus as a group but, depending on who you talked to in the group and, there's a number of papers in the literature, that suggest that efficiency while the landfill is still accepting materials, even if there is gas collection in place, collection efficiency is closer to the IPCC value than the EPA default. But, there's also evidence that once you get a closed landfill, the gas collection efficiency comes to be just about on par with the methane generation rate. So, rather than looking at it as a 75 percent or a single number over the lifetime, think of it in stages. And, for us a group in the CCX, we focus on that first stage, no collection, zero efficiency. Next slide.

OK. And, this is our conclusion after months and months of discussion. I should say that the CCX subcommittee that was working on this had a lot of people from government, there were representatives from waste collection through private industry and, also members of the offset committee on the CCX. So, it was a pretty wide ranging group. And, because it was as wide ranging as it was, we very often had some disagreements. And, needed aspirin after the calls. But, we have reached consensus to focus on the gas period of no collection where efficiency is zero. And, next.

OK. Then we get to the order of decay concepts. And, I'll try to speed up here a little bit because Brenda has a talk about this.

EPA has a single K value for all of MSW. There was recently a meeting where people that were responsible for the EPA warm model were – had called in a range of scientists to talk about whether this was appropriate and whether a lot of assumptions on the organics component of the warm model were appropriate. And, one of the things that was brought out was that it might be time for individual K values. Now, IPCC already has individual K values. And, what they do is they vary it by the climate of where the landfill is located. However, as we talked about earlier, our sanitary landfills make their own weather. And so, here, if you use the un PCC default, you're going to go for that hot, tropical landfill with pretty high moisture because that's what it's like in a sanitary fill. And, they're K value for that is .231.

Within our group there was a lot of pressure to go with a higher K value. And, we were talking about things like one to 1.4 which make degradation of food wastes within about a year after deposition into a cell. And, here this lovely picture is my own home, food waste bin. After a week you can see that a pretty high amount of decomposition has taken place. And, I'm living in Seattle and, this was not taken in the summertime. So, food waste is something that will degrade fairly quickly. I think our consensus here, as a group, was to go with the more conservative IPCC value, but we're going to get a final draft of the protocol next – in the next few weeks. Next slide, please. And, we'll be up to number 34.

(INAUDIBLE)

OK. If you use – here's – and, somebody is telling good jokes in the background here. And, I can't hear them, I can just here the laughing. So, if you're going to tell a good joke, you should tell it louder.

Anyway, if you use these factors, this is the kind of decay, this is like a .8, it's in between the two. And, you can see the rate of methane generation over a four year period. And, you can see that most – this is for food waste, which is going to be your most quickly degraded material with bio-cellulose next and, yard waste after that. We can – you can see that most of the gas comes out fairly quickly from these materials. And next?

BRENDA SMYTH (ph): OK, good afternoon. I'm Brenda Smyth (ph) and I'm going to cover the topic of anaerobic digestion, which I will refer to as AD throughout my presentation.

AD is a biological process typically employed in many waste water treatment facilities. But it also is the principal process occurring in landfills, as Sally (ph) just mentioned. Large animal farms use AD primarily for manure lagoons with capture of methane for energy production. Internationally, AD has been used for decades primarily in rural areas for the production of biogas for use as cooking and lighting fuel, and many household-scale digesters are employed in rural China and India. More recently Europe has developed large-scale centralized systems for municipal solid waste treatment with electricity generation as a co-product.

Some of the points I will be covering on AD include a discussion of the benefits, the different types of technologies, and policy issues. Then I'll go over the facilities in California and the projects and activities that we are undertaking here at the Waste Board. And finally, I will link AD to climate change, protocols, and carbon offsets, and then kick this presentation back to Sally (ph) for the final wrap-up.

OK, now we're on slide 36. Biodegradation (ph) of organic material occurs in nature principally through the action of aerobic microorganisms. Ultimately complete oxidation of the carbonation organic material results in the production of carbon dioxide and water. Anaerobic microorganisms degrade the organic matter in the absence of oxygen with ultimate products being CO2 and methane. (INAUDIBLE) lignin and lignin-encased biomass degrade very slowly. Therefore, (INAUDIBLE) waste is not a good feedstock for AD.

Anaerobic microorganisms occur naturally in low-oxygen (INAUDIBLE) marshes, sediments, wetlands in the digestive tract of ruminant animals and certain species of insects and also in landfills. Four biological chemical stages of anaerobic digestion are hydrolysis, acidogenesis, acetogenesis, and finally, methanogenesis. In the first step, hydrolysis produces sugars and amino acids that are then converted to organic acids, which are converted to acidic acids, and finally within the (INAUDIBLE) genic bacteria, (INAUDIBLE) are converted are converted to methane and CO2.

There's a need to carefully control the digestion temperature pH and the loading rates for successful reactions and breakdown of organic materials. In large AD processors, organic materials are the input, and biogas, digester ethylene, and digestate are the outputs.

The biogas can be used to produce energy in the form of methane and hydrogen, which in turn can be converted into liquefied natural gas and (INAUDIBLE) natural gas or electricity. These energy sources can be used as fuel in the agricultural sector, and I'm trying to point out these so you can see the point on this slide, the digestate are solid residue from AD. Can be used additionally as a feedstock to produce compost which then be applied as a soil amendment or fertilizer on farmland over here. And then (INAUDIBLE) the ag waste or biomass can be the feedstock source for the AD (INAUDIBLE).

Anaerobic digestion by definition involves using an enclosed covered system for accelerating decomposition of organic materials for the dual purposes of biogas production and waste volume reduction. Because the system is closed and emissions are captured to create various energy products, the use of AD technology by default creates a net decrease in GHG emissions, primarily by reducing the amount of methane produced and released in conventional landfills if that's the baseline management option.

AD technology creates an additional GHG benefit if the organic residual, or the digestate, is used as a feedstock for composting and then used as a soil amendment in fertilizer. In addition, most closed systems also obviate other potential environmental problems, including (INAUDIBLE) groundwater contamination, nutrient loading, and runoff (INAUDIBLE) and other problems (INAUDIBLE) organic compounds and other issues.

OK, we're on slide 39 now. Different classes (ph) of AD systems exist. They can vary widely depending on siting (ph) requirements, input and output products and uses. However, the context (ph) of anaerobic technology is the same and mimics what occurs in nature. There are three different natural temperature regimes for anaerobic bacteria – cryophilic (ph), mesophilic, and thermophilic. Cryophilic (ph) is a bacteria that thrives in cold conditions around 40 to 68 degrees Fahrenheit. Mesophilic is the moderate temperature between about 77 and 104 degrees Fahrenheit, and thermophilic is relatively high, from 113 to 176 degrees Fahrenheit. Typically AD processes use either a mesophilic or a thermophilic process.

AD processes are also distinguished by the processing equipment design. Bioreactors have various stages of processing that makes them unique, and we'll talk about some of the various designs in the next slide. And of course the feedstock will dictate the bioreactor design, depending on whether it's predominantly liquid as in waste water or solid as in solid waste.

Some example of AD technologies that are used in waste water treatment plants are listed on this slide. Covered lagoons are also used for dairy, mixed digester and (INAUDIBLE) digesters are used for waste water treatment. The UASB, or the Upflow (ph) Anaerobic Sludge Blanket Reactor. It is one that some of you may have heard of aerobio. They use this technology. And the upflow (ph) provides for some of the mixing there. And anaerobic digester (INAUDIBLE) batch reactor is actually used by food processors.

OK. These are additional types of AD technologies that use solid waste as inputs to create biogas. For the (INAUDIBLE) company names such as Dranko (ph), Valorga (ph), BTA (ph), Compo (ph) Gas. And for example, Dranko (ph) and Valorga (ph) are single-stage processes. BTA (ph) (INAUDIBLE) process. And the APF (ph) digester, the anaerobic phased solids digester, is the UC Davis process and the (INAUDIBLE) actually had the project featuring that. I'll talk about it a little bit later.

This shows an example of biogas production. Occurs at dairy AD facilities and these are in six different – six different (INAUDIBLE) as indicated by the legend. So, the next box is (INAUDIBLE) biogas (INAUDIBLE) per day. (INAUDIBLE) music. Sorry about that. I don't where that …

UNIDENTIFIED PARTICIPANT: Sorry. We'll get that muted for you.

BRENDA SMYTH (ph): Thank you. The left axis corresponds to the curves that have a peak on the left side of the chart and (INAUDIBLE) the 20-day mark when the digestion process is completed. And on the right axis, this is (INAUDIBLE) biogas per gram of volatile solids. This is a cumulative yield over the entire digestion cycle and corresponds to the curves that reach the max on the right-hand side of the chart. Notice that most of the gas is produced within the first seven to 10 days, and then also notice how consistent the curves are between six different facilities in six different states.

I'm going to try and (INAUDIBLE) the next slide for all of you. We'll see how that works.

OK, now that I'm warmed up, this slide has a perspective on who will be impacted if we expand AD. Landfill operators would be impacted. More diversion of organic materials would reduce disposal volumes and potential gross tipping fees. Incentive to encourage more diversion of organic materials to AD, for instance, would have to include an increase in landfill tipping fees. As a result, (INAUDIBLE) operators might experience a net decline in fees from reduced volume. They might make up some of these losses through an increase in tip fee per unit of disposal.

Composters – increased AD activity could potentially mean less feed stocks for composters. Diminished feedstocks for composters could lead to price increases since higher input costs would likely be passed on to end users. One way to mitigate for competition among feedstocks between the two industries is to actively seek post-MRF, or material recovery facility, organic waste for AD, feedstocks that would likely be too contaminated for composting. Biosolids process is public owned waste water treatment plants. Increasing the use at TOTWs (ph) would reduce energy cost by using onsite produced methane to power plants. In addition, digesters could mitigate some of the problems. TOTWs (ph) are experiencing and finding markets for biosolids since many California jurisdictions have implemented or are considering land use stands (ph) for class B biosolids.

Agriculture and livestock operator, AD we're (INAUDIBLE) on site disposal solution that could produce power and reduce numerous extra (INAUDIBLE) including nitrate loading, the (INAUDIBLE) methane emissions, ground water leaching, odor (INAUDIBLE) issues, and (INAUDIBLE) things like that.

(INAUDIBLE) processes, as mentioned above, the demand for post-MRF organic residual may increase, so MRFs may need to expand capacity and (INAUDIBLE) organic sections from other recyclables. And then any institutions that regularly dispose of organic materials, such as restaurants, schools, prisons, may actually realize a net cost savings from – for growing expenses and landfill tipping fees. Additionally, energy production (INAUDIBLE) could serve two further subsidized diversion programs, depending on how incentive programs are structured or implemented.

Let's talk about AD in California. Despite advances in organic waste diversion, AD (INAUDIBLE) ventures have not yet materialized in California. Prior to 2002, there were fewer than five dairy digesters. Ten digesters have been built in California dairy since 2002 as part of the California Energy Commission's Dairy Power Production program, and an additional nine were (INAUDIBLE) in 2006. At least five California food processors (ph) have AD facilities for treating waste water.

(INAUDIBLE) operating cost are higher for AD than for composting and landfilling. The low tipping fees in California and relatively low energy prices compared to those in Europe make it difficult for AD and other conversion technologies to be cost-competitive. However, (INAUDIBLE) domestic energy process as we all know is changing those economics. Most of the AD facilities in California are utilized by the sludge and waste water treatment plants. There are approximately 137 waste water treatment plants using this technology, and they have an estimated excess capacity of approximately 15 – 30 (ph) percent.

A few of these facilities supplement their operations with other (INAUDIBLE) of organic waste. The UC Davis biogas energy demonstration plant, which is a waste water project, is the only stand-alone facility constructed for acceptance of only organic waste. And I've also featured three examples here in this slide. One if the (INAUDIBLE) utilities agency, which is located in San Bernardino and uses AD as the waste water treatment plant for the sludge, but it also supplements its feed stock with approximately 300 tons of dairy manure and 90 tons of food waste each day.

A waste water pretreatment facility in Fresno was designed for us in the processing and cleaning of figs. The valley fig growers process approximately 8,500 tons of figs and raisins annually, which generate about 40,000 gallons of (INAUDIBLE) waste every day. And the Eastbay (ph) Municipal Utility District's main waste water treatment plant could digest sludge and food waste. A recent study completed in March of this year determined that a hundred tons of feed waste per day, provide sufficient power for an estimated 800 to 1,400 homes for one year.

So, how can we increase the implementation of AD in California? Regulatory changes, for one. In order for AD of municipal solid waste to become a more viable option in California, regulatory agencies need a streamlined permitting process specific to AD (INAUDIBLE). Since there are solid and liquid waste and energy issues, AD could require different permits in different situations or even multiple permits.

Energy market penetration – AD can typically produce much more electricity than the AD facility needs. In order to be financially viable, AD operators need access to electricity markets and reasonable prices. California has had difficulty encouraging grid operators to upgrade the grid to allow renewable energy producers to connect. And in many cases, the prices offered are too low to make a project financially feasible. Also federal tax credits for renewable electricity are being phased out. Providing financial incentives is probably the most effective method of encouraging the development of AD.

Tipping fees – AD (INAUDIBLE) organic faction of municipal solid waste should be supported through tipping price fee structures to made AD cost competitive. And we've already talked about the low landfill tipping fees in California. Carbon credit – digesters have (ph) to reduce greenhouse gas emissions. A mature market for carbon could result in carbon credits for AD systems, making AD more cost competitive than other organic waste material options such as landfilling.

And finally, waste management programs – state programs (INAUDIBLE) energy commission's dairy power production program that we talked about just a little bit ago have been very successful at promoting AD in the agricultural sector in California. Similar technical and price support programs could be used to help establish AD for MSW (ph) as a viable alternative to current organic waste disposal methods.

(INAUDIBLE) getting the next slide up. There we go.

This slide features some of the projects (INAUDIBLE) board is working on related to AD. For a moment I thought it was a blank slide, so I'm relieved to see that we have some projects. In the research development and demonstration area, we have a couple of projects. One is the UC Davis anaerobic digester pilot project. It's $125,000 contract, and this one is conducting trials with post-MRF residuals. We have a draft document, which should be published imminently and be posted on our Web site, and it's titled, "Current AD Technologies Used for Treatment of Municipal Organic Solid Waste." And this publication looks at all the different AD technologies and evaluates them for MSW (ph). And again, that should be posted shortly.

And then we're also on this project currently waiting for test results from post-MRF trials that we anticipate in August, so they're coming out. The project has a processing capacity of around five to eight tons per day.

Another project that we have is the locality landfill bioreactor project, which is actually the (INAUDIBLE) anaerobic digestion, so, within the – you know a landfill. It's a $200,000 contract where 200 tons of source-separated organics were placed in this cell in an anaerobic composting environment a year ago in June 2007. It's under an accelerated biogas production and it's under an anaerobic – well, it will be suggested to – it's under anaerobic conditions now, but they'll switch over to aerobic conditions this month. And then excavation of the cell is planned for August 2008 where they will finish composting and quality testing of the material.

And other activities include regulatory guidance documents. The Waste Board has a – it's listed here in the slide as an AD guidance document, but it's actually conversion technology guidance document or glitch (ph) anaerobic digestion is one of those technologies being featured there. And it should – it's also available on our Web site. It was developed December of last year.

And then we are involved in participation of the Maata (ph) Agency effort. There is a guidance document being produced by Kelly Peay (ph) and it brings to the table many of the regulatory agencies, including the (INAUDIBLE), the Water Board, (INAUDIBLE), ARB and others. And this multi-agency guidance document is looking at permitting issues for AD. Joy Luther (ph), I believe, is our Waste Board contact from compliance on this multi-agency team.

And last, we are also involved in a lot of signing and outreach activities. We've been a member of the California Biometh (ph) Collaborative for four years now, and this collaborative works to enhance sustainable management and development of biometh (ph) in California for the production of renewable energy, biofuels, and products. And then, I've listed a few Web sites there that you might find of interest and some more information.

My computer is a little slow, so I'm waiting for my slide to come up. There we go.

This slide just summarizes the greenhouse gas emission reductions associated with AD, and those result in primarily three emission reductions. Methane emissions are reduced by diverting organic materials from landfills to digesters which are fully enclosed, closed loop systems. Energy is produced through methane and hydrogen productions which offsets traditional fossil fuel production and end (ph) use and which further reduces GHG emissions. And finally, the use of the digestate to produce compost results in additional GHG (ph) emission reductions through beneficial offsets (ph) there.

OK, and I'm waiting on this slide to come up. I don't even have any fun graphics in these, so, sorry. OK, we're now on slide 48, and this slide is featuring the climate exchanges. The Chicago Climate Exchange is North America's (INAUDIBLE) system to reduce emissions of GHGs with offset (ph) projects worldwide. The CCX numbers (INAUDIBLE) in the end will be (INAUDIBLE) reduction targets a minimum of one percent per year for a channel reduction of four percent below their baseline for phase one, and then six percent below baseline by 2010 for phase two.

Those who reduce their – below their target (INAUDIBLE) plus allowances to sell or bank, those who remit above their targets complied by purchasing CCX carbon financial instruments or CFI contracts, the commodity that's traded on the CCX. Each CFI represents a hundred metric tons of CO2 equivalent. And (INAUDIBLE) also has developed standardized (INAUDIBLE) issuing CFI (ph) contracts through project types including agricultural methane, (INAUDIBLE) methane, agricultural soil carbon, renewable energy, and there are others, as well.

The California Climate Action Registry, CCAR, was established by the California State Legislature as a voluntary greenhouse gas registry that promulgates GHG reporting standards (INAUDIBLE) organizations to measure, report, verify, and reduce their GHG emissions in California and also in the United States. The State of California has worked closely with CCAR to develop its reporting and verification guidance, including both a general reporting (INAUDIBLE) – I'm sorry, protocol, a verification protocol, and also industry-specific reporting protocols based on the principals of relevance, completeness, consistency, accuracy, and transparency.

Their industry-specific protocols include forest protocols, power utility protocols, (INAUDIBLE) protocols, and their project-specific protocols include forest, landfills, and livestock. And the protocols that are in progress include local government operations and others.

OK, and under these exchanges, there are developments of protocols with respect to AD. The CTX agricultural methane gas project guidelines is a baseline calculation that requires a project based on manure management (INAUDIBLE) be defined as liquid or slurry, deep pit or anaerobic lagoon. And then exchange methane offsets will be issued to owners of GHG emission reductions achieved by agricultural methane collection and combustion systems placed into operation on or after January 1, '99. And one of the protocols we talked about for CCAR was the livestock project reporting protocol and livestock project verification protocol, and it's associated with installing a manure biogas controlled system for livestock operations such as dairy cattle and swine farms.

And this protocol is available for public use, and it's a applicable in California and nationwide, as I mentioned. Project developers that install manure biogas capturing combustion technologies will use this protocol to register GHG reductions with the registry. These protocols were adopted in June of 2007, however they'll currently be under comment. They've been updated, and the CCAR's accepting comments on this protocol up until July 25, and you can send that to the registry.

And I just wanted to feature a project in California that is selling carbon offsets, and that's Joseph (ph) Farms and they operate a methane digester system that generates power for operations from their own waste. The digester is a seven-acre anaerobic covered lagoon which generates biogas. The gas is scrubbed and then piped to two power generators. One is at a 300-kilowatt hour and the other one is 400. The power generated by these two large generators is used to provide electricity for Joseph (ph) Farm's cheese plant. And the heat captured from the generators and exhaust is used to heat water for the cheese plant usage, offsetting some of the need for propane to heat boilers. As much as 80 percent of the power required to operate the cheese plant is supplied by this system.

Now I will take this back to Sally (ph) for the wrap-up.

UNIDENTIFIED PARTICIPANT: Thanks, Brenda (ph). Sally, the floor is yours.

SALLY BROWN (ph): OK, and I will try and not linger over slides, but will also appreciate your manning the controls here. OK. When you have anaerobic decomposition in a digester, you get stuff at the end. That stuff will get into (ph) waters and it'll end up still being primarily water and that is material that's pretty high in nutrients and can be composted. So, whether you take the material out of the landfill and go directly to composting or if you take it to anaerobic digestion – controlled anaerobic digestion, you can still at the end have a material that gets composted. And composting is an aerobic process. So, we're up to that part of the presentation. Here's a compost facility and a (INAUDIBLE) doing a turn right here in number 52. If we could go to the next? OK.

There are different parts of a composting process, and a lot of people have assumed that composting in and of itself is – makes such wonderful stuff that everybody knows is so great that compost has to be a fabulous thing for greenhouse gasses, as well. And in fact, the composting process can be a source of greenhouse gas emission. So, you have to realize that compost can have some fugitive emissions and almost always does have some fugitive emissions associated with it. If you do composting on anything other than a backyard scale, you're going to use heavy equipment, and that equipment is going to be for both transport to get stuff to the facility, as well as to manage the composting process. And every time you use equipment, you use fuel, and if you use fuel, you get greenhouse gas emissions.

Realize that getting stuff to the landfill also requires some fuel, but what we decided in the protocol was to discount transport in most cases because equivalent transport to compost site versus transport to a landfill site. However, when you use – use equipment at the compost facility, if you go to the next slide, which is number 54, you can start quantifying how much fuel you used to take care of a pile.

Now, we have two (sack) two sites that we're looking at here for values. One was dyne by the recycled organics University of New South Wales in Australia. Other done by EPA. Both looked at wind drove (ph) facilities. And they both came up with pretty much the same answer. Five to six kilograms of fuel for a wind drove (ph) facility per wet ton of material and that comes to about 20 kilograms of CO2, so hot a whole bunch here in the grand scheme of things when they're in (INAUDIBLE) an emission.

And then if you go to the next – OK. In our protocol, we came up with default factors. We went beyond the wind drove (ph). We went to the aerated static pile, we went to mechanical systems. There's a range of different compost systems, wind drove (ph) being the most common and also the least energy intensive. So, the more energy, the fancier your system, the more energy it will use. And here are some estimates. A lot of cases you'll use electricity and you'll have to do the site-specific conversion where your compost facility is located, where the electricity comes from to get a conversion of the greenhouse gas equivalent. So, what we did in the protocol was do average electricity uses for different kinds of systems. And we can go to the next.

I should add if your composting material that has been diverted as from a landfill as one of the highly (INAUDIBLE) materials, all these emissions that I'm going to go over here from the composting process are going to be minimal in comparison to the methane avoidance emissions that you get from diversion.

They will count, but they will be minimal, OK? The composting itself, now you're doing this an arrow of accession because that's the way the waste decomposes and turns into compost most efficiently. However, like in a landfill, in a compost pile, there'll be pockets that may be anaerobic.

Realize people can be very concerned about fugitive emissions of greenhouse gases during composting, but just think of the magnitude change. If you're taking stuff from a pile than a landfill where it was made to be anaerobic, an attempt was made to make this an anaerobic type for decomposition.

First is a compost pile where it's supposed to be as anaerobic as possible to reduce odors and accelerate formation of compost. You can realize that however much is emitted from a compost pile, it's going to be much smaller than what's emitted from an anaerobic facility.

OK, however, stuff does come out of the pile and let's get some information on that. You guys can read the slides so I don't have to go through that. But you can also manage your compost facility to minimize formation of fugitive greenhouse gases.

And next slide, OK, I love this because this is a illustration. This is from a paper from 2001 (INAUDIBLE) and you see this is the depth of the pile, and you see where you find the methane and where you find the nitrous oxide and also when.

So how deep it is at the very bottom of the pile is where you're finding your methane. The darker color – oh my computer just went on to sleep so I just had to wake it up here – anyway, when you get to the bottom of the pile, that's where you're going to be most likely to find methane, most likely to find anaerobic conditions.

And in fact, aerated, the top portion of pile's going to be your more aerated portion of your pile, and there's some evidence that suggests that your top portion of your pile will oxidize any methane that tries to migrate through the pile.

Nitrous oxide, not as clear, also notice that it's in much smaller units. So don't get – it's parts per billion here rather than percentage so it's a huge difference in units. So don't get upset by the dark colors, but realize it's in the middle of the pile, the portion that's going to be low in oxygen but not necessarily absolutely no oxygen.

And if we go to the next slide, what you realize with these is, the main thing here is air. If you have sufficient air to maintain the pile in the vast majority of its parts and sections as an aerobic compost pile, the chances of getting fugitive emissions are going to decrease enormously.

So as the (INAUDIBLE) of the pile goes up, your greenhouse gas potential goes down. Now one thing that's a very easy way to say, OK, if you want to qualify for credits here, what kind of monitoring do you have do. And this has already been done in California.

If you require that compost facilities meet the EPA time and temperature requirements for pathogen destruction, which is routinely required for all biosolids, compost facilities, in many states required for food composting facilities, in California required for composting facilities, that 55 degrees centigrade, three days for each of five turns in a (INAUDIBLE) pile.

Those are the time and temperature regs. You're going to maintain aerobic conditions that'll not only reduce your methane to almost nothing, it will also prevent odors from forming, it'll give you pathogen free material, so it's a win-win all around and that's what the group has decided as an easy adoption measure, as one thing to require.

Now, if we go to the next, another thing, and this is what you see in the recycle organics and this makes a whole lot of sense if you worked on a compost facility. If you have to add water to the pile, if the mixture is wet enough for the microbes to decompose, there's a very good chance that the site is so dry that you really don't have to worry about methane release.

So in cases, what we specify in the protocol, is cases that supplemental water is added to maintain sufficient moisture, you can negate the potential, or discount the potential for methane and nitrous oxide to be released. And I have to go really fast here.

OK, next, OK, if you have a biofilter, odor control system, this will likely oxidize the methane. Here's a nice smelly fish you can mess with that pike when it rots. So another case, these are controls you can have in place and these are all going to be specified in the protocol. A lot of them are straightforward good practices for composting.

So next, OK, C to N ratios in material. This is not in the protocol, but this is a really nice tool. If you have too much nitrogen, you're going to have a higher chance for nitrous oxide formation. This is from a study with biosolids only added to soil at a very high rate and as you see, the end ratio increased and nitrous oxide production goes way down.

The same will be true in a compost pile. So don't try and compost pure manure, don't try and compost pure biosolids. And next, moisture content, here's a study and it shows two different C to N ratios as well as two different dry matter concentrations.

And once you reduce that moisture content and you increase that C to N ratio a little bit, you get an elimination of methane and nitrous oxide avoidance. So we do have a moisture content clause in the CCX (ph) protocol. And there it is, in the light blue on the bottom, and again, good operating practice.

And next one, OK, so we – in the protocol we give that you have to time and temperature for EPA, you have to have – there are certain cases if you have certain manager practices in place you can discount any fugitive emissions.

And if none of those apply, we have default values to give you some deductions from your credit for fugitive release of methane and fugitive release of nitrogen. These both are in line with the IPCC recommended value.

And again, if you take a material out of landfill that we've identified in this protocol, these are going to be minimal in comparison to the credits you would get for methane avoidance. And next, OK, use of compost.

Now, the EPA WARM model, one of the reasons they had people in to talk about this was that there were minimal credits, greenhouse gas credits, the way they modeled things for the use of compost. What they modeled was using compost of field corn at relatively low application rates and they only considered carbon sequestration potential.

The recycled organic seed in New South Wales did a much more sophisticated modeling using compost as mulch on grapes or cotton directly incorporated into soil. And they considered a much wider range of potential benefits.

Realize these potential benefits, those that can be very significant, and they're being evaluated in the LCA on organics that the waste management board is looking at, and I'll talk about that in just a second, are going to be benefits that don't have great greenhouse gas implications, but have a lot of benefits for soil sustainability, agricultural sustainability.

And in fact, if you go to the next slide and look at the percent differences that the recycled organics unit got, this is for wine grapes in a vineyard. Water savings of about 15, 10 to 15 percent, which comes out to a million liters of water (INAUDIBLE). That's a whole lot of showers.

Big time fertilizer savings, close to 50 percent for nitrogen and phosphorus, just about elimination of herbicide use, elimination or erosion and observe big yield increase. And next, this is a picture slide, you get to see a picture.

With that California waste management board study, I'm doing a piece of this with Matt Cotton (ph). And in fact, he and I just went on a compost road trip, like it was with Dean Martin and Jerry Lewis on the road to – anyway, it was Sally Brown (ph) and Matt Cotton and we weren't nearly as funny as the other movie.

What we did was, we sampled a range of farms from the Palm Springs area up north to the Monterey area using composted sites versus non-composted sites. And here I am sampling in an almond orchard.

Now you can see me getting the soil cores and these are currently being analyzed in the lab in California. If you go to the next, we sampled a range of crops that can be divided into two big categories—orchard row crops where compost was applied right under the tree or the vine, and then row crops where the stuff was applied to the field as a whole, in both tilled and no-till systems.

And what we found was a lot of the growers that are using a lot of compost are organic growers and they're getting a vast majority of their fertilizers from the compost and they're using it for many things.

Fruit quality is one the biggest reasons that people are using compost. You should also know that we're doing a similar thing in Washington state, and there's some of the cooperators. And the next, where's the rest of the picture? Come on, guys. Here's our soil per site, you can see what we're doing.

We're looking at the water infiltration rate, you can see that length of pipe that's going to water holding capacity, that blue tee (ph) there is bulk density and then we also took individual cores and composited them for soil chemical analysis.

So we're looking at a pretty broad range here, soil microbial biological function is another thing that we're looking at. And the next, here is ten years of compost and you can see we saw this again and again. You do get that organic matter accumulation. You can see that black top portion of the soil there, that's from the compost addition.

How much is being retained in the soil, how much increase in seed do we get, this is one of the things we'll be measuring. And next, OK, this poor guy, Frank (ph), soil control labs, he had has his hands full.

This is the all of the samples that we collected and what I will do is, we have one set. We started to get results from this and that's on the next slide. Bulk density, this is a measure of how heavy a soil is, and you want your soil to be light and fluffy.

If any of you have gardens, you know that heavy soil is not good for getting water into it, it's not good for plants to get their roots into it, so you want a bulk density to be lower. And in fact, in a farm in India, California, organic lemons and grapes, what we see is about an 80 percent reduction in bulk density with compost use.

So this is the first inkling of results and this bulk density we saw pretty consistently through all the orchard soils that we sampled. I haven't done the stats on that, but so far, first results looking very nice. And the next slide, please.

Ok, talking to growers, I already said we heard again and again, growers that grow for Sunkist, growers that grow avocados, growers that grow vine grapes, quality fruit, quality is the way that they compete, not just yield. And what they see with compost is a big increase in produce quality, fertilizer, erosion control, water savings.

One of the guys that we sampled, he wasn't an organic grower but he was conventional grower, but however he'd been using compost religiously. At one point, he stopped for two years, and he said when he stopped using the compost, the vines just crashed and went right back on.

He was religious enough about this that when he couldn't buy compost early, early on, he was making his own. Now he's happily buying from a number of sources, he's in the central valley. And next, OK, so when you're talking about this process, right now the credits for the compost are only for methane avoidance, for landfill diversion. And this if for limited feedstocks – foodstocks, biosolids and yard waste material. There are process emissions.

These are minimal and there are factors in the protocol to control these and there are benefits. The benefits are not quantified in the protocol. Their benefits in terms of greenhouse gases are small in comparison to methane avoidance.

We're working both in California and in Washington to start quantifying the benefits and we are not the only ones doing this. And that's it.

UNIDENTIFIED PARTICIPANT: Great, well now we have a couple minutes set aside for questions for both Sally (ph) and Brenda (ph). Thank you, both, for those presentations. We do have one more speaker today who has been studying (INAUDIBLE) so we'll just take a couple minutes of presentations and questions and we'll move on to Gary (ph).

So let's see. We have a lot of great questions here and if you wrote in a question and you don't get that answered today, we'll send you an email with the answer. This is for Brenda (ph). Is anaerobic digestion being evaluated as part of the integrated waste management board's organic life cycle analysis? And if so, can you speak about that for a minute?

BRENDA SMYTH (ph): Yes it is, and actually it's a good question for both me and Sally (ph) because Sally (ph) is on our life cycle analysis of organics project team. And it is one of the organics managements (INAUDIBLE) that's being considered. The project (INAUDIBLE) others is biocomposting, the baseline consideration is landfilling. So hopefully that answers your question unless Sally has something else to offer.

SALLY BROWN (ph):: I know that we're –the people on the project are trying to gather information on excess (INADUIBLE) capacity and waste water treatment plants. They've been in touch with the people in East Bay (ph) about their project and we're trying to include this as a very viable option.

UNIDENTIFIED PARTICIPANT: OK, great. Now we have a question about PLA, which I think is polylactic acid. If PLA degrades at higher temperatures, will it degrade in a warm environment like a landfill and thus produce methane?

SALLY BROWN (ph): I have no idea. I mean, that's an easy answer. (INAUDIBLE)

UNIDENTIFIED PARTICIPANT: We can look into that too and someone (INAUDIBLE) we can send you an email. So Sally, I think this one is directed for you. Even if methane collection in a landfill is zero before gas collection (INAUDIBLE) is put in place, won't there still be some methane oxidation in the cover materials, which could be...

SALLY BROWN (ph): Yes, I can answer that. Yes, in fact, that's taken into account in the equation. And it's the – we use the default value of the 10 percent oxidation rate which is what IPCC and EPA also uses. And even though it may be higher, being that this is the value given by EPA and IPCC, it's very easy to accept and very hard to go against at this point in time.

UNIDENTIFIED PARTICIPANT: OK, another landfill question here, Matt (ph). How much do landfills tipping fees need to increase for anaerobic digestion to be economically competitive?

BRENDA SMYTH (ph): I'll take a stab at that for California. I haven't looked at the average landfill tipping fee in California, but they vary depending on what region you're in. And I would guess that the average might be around $40 or $45 per ton.

And again, depending on the anaerobic digestion facility, what types of feedstock, where to put these, all that, I'm thinking it would be in the range to $60 to $70 per ton. So that's kind of your top difference there.

UNIDENTIFIED PARTICIPANT: OK, $60 to $70 per ton (INAUDIBLE).

SALLY BROWN (ph): Can I add one thing there? What you see in Europe is that tipping fees have gone to over $200 a ton, and then you also see in some countries, prorated purchasing price for energy from anaerobic digesters.

So two things working in tandem, a higher tipping fee as well as higher energy paid to energy to coming from anaerobic digestion, which decreases over time. So it's a two-pronged approach to making anaerobic digestion cost-effective.

UNIDENTIFIED PARTICIPANT: OK, why is the fee for sequestration considered for composting but not for landfills?

SALLY BROWN (ph): Actually, in the protocol for the CCX (ph), it's not considered in composting. The EPA WARM model does have a minimal component of carbon sequestration (INAUDIBLE) and it does.

The material that we're talking about for this protocol however, is very rapidly (INAUDIBLE) and is not the material that would be sequestered in a landfill. So for the subsection in MSW (ph) we're talking about, that's really not a pertinent question.

UNIDENTIFIED PARTICIPANT: OK, is there any work being done to develop a protocol for the avoided greenhouse gas emissions from use of digesting as compost?

SALLY BROWN (ph): There's talk about a protocol for alternative fertilizer sources, so using different sources and in different nitrogen management practices, there's also – I have a grad student working on a protocol for carbon accumulation and soils restores with organic amendments.

There's an existing protocol for no-till farming and there's research coming out in a number of these areas that show that if you use organic amendments in combination with no-till you get very significant increases in carbon accumulation. Realize this is a very new process and so I would imagine these things will come with time.

UNIDENTIFIED PARTICIPANT: OK, I would like to share one more question before we move on to the final presentation, and I think this is directed to Brenda (ph). Brenda (ph), you said composters could be denied some feedstock directed to anaerobic digestion, but wouldn't composters benefit from using the stabilized solid residues from AD?

BRENDA SMYTH (ph): Yes, absolutely, that would be an additional feedstock to composters typically coming, as the digestate (ph), coming out of an anaerobic digestion facility. It's not finished, it needs to be composted and so that would be directed to composters, that's correct.

UNIDENTIFIED PARTICIPANT: OK, great, well we might have some time for additional questions at the end of all the presentations, but now let's move on to our final presentation and Gary Liss.

GARY: Thank you. My goal is to talk about how zero waste fits in with all the conference that we've been talking about in terms of climate change. And particularly, I'm going to look at how zero waste as a (INAUDIBLE) tool to accomplish the goal. I'm having a problem with my computer now too, so TOMMIE, (ph) if you could march the slides along like you did for Sally (ph) I'd appreciate it.

UNIDENTIFIED PARTICIPANT: Will do.

GARY: So the next slide, one of the things we first wanted to take a look at is, what do we mean by zero waste. And we go to the basic phrase of reduce, reuse, recycle and say that if in fact we did reduce, reuse and recycle, we'd be very close to achieving zero waste.

And so, the focus of the past decade or two has been on recycling, and we need to focus first on reducing and reusing in waste and discarded materials, and then recycling or composting the rest. Next slide, please.

The definition of zero waste is more formal a look at what we mean by zero waste. And there's two key phrases there. One, that all discarded materials are resources for others to use and secondly, that we don't want to burn or bury those resources.

Next slide, through the process today, we've heard a lot about the connections between wasting and climate change. So I won't go into a lot of these details, although on my slide, I do use the conventional methane (INAUDIBLE) 21 times more potent than CO_2.

I concur with Sally Brown (ph) and the (INAUDIBLE) climate.org report that 72 times is the key number, the multiplier that we need to keep in mind because it is, in the next 20 years, where we're approaching the tipping point when it comes to climate change and we need to be addressing that in these analyses.

When the Recyclers Global Warming Council of the California Resource Recovery Association use the EPA WARM model and looked at all the materials currently being discarded in California and seeing what would happen if all those were recycled or composted, they found it was the equivalent of taking all cars off the roads in terms of greenhouse gases.

When you think in those terms, it underscores why this is so important. The other thing that we'd like to emphasize is the wasteberg, (ph) which talks about (INAUDIBLE) in front of us, there's 71 tons produced upstream from mining, manufacturing and distribution of products.

And for those looking for a citation on that, it's Page 13 of the Wasting and Recycling in the U.S. report. (INAUDIBLE) that's a ilsr.org Web site. And so when you look at that 71 ton multiplier for the wasteberg, (ph) it really underscores why we can't recycle our way out of this problem.

We need to actually stop waste from being created in the first place and we need to reuse products for their original form and function as long as possible so we don't have to keep mining, manufacturing and distributing new products. And that's the importance of that 71.

If you combine the 71 tons upstream for 72 times potency, you start seeing why wasting and climate change and zero waste policies are so critical to moving forward. For people not as familiar with the zero waste, I also want to underscore that zero waste is really an umbrella term for a wide variety of policies, programs, sensibilities that can work to reduce our waste, reuse it and recycle and compost.

And one of the things that zero waste policies work to do it to change the system and to change the economic – if you look at the tipping (ph) piece we just heard about in Europe from Sally Brown, (ph) of $200 a ton, in many of the nations there, the tipping fees have included in them a $20 to $40 per ton surcharge, a landfill surcharge, which was adopted by the individual countries in order to fund new reduce, reuse and recycling programs and to phase organics out of the landfill.

The European Union adopted a landfill directive to phase organics out of landfills by the next decade, .and the next decade, I believe 2016. And in this country, there's a new campaign that's (INAUDIBLE) recycling network and BioCycle has launched to keep compostable organics out of landfills as well.

Just like the European model, to get those organics into more controlled systems to recover the benefits like we've been hearing about earlier in the presentation, in both composting systems and anaerobic digestion, biological systems. Next slide, please.

On climate action plans, one of the things I want to underscore is, this is probably one of the biggest connections now between zero waste and climate change. Money progresses (INAUDIBLE) around the country and around the world are trying to move forward faster than their federal governments to address climate change because they're so concerned about it.

And particularly since "An Inconvenient Truth," in the last two years there's been a huge upswing in interest by every elected official to be the greenest officials, to have their community be the greenest community, and to sponsor that, there are programs that have been set up which are generally referred to as cool cities or cool counties programs.

And as part of them, we have a variety of things being done to move forward at the local level to address climate action issues. The first is inventory, submission inventories, where they go in and look at the sources of different types of emissions coming from the communities and then the second step is developed climate action plans to move forward with programs to address those inventories.

Actually, I got my computer back on if you could give me control back, TOMMIE, (ph) I should be able to take it from here. ICLEI is one of the key groups that is working on this. Originally called the International Council for Local Environmental Initiatives, it now goes by Local Governments for Sustainability.

And the ICLEI is working with over 800 cities worldwide, including all the communities working with the U.S. (INAUDIBLE) mayors on their climate protection plans with the CR Club (ph) as well, to provide support to them to develop these inventories and climate actions plans. One of the things we like to highlight though, in terms of zero waste, of the different Cruel City (ph) programs that are out there, there is only one, the urban environmental accord, developed by the United Nations in 2005, that includes zero waste by 2040.

And in fact other (INAUDIBLE) programs like that at the U.S. Conference of Mayors, includes landfill gas recovery and burning waste as the ways as to address common change, which is a contradiction in terms from those in the zero waste arena.

So, we urge anyone working on climate action plans, to look at the urban environmental accords, and pursue their provisions to zero wastes by 2040, the key component of any local climate action plan.

Communities all over the world who haven't braved zero waste, particularly in recent years, we see a huge increase in that. New Haland (ph) led the way with over 70 percent over New Zealand cities having adopted it. Major cities, small cities around the world have adopted this, Buenos Ares of series, Toronto, major cities outside the U.S. and in the U.S., we have again large and small cities. California, over 20 cities have adopted zero waste as a goal, and are (INAUDIBLE) for that.

Bay area, many of these cities are working together to the Bay area's zero waste communities group to help pull their resources to develop initiative. Many of the cities have developed zero waste plans already, and others are developing them as we speak, such as Los Angeles, and Austin, Texas (INAUDIBLE) are helping plans right now.

When you look at the issue of zero waste, is it obtainable? We've have talked about that Natrusa (ph) model, that in nature there are no landfills or incinerators, that everything in nature is resource or a home for something else, and from nature we have 3-and-a-half billion years of experience in how nature figures out how to accomplish that, and that we need to look at how nature does that.

In America particularly, we think in terms of recycling, in terms of mostly crushing and grinding things, and what we need to do is broaden our thinking to use biology and things like the Anaerobic Digestion, and composting systems we heard about earlier today, but also all sorts of chemistry, physics, natural principle, which is those promoted by Teeny Vendis (ph) and Idomenicry (ph), and Zeery (ph) the zero emissions research and initiatives.

The other thing we talk about is, don't get hung up on the zero, the message is zero waste, we're darn close. We're seeing that our goal is just to achieve zero air, water and land omission, but we are defining success increasingly by diverting 90 percent of the departed materials from landfills and incineration.

And we're finding that businesses are leading the way to zero waste, having already achieved that type of reduction, and again this slide highlights a wide range of businesses, many of which are documented on the grrn.org web site that like in our large and small businesses, electronics and organics businesses, some of them are like in San Francisco, a number of restaurants.

They are there because the community is a zero waste community that provided their services so that their businesses can participate easily, conveniently and at lower costs then wasting, and when they have that type of a system in place everyone can participate and that is why there is a number of restaurants on this list, and there is lots more out there.

Other companies on the list have been doing this for many years. Xerox Corporation did it because they based out equipment. It came back in either assets or a liability, they chose to make it an asset. They refurbished the machines, put them out there when they couldn't refurbish them any more, they took the parts out, refurbished other machines and when they couldn't get anything else out then they would recycle the rest as part of their waste free factory that was developed at the beginning of the 1990's.

The other thing to note are that over 2,800 businesses in Japan have adopted zero waste as a goal and that 99 percent have achieved zero to landfill all ready.

Many Zero Waste businesses have been highlighting their successes at the Earth Resource Foundation conferences and there is a link here to past conference presentations where you can go to get the presentations yourselves to show to others.

Why do businesses adopt zero waste, is a multifaceted thing. Sometimes it is because someone asked, like in Japan the Environmental Ministry asked businesses to join in with the implementation of the Kyoto Protocol, and that's why there's so many Japanese companies that have achieved that. Other things have moved businesses towards this, such as their own policies for continuous improvement, like Pillsbury where they wanted to do 10 percent better at waste reduction each year.

So this variety of policies can move them. Economics; all the Zero Waste businesses who haven't been documented have saved money. They increased their efficiency. They avoid liabilities, typically liabilities associated with land filling once they recognize that every kind of waste they put in a landfill can come back and haunt them.

When those landfills close down, typically private landfills, the landfill operators and owners can walk away from those landfills 30 years after they're closed, or when there's no threat to the environment in California, and then once there's no one responsible, those landfills are going to open up and cause significant liability.

That circle of the super pun kicks in, and those lawyers said, figure how much waste was sent to the facility and they send you a bill for your share of any leaking that's going on. So avoiding that liability is a really significant driver, particularly highlighted be Bank of America at one of our Zero Waste Business Conferences.

Trying to distinguish themselves as being a businesses, Toyota (ph) highlights now in their ads on TV that they're not only for zero emissions, they're for zero waste, trying to distinguish themselves as the greenest of the green companies that are out there.

Other companies are responding to activist pressures, and a lot of businesses are doing it because it's the right thing to do, and their company executives embrace those goals. To support those green businesses, and Zero Waste businesses, communities like Oakland have included in their zero waste plan key goals, such as are indicated on this slide to support those green businesses to buy green goods and services from Zero Waste businesses, and to recognize that for every 10,000 tons of material if you landfill it, it only creates one job, where if you compost it, it creates four jobs.

If you recycle it, 10,000 tons of material creates 10 jobs, and if reused, 10,000 tons of reusable, it creates 75 to 250 jobs, and that's a recycling industry is as large as the automobile industry in America, as large as the motion industry in California, and five times the size of the garbage industry.

So, this is a significant employer in America. Why waste those jobs? Why throw them away? Let's use Zero Waste policies as a tool to move forward. To do that, we need to get them included in the climate change plans locally, and at the state and federal level.

AB 32, the Global Warming Solutions Act in California is a key tool for doing that. The Economic and Technology Advancement Advisory Committee of EPAct, of the air resources for the next 32, came out with a report in February that highlights the importance of doing this, and the page numbers and URL to that report are listed.

The EPAct report was a very independent review of these issues. Basically by businesses who will be effected by AB 32, and those recommendations constructing so much (INAUDIBLE) between (INAUDIBLE) climate change highlight the importance of moving forward with that.

The AB 32 scoping plan is just being considered by the air resources board, needs to incorporate the EPAct recommendations and has not done so, so this is an important opportunity now to make sure that they have resources for, listen to their business interest.

The economic and technology advancement advisory committee and embraces those recommendations and includes them in their scope and plan. There are other – many other facets (to get from the patient) of AB 32, a couple of which are indicated here.

There are a number of climate change groups that are out there as resources who enable people to look into these issues.

One of the most recent developments is to stop trashing the climate report which had like all of the connections and details and URL’s for these are listed and there’s a number of other resources listed.

There’s other organizations, the California Resource Recovery Association is also having their annual conference this year focus on the connections between wasting and climate change and what they call carbonopoly (ph).

Again, we can’t afford to lose and there’s some great resources on this list that people can follow up and pursue together to join with the Zero Waste efforts.

This is a great slide on what are the different components of Zero Waste economy, many of which are embraced and embodied in the Zero Waste plan that have been adopted by certain communities.

Mark Aglioti (ph) in open used this particular slide when he was first talking to people about Zero Waste in Oakland and just put this one page around the highlights considering facets of it and when he was trying to get people to understand the basics of what he was talking about, referred to the (INAUDIBLE).

So, with that, I've got my warning for time and am open to questions, thank you.

TIMONIE: (INAUDIBLE). We have quite a few good questions coming in and again, I just want to let people know, if we don't have time to answer your question on the phone here today, we'll try to send you an email.

(INAUDIBLE) what is your actual basis in the things that (INAUDIBLE) one of the largest sources of greenhouse gases given that the ARB inventory shows that its one percent of the overall emissions?

TIMONIE: I would defer to the other speakers as being more expert on that question, if anyone else wants to try and handle that?

I put into anyone else trying to – I just say that's an often cited statistic–somebody, detail analysis, if you go to EPA.gov, waste site and click, and search for climate change, there's 10 years of documentation of all sorts of reports and studies on the connections between wasting and climate change and the (INAUDIBLE) those numbers.

UNIDENTIFIED PARTICIPANT: OK, thanks. And just one more question before we run out of time. You mentioned Oakland, do you know of any other specific cities including waste reduction and climate plans. Someone mentioned that the city of Alameda (ph) has adopted a climate action plan that includes Zero Waste.

UNIDENTIFIED PARTICIPANT: Yes, San Francisco was one of the first to actually end their climate action plan for the city about 5 or 6 years ago include Zero Waste initiatives as part of that. There they saw that those could be about 10 percent of the total (INAUDIBLE) accepted if they implemented their recycling and composting initiatives.

They were not able to quantify source reduction initiatives as part of that and the city of Alameda (ph), all (16) communities in Alameda County have been working with funding from the (South Waste) dot org.

The local waste management (INAUDIBLE) and post-reduction authority, they're to develop community climate action plan with the system strong equally, and the city of Alameda (ph), I'm glad you mentioned, because that plan shows that of all the things that they could do including owning their own municipal utility, that the largest thing that they could do most critically to direct climate change was to reduce, (INAUDIBLE) and recycle.

And those initiatives are really highlighting our key message that, when you call Zero Waste or you just focus on maximizing reducing and recycling and through our policy is to take our products, whatever you call it, if you're pursuing those things to address the wasting connections and climate change at the local level, Zero Waste and those initiatives are the single, fastest, most effective, cheapest ways to address climate change.

UNIDENTIFIED PARTICIPANT: OK, great. Maybe just one last question, maybe like a one minute answer. How is your company declared Zero Waste, is there some kind of a certification?

UNIDENTIFIED PARTICIPANT: There's a certification being considered right now, to be developed but there isn't a process in place.

So, at this point, we urge you to follow the only irrefused (ph) internationally accepted definition of Zero Waste which is the one on slide 77 from the Zero Waste international line of the presentation today at (INAUDIBLE) . org who adopts that as the goal for our program and it measures itself according to Zero Waste business standards adopted by the Zero Waste international alliance with the (INAUDIBLE) recycling network and the standard base of the threshold to measure their achievement is over 90 percent being diverted from landfills and incineration and if you're at that level, those would be appropriate to call yourself Zero Waste and let's, you know, I work with (INAUDIBLE) recycling network, designed to reach companies that aren't considered zero waste businesses and I would love to hear from you.

UNIDENTIFIED PARTICIPANT: OK, great, thank you. I hate to have to end this, we still have a lot of questions but we'll try to send you guys answers over email and with that, I'm going to hand it over to Dana Warren (ph) with EPA to wrap it up here.

DANA (ph): Thank you very much everyone for participating in today's West Coast Webinar (ph) on climate change, waste prevention recovery and disposal.

Speakers, thank you very much, your presentations were very informative and useful and we really appreciate your contributions.

I want to just give a quick overview of our next Webinar (ph) which is on August 5th from 1:00 to 3:30 p.m. pacific time and it will cover accounting systems, modeling and economic incentives.

We'll hear from Kate Krebs (ph) formally of the National Recycling College who will provide an introductory overview on the national perspective. We'll hear from Jeff Morris (ph) of Sound Resource Management who will cover climate change and resource management modeling tools.

We'll hear from Evan Edgar (ph), of Edgar (ph) and Associates, who will cover economic incentives, climate change and resource management.

We'll hear from Lisa Skumatz (ph) of Skumatz's (ph) Economic Research Associates, Incorporated on reducing greenhouse gas emissions with recycling investment and we'll hear from Joshuah Stolaroff of the US EPA headquarters who will cover materials management and greenhouse gas accounting.

We hope you can participate. Please don't forget to give us feedback on today's session. It helps us to provide you with better information about our Webinars (ph). TOMMIE Jean (ph) will provide you with more information on how feedback will work. Thank you so much.

TOMMIE JEAN (ph): Just to wrap up, and thank you so much for participating today. When you are logging off, there will be a pop-up window that asks you just about four simple questions. If you could answer those for us, we would really appreciate it.

In addition, you'll get an email that gives you a link to a more complete survey where you can type in a little bit more information to help us when you leave to figure out whether the information today was great, how you used it and what we can do to improve these in the future.

So, again, the pop-up survey, you will have one chance to answer it when you're logging off. The email survey you'll get and that'll be open for about a week for you to fill out. Thanks for your participation today and the session is closed.

END