Session 4 Transcript

GMI Biogas Subcommittee Training Series: Best Practices for Landfill and Organic Waste Management

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PATRICK COATARPETER: For those of you who are new today, my name is Pat CoatarPeter, and I'm an environmental policy analyst with the Climate Change Division and the Office of Air and Radiation at the US Environmental Protection Agency (EPA). My work supports the bio gas sector at the global methane initiative with a focus on reducing methane emissions from municipal solid waste management around the world. Really happy to be with you today and this week. I've really enjoyed these trainings. I hope you all have as well. Moving on, we also have Sandra Mazo-Nix again with us today. She's a senior associate with Abt Global with over 17 years of professional experience in the municipal solid waste management, climate change and greenhouse gas (GHG) mitigation sectors. Her primary duties at Abt Global involve spearheading solid waste management initiatives for diverse government agencies at both national and sub national levels, including the US Environmental Protection Agency, the Climate and Clean Air Coalition and the Global Methane Initiative (GMI). Sandra will be our moderator again to for today's session. We also have with us Mr. David Cooley, who's a senior associate with Abt Global, and he has over 15 years of experience analyzing policies and programs for air pollution and greenhouse gas emissions reductions. He currently serves as the project manager for Abt Global's support of the Global Methane Initiative at EPA. We also have with us Mr. Lucas Nachman. He's a senior program--or excuse me, Senior Project Professional with SCS Engineers. His work efforts have focused on Landfill Clean Air Act Compliance and reporting, permitting, federal greenhouse gas reporting, and landfill gas design and study. Since starting with SCS, he's provided greenhouse gas reporting rule program support to his clients, including completing inventories and calculating emissions, working with specific GHG reporting tools, and he's served as a designated representative for interactions between client and EPA. Very happy to have our clients--or excuse me, very happy to have our panelists with us today. Looking forward to a really exciting conversation. And with that, I think we can move on. I'll go to the overview of today's session. Thank you. So we have a great agenda planned for today. First David will present on the importance of evaluating methane reductions and the basics of measurement reporting and verification of methane emissions. Then Lucas will present an example of an MRV system. And after that, we'll have a 15 minute open discussion led by Sandra. As in the previous days, Sandra will read the questions you put into the Q&A box for panelists, but you can also raise your hand, use the raise hand function, and we'll call on you to ask your question, or you can certainly follow up on a question that you've asked or has been answered verbally. We're more than open to discussion as we've started to dip into the last few days. So then after the discussion, I think it's going to be--excuse me, Lucas present--or excuse me, I think it's going to be David presenting on GMI tools and resources for methane measurement. And then finally we'll have another open discussion. This one will be a little

longer, and we can certainly open it up to any questions or comments you might have for today's discussions or for the rest of the week as well. So very happy to be with you again today. Looking forward to an exciting session. And that's going to be it for me. Thanks very much.

DAVID COOLEY: Great. So hello, everyone. My name is David Cooley. I'm with Abt Global, and I'm going to be kicking things off this morning with a discussion of the importance of evaluating methane reductions. So if you can go to the next slide. So just kind of a recap on methane and why we're talking about that. You know, this training is being put on through EPA, through their support of the global methane initiative. And the reason we're talking about methane today is that it's a very powerful greenhouse gas. It is a more powerful greenhouse gas than carbon dioxide. And methane can trap more than 28 times the amount of heat per ton than carbon dioxide over a 100 year period. And it's also kind of a traditional air pollutant as well. It's a precursor to tropospheric ozone, which is smog. So it can--methane also reduces air quality locally as well as causing global greenhouse gas increases. And a key thing about methane, though, is that it's a short lived climate pollutant. Whereas carbon dioxide can live in the atmosphere

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for hundreds of years, methane actually will come out of the atmosphere within about 12 years. And so in terms of reducing greenhouse gases and fighting climate change, methane actually offers us a very good opportunity at a climate action. And so if we cut methane now, that delivers substantial immediate climate benefits that, you know, can be felt in a few years. Whereas, like, you know, like we said, if you cut carbon dioxide now, there'd still be a large buildup of carbon dioxide in the atmosphere. So, yeah, there's a big opportunity here to reduce methane, convert it into clean energy, and then that also enhances energy security for countries. So next line, you may be familiar with this, the global methane pledge, which was released a couple of years ago at the United Nations Framework Convention on climate change, UNFCCC, conference of the parties. So this is called the Global Methane Pledge. It was a pledge of more than 150 countries, I think as of this year, something like a 158 countries, including Pakistan, to reduce methane emissions globally. So collectively, the goal is for the signatories of this pledge to reduce methane emissions by 30% below 2020 levels by the year 2030. So achieving this pledge will require significant reductions in methane emissions across multiple sectors, including waste, which is what we're talking about today. So the next slide. So when you have a big pledge like this, a big international commitment to reduce methane emissions or any kind of emissions, there needs to be some sort of system of transparency to check that that the emission reductions were actually achieved. And so that is really kind of the purview of what we call MRV, or measurement reporting and verification. And so the idea behind MRV is you're collecting data on emissions and emission reductions of methane. And so you can use that to develop robust emissions inventory. So every country develops their own greenhouse gas inventories and collecting better data on kind of project level admissions can

help improve those inventories. It can help show that you're meeting commitments towards things like the global methane pledge, so that, you know, if you are tracking emission reductions at the project level, you can show that you're actually achieving the goals of the methane pledge. It can also help access to external funding. If you can show that you're able to achieve these emission reductions, this can help bring in additional climate finance opportunities. And it also can help contribute to the achievement of sustainable development goals. So, you know, things like improving access to clean energy, improving sanitation, you know, other important sustainable development goals. So next slide. So I mentioned this term measurement reporting and verification. And this is really all about, you know, tracking data on emissions, reporting it to somebody, and then really having, you know, going through a process of verifying that the data that was collected is accurate. So we'll kind of walk through each of these steps here in turn. So yeah, next slide. So yeah, as I mentioned, MRV is this sort of three step process. First, you have to measure what, you know, the emissions. This is going to be tracking, documenting data and information. So that can include, you know, actually directly monitoring emissions. So, you know, using a bio gas flow meter to determine how much bio gas is captured. It could be modeling. So saying, you know, if there's, for example, waste diverted from a landfill, we can model, well, how much methane would have been admitted if that waste had been--had gone to the to the landfill or, you know, depending on the project, it could be some kind of

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combination of both of those things. So you have to measure the data in terms of, you know, the amount of emissions coming from a facility and the amount of emission reductions after you've done an intervention, you know, to reduce those emissions. Then the next step is you have to report that to somebody. And so that can sort of differ depending on different circumstances. But generally, you know, that could be a national government that's putting together a GHG inventory. It could be a carbon credit accreditation body. But so the, you know, there's a process where you, you know, you've collected the data, then you send it off to, you know, another institution to review that data. And then finally there is typically a verification process where somebody comes in and independently assesses the reported GHG emissions. And so that can take different forms. It could be, you know, just somebody verifying the calculations that you've made. It could be somebody coming to the site and looking to make sure that, you know, equipment is installed and operated correctly. But, yeah, typically there's a third party that comes in, that makes sure that the emission reductions actually did occur. So the next slide. This can happen at sort of different levels. So, you know, how I mentioned, there's the Global Methane Pledge. So, you know, at an international level, things like MRV are needed to be able to show that the countries that have signed this Global Methane Pledge are actually meeting the commitments that they said that they did. So that's sort of one important reason why we need to do MRV of these emission reduction projects. And it's also important kind of at a national level, cause, you know, like I mentioned before, that allows things for, you know, just to get--give countries a better understanding of their

emissions to help them improve their greenhouse gas inventories and, you know, allow them to identify, well, what are the sectors that are having the highest emissions and where can we go in and really implement projects to reduce emissions in those sectors. At an organization and facility level, this kind of helps facilitate policy making, provides an understanding for organizations or individual facilities, what are their actual emissions and what are the opportunities to reduce those emissions. And then finally at the sort of most, at the bottom, kind of most granular level, individual projects. And this is kind of where you get the best and richest data is being able to track data at the actual project level. Like I mentioned, tracking actual flow of bio gas or, you know, actual, you know, modeling actual emissions from individual landfills or other facilities. And that, you know, helps you track, you know, like I said, it gives you the sort of best data on the actual emissions from the project. And so MRV like I said, it's sort of done at multiple levels. You want to collect as much data as you possibly can at the project level, and then also at the national level, you collect very, you know, sort of higher level data, and then they, you know, you can sort of use that bottom up level, project level data to kind of improve and help reconcile the national level data for your GHG inventory. Next slide. So there's, you know, just different approaches and different, you know, kind of reasons for using MRV frameworks. So one is when you just want to understand, you know, the basic emissions within a country or a facility. So, again, you know, this helps improve GHG inventories. That can be a national level inventory. It could be the inventory of, you know, a state or even just an organization or a city. So that's one process is just looking at what are the actual emissions. Then the other--another process is looking at mitigation actions. So if you've done something to

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actively reduce the emissions at a facility, so you're collecting landfill gas, you're diverting waste to compost or anaerobic digestion (AD), you've done something to reduce emissions, you want to do MRV to collect data on that, the reduction and emissions and show that you're, you know, you're achieving those targets. And then also in terms of doing reporting for support. So if you received funding from donor countries or national governments or other, you know, private entities to do things like mitigation actions, you want to be able to show how you've achieved those actions. So you've, you know, collected the data to show that you've achieved sort of the goals of the plan that was supported by external donors. Next slide. Okay. So there are kind of multiple uses of kind of project level MRV data. And so when you put together greenhouse gas inventory, so this is, you know, just a picture of what are the emissions y, you know, all countries that are signatories to the UNFCCC, which is essentially all countries, have to put together, at this point, I think it's biannual inventories, greenhouse gas inventories to estimate what are their total emissions. There's multiple kind of methods within the process for developing those inventories. So they are tier one, tier two, tier three. Basically tier one is kind of very sort of generic data using kind of pretty simple methods all the way up to tier three, which is, you know, collecting very specific project level data on, you know, emissions and emission reductions at the kind of project or facility level. And so the idea is, you know,

many countries use tier one methods when they put their inventories together, but, you know, the data that we get to understand the total emission picture for greenhouse gases will be improved, you know, if we can get countries moving up to the tier two or tier three level where they're using better, kind of more specific data. And so, in particular, collecting data at the project level will give countries a better ability to report at that tier three level to say like this is, you know, very high quality data. We have a really good understanding of the emissions from our sector. So, you know, this data kind of helps improve the overall greenhouse gas reporting. Next slide. Okay. So MRV, it's measurement reporting and verification. So the M is measurement. And what you need to do is first develop a measurement plan. So the steps I'm talking about today have come from a resource that the Global Methane Initiative has put out on best practices for MRV. And we'll talk a little bit more about that later on when we talk about or GMI resources. But yeah. So the M is for measurement, and yeah, you put together a measurement plan you that includes, you know, an overview of the facility, how it operates, the roles and responsibilities of the facility personnel, who's supposed to be operating the plant, who's supposed to be collecting data. You know, what is the--and, you know, if it's an emission reduction project, what is the goal, what is the plan, how are we reducing emissions? All of this goes into this measurement plan. And then sort of the kind of most important steps or among the most important stepsof the measurement plan is what is the data that you're going to be collecting? So, you know, what is the equipment that you're going to use to collect that data? Is it you're actually collecting flow of bio gas that's going to a flare or a generator that that's, you know, destroying the methane that comes from the landfill, or what are the methods that you're going to be using to quantify reducing greenhouse gas emission? So all this goes into a plan of, you know, how we're going to collect data on emission reductions. Next slide. Then you have to go and quantify those emission reductions. And there's kind of multiple steps

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in that process. So first, you have to kind of understand what is sort of the business' usual emissions. So if you were not to implement a project to reduce those emissions, you didn't collect the landfill gas, or you didn't divert waste away from the landfill, and all of that waste just went into the landfill, what would the emissions be? So you can estimate those emissions kind of, you know, before the project is implemented, and then once you have implemented the project, you need to estimate the actual emissions, once the project has been implemented. So, you know, the difference between those two, so you'll have a baseline emissions. You'll have hopefully lower emissions once the project has been implemented. And, you know, the difference between those two is the emission reductions that the project achieved. Typically projects do this annually. I mean, you know, in some cases if you're, you know, actually sort of measuring in real time, you know, bio gas flow and bio gas destruction at a flare or generator, you're sort of constantly measuring those things. But typically you sort of, at the end of the year, you kind of put all of that data together and estimate what were your total emission reductions. There are a bunch of tools out there to do this sort of thing. And we're going to talk later on about one that the Global Methane Initiative has put out called the

Solid Waste Emissions Estimation Tool or SWEET. And we'll talk a bit about how you can use that to complete these steps. Next slide. So the R in MRV is for reporting. And so you take those, the data that you collect, and you report it to sort of someone. And that sort of depends on local circumstances. So it could be a national agency, depending on kind of regulations for reporting to them. And that national agency can take that and improve their GHG inventory. It could be a local government or a state level government. It could be a voluntary program that you can use to sort of show the emission reductions that you've achieved. Or it could be a financial institution, you know, a bank or a donor that has loaned or granted money to the project to, you know, if they did that for the goal of achieving emission reductions, you would report your data to them to show that you've achieved those reductions. Or if you're getting carbon credits from the project, you would achieve those and report the emission reductions to that carbon offset program. And it could be multiple of these things. So it could be, you know, that you're reporting to your national government and your state government and financial institutions. So, yeah, but typically you've collected the data, then you report it to somebody who collects that that information and collects it from multiple facilities and multiple projects. Next slide. And then the V in MRV is verification. So typically the greenhouse gas emissions data that you've collected needs to be verified by a third party, somebody that's not involved in the project, so that they can come check to see that, you know, the project is real, you have actually collected the data that that you said you had, that you actually, you know, achieve the emission reductions that you said you had, make sure that, you know, like I said, sometimes that can be--include, you know, people coming to the site, checking to make sure that bio gas is being destroyed or, you know, checking to see that compost facilities or anaerobic digestion facilities are being operated correctly. And so all of this then goes on to say that, you know, the data that you've collected is accurate and, you know, if, for example, if you're participating in a carbon offset program, this is a requirement of those programs, so that you wouldn't get your carbon credits until a third party comes in and verifies that those emission reductions have taken place. Depending on the, you know, local conditions, that this verification could happen every year, every other year,

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every three years. It sort of depends on different rules of different programs. But the bottom line here is you got to have a third party come check to make sure that these emission reductions actually happened. Next slide. Okay. So I did mention a resource that the Global Methane Initiative has put out. It's called the Policymaker Handbook for measuring--measurement, reporting, and verification, MRV, of bio gas projects. It's available on the Global Methane Initiative's website. And it gives more detail in terms in covering the sort of the topics that I just went over in terms of MRV and specifically MRV for kind of the bio gas sector, including solid waste. Next slide. I'll hand things over to Lucas for an example of an MRV system.

LUCAS NACHMAN: Great. Thanks. Thanks, David. Go to the next slide. So, yeah. So in the US here, the MRV system that we use for our landfills is the greenhouse gas reporting program. It's used for a variety of other industries as well, but this is the system that us and the solid waste industry are familiar with here, and it's administered by the US EPA part of the Clean Air Act regulations. And the main idea of the program is to get a greenhouse gas emissions inventory, essentially, from the different facilities, including landfills, oil refineries, you name it. But just to kind of get a general overview of the inventory and the amount of greenhouse gases from each emission source. And we do this report on an annual basis. So it's an annual emissions, and it's submitted in March of the year. So for in March 2024, we submitted the 2023 emissions from our facilities. So the requirement is if your facility is submitting over 25,000 metric tons of CO2 equivalent, you report your emissions, so that most landfills are going to fall into this. And just, as a note, all the emissions are reported in CO2 equivalent, even though at landfills, most of that is going to be methane, various other greenhouse gases, but they all have a conversion factor that you then convert over to the CO2 equivalent. And, again, the objectives are to track and report the greenhouse gas emissions from the facilities. And, with this data, it allows EPA or government or any other agency looking at this to support climate change policies and regulations. We have the data there, and now we get to use and analyze it, track it over years. So it's a very--it's, again, a good example of the MRV system that David just talked about. There is a home page there. The EPA.gov GHG report is a great resource to kind of give an overview of this system. Next slide. All right. So just talking about direct emitting facilities mostly, where are greenhouse gas emissions coming from? A landfill. We're going to talk about that today. The landfills fall into the direct emitting facility category, which basically means it's a stationary source. It's not a source moving around. So you'd also--power plants, everything that's not, you know, transportation or something like that would typically be a direct emitting facility. I'll maybe go into these sources a little bit more, but landfill emissions can kind of be broken down into maybe three categories, the fugitive emission. So a landfill is as waste decompose over time and decomposes anaerobically, methane is generated. If there's no controls in place, methane will then just be emitted from the surface of the landfill. If the system has a--or if the landfill has a gas collection and control system, so that gas that's generated is routed to either a flare or an energy use or an end use product, either an electrical facility, gas facility, whatever it is, there's also emissions associated

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with that process equipment. And then there's also other insignificant emissions from landfills that are reported. You know, this might be propane for space heaters or, you know, you know, fuel or oils used on site for equipment maintenance. But those are generally the emissions that you would be looking at, the sources of emissions from a landfill and more information for calculations and everything, again, is available on the EPA website. You can go to the next slide. All right. So the part of the greenhouse gas program that we use is the subpart HH for the municipal solid waste landfills. And this just kind of gives what information and which landfills and what information they're required to report. So any open or closed landfill that has

accepted waste since 1980. So that's going to be a variety of the landfills in our country. And then, like I said earlier, anything over 25,000 metric tons of CO2 equivalent requires emissions to be reported. So what is reported, the data that gets reported, the gas generation and gas emissions. So to kind of break that down, we have a gas model. We use modeling based on the waste in place, based on the amount of, you know, certain environmental factors like amount of rain or just wetness of the soil, we kind of can get an expected gas generation. The EPA puts forth a land gem model. That's a great model for that. And then based on that generation, we can calculate methane emissions based on a couple of other factors. If there's a gas system in place, the amount of cover, the quality of cover, if the landfill is closed or open, all of these can go into direct fugitive emissions. Then we also can calculate destruction, so we know what the emissions are. And then we can also calculate usually by a flow meter, we can directly count the amount of gas that's destroyed, either by a flare or diverted to an end use. And then there's also, you know, other emissions from stationary source categories that, you know, you might have some nitrous oxides or CO2 from just other sources that we also report. But I've worked on other greenhouse gas inventories for different industries. And, in some ways, landfills are pretty straightforward when it comes to relatively few places that we actually have to sit and count and quantify emissions. But those all get reported and added up and reported as a singular CO2 equivalent number that gets reported to the EPA as part of the GHG program. All right, next slide. So, again, kind of a summary, again, a little model of the landfill here and where all of our emissions come from, the omissions are calculated differently, slightly differently based on if there's a system in place or not. You're generally going to have more methane if you don't have a gas collection and control system. The gas collection and control system, even if it's just flared, converts that methane into CO2 as it burns and destroys a lot of the methane. But, again, yeah, we model the generation, the amount of gas that, you know, you would expect based on the type of waste in place, and then you can actually calculate with, again, flow meters in place. You also have gas analyzers that will let you know how much of that that gas that is being sent to the flare, sent offsite, is methane. Generally, it's about 50% there. And so we can, you know, use those flow meters to, again, measure the difference maybe of gas that would normally be admitted to what we are diverting or reducing our reduction levels. The other thing about this tool, it does allow you to see the amount of gas or the amount of greenhouse gas emissions, you track it year by year. So you can see for your individual site if you are meeting any goals or reducing reductions over time.

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In some cases, landfills are getting bigger, so you might not necessarily see a reduction, but one way or the other, you can know what's there and track it. So next slide. All right. So, again, the methodology that you would expect to see from landfill specifically, so some of the key information that you need is the amount of waste in place in the landfill. A lot of times this comes from, you know, scale records as the trucks that go to dump the trash in, you take that weight measurement. If you don't necessarily have the exact tonnage or, you know, weight of that mass of waste in place, you can estimate by based on just the cubic area or size there in a

predicted density. We also like to know what type of waste, if it's more, you know, organics of food waste or plant waste versus plastics or paper, you might have some different--it will have a different amount of generation expectancy. Then, of course, the big one is the gas collection. This is a quantified number that, again, you have a flow meter in your system that will directly tell you in standard cubic feet or other form of the actual amount of gas that's being diverted to a flare or diverted to a third party user. Again, a methane content. So there are either sensors or handheld analytical measurement devices that will let you know the methane percentage of that gas, and yeah. And then once you have that data, you can put it into some various models. The greenhouse gas reporting program (GHGRP) has a model that they use there, and it's a decay equation that gives you the different--the amount of generated gas. It will give you the expected fugitives emissions from your landfill. And then based on different--for different flares and different devices, there'll be various emission factors associated with that that will tell you how much methane is destroyed or how much CO2 is to be expected, that would be released. And then yeah, and then there are equations running in the background that there's several tools out there that once you get all this data, it can convert everything from that methane to the CO2 equivalent that we ultimately have to report. Next slide. And so yeah, here's--this is from the GHG reporting programs tool. This shows kind of the breakdown of I've been talking a lot about the M, the measurement stage of the MRV program, but this is the reporting and verification process. So I guess, yeah, we kind of start there at the top left corner there, the reporter self-certified, submitting annual report. So, you know, we as landfill owners and operators, we calculate the data, verify it often with landfills, will use a third party consultant to help them with that process. They then will submit and report to the EPA's reporting program, which is known here, e-GGRT, just the greenhouse gas reporting tool. And that program has several pre-submittal checks making sure you know you're submitting the right--the data from the correct landfill, items like that to first check to make sure first part of the verification project. And then as we continue to go around that top right corner, data is dumped into the e-GGRT database. After that, we go into the verification process. And so this is done by members of the e-GGRT program. So that is the third party verify or hear where they go through the data and just do the verification checking to make sure the data looks right, looking for changes over time, to look for anything that stands out that then they can come back and question the facility if something doesn't look quite look right. And then the facility and EPA kind of go back and forth to kind of make sure that the data looks good, and it's ready to complete. If there's anything that doesn't look good, the reporter can go back and check,

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see if they missed a section of data, for example, whatever that may be, give them a chance to make sure we're all on the same page. Once we're all on the same page, verification is completed. The data goes into the database, and it's then there to be used for all the reasons that we would use and want the data. So that's kind of just, again, an outline of what this particular system, most systems are--most MRV systems are generally the same, but this is the big one that we use here for reporting emissions from landfills here in the US. Next slide, then

that'll be it. All right. And I think I'll hand it over now to Sandra, who will be doing the Q&A session.

SANDRA MAZO-NIX: Thank you so much, Lucas and David, for those comprehensive presentations. So now we have 15 minutes for an open discussion. And I'll ask David and Lucas to please turn on their camera, so our attendees can see you. And so, as Patrick mentioned, you can post your questions using the Q&A in the right-hand side of the of the panel, but you can also raise your hand, and we will unmute you. For now, we have two questions from Rizwan Jabbar. The first question, I guess, David, you could take this one, is what sort of carpet credit methodology will be most appropriate for greenhouse gas emissions from municipal solid waste from a country like Pakistan.

DAVID COOLEY: Great. Yeah, good question. So, there are multiple organizations out there in sort of both the voluntary and regulatory carbon markets. So, in the voluntary carbon market, there's groups called, like, the verified carbon standard or Verra. There's another called the gold standard. And these organizations put together methodologies that you can use to develop your carbon credits. And, you know, the way that works is they'll identify specific project types. And so that's what you'll need to do is kind of make sure that you fit within the right project type. And so that could--and I think each of these organizations have carbon credits based on collecting and destroying landfill gas either in a flare or an a generator or some other method of destroying landfill gas. So that's a good approach. And then they also have methodologies for diverting waste away from landfills, either to compost facilities or anaerobic digestion facilities. And so, you would need to look at the--kind of the requirements of those methodologies. And so, yeah, I think two that are definitely worth looking at are the verified carbon standard and the gold standard. And then there's another one that I sort of just learned about recently, and I'm trying to get up to speed on, but it's an opportunity called the joint crediting mechanism that is from, I believe, the government of Japan. And I mentioned the Global Methane Pledge earlier, and they're looking for opportunities to kind of reduce methane emissions. And Japan will actually put some funding into projects to reduce methane emissions, and then they'll kind of split the emission reductions and say some of the emission reductions from that project Japan gets to use towards their emission retention targets, and the other country gets, you know, to keep some of those emission reductions. So, yeah, that's another interesting opportunity as well. So, yeah, I think those are all ones that that would be worthwhile for something like Pakistan.

SANDRA MAZO-NIX: Okay. Thank you, David. The other question is are there any other open source greenhouse gas measurement models in the market?

DAVID COOLEY: There are models out there in the market. I know EPA has put out models in terms of there's a model called land gym that I think is more geared towards the United States. We have SWEET, which I'll be talking about after this session. There are certainly other models,

but those are the ones I can think of off the top of my head. I don't know, Lucas, if you know of others?

LUCAS NACHMAN: No, those are the ones that I can think of too.

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SANDRA MAZO-NIX: Okay. Thank you. I know maybe Rizwan if you have a follow up question, I encourage you to raise your hand, and we will unmute you. Yes, please, can you unmute Rizwan please? Beleil, can you please unmute Rizwan?

BELEIL LAMB: Yes, looking for him.

SANDRA MAZO-NIX: There we go. Unmuted, now muted again. Rizwan, can you hear us?

RIZWAN JABBAR: Yes. My question is related to the limit of greenhouse gasses. It was mentioned that it's 25,000 metric tons for, if I'm right, it is for some certain facility, 25,000 per year. But if a facility reaches this, goes above this threshold, are there penalty or repercussions or some sort of this mechanism applied there for these scenarios? Can you please explain this?

LUCAS NACHMAN: Yeah. So that that is a kind of a minimum threshold. So once a facility goes over that, that just means that they are required to report into the GHG reporting program. So if your facility is below that, there's no, you know, federal law that you're required to report the emissions. But once you exceed that limit, that puts you into that program. So there's no necessarily financial penalties or anything associated with that, just the requirement to report.

RIZWAN JABBAR: Okay. And my next question is follow up to the question read to carbon credit from David. Can you further explain the point you just mentioned, joined carbon mechanism from government of Japan? Because I have heard the other VCM and article six and gold standard, etcetera. I've studied those methodologies, but this one is new. So we, for our project, are exploring these options to claim the carbon credits as our project has a potential to reduce the greenhouse gasses emissions significantly. So we are looking for this opportunity. Can you please further elaborate this methodology?

DAVID COOLEY: Well, I can try. It's new to me as well. I really just learned about it very recently, so I've been starting to do some research on it myself. But my understanding is that the government of Japan has put together this program that will help provide funding. And I don't know all the details of how much or kind of what percentage. I'm still kind of learning all of that stuff, but would provide funding to projects to support greenhouse gas submission reduction projects. And, you know, yeah, if you're familiar with the gold standard or the any of those other ones, it works in very much kind of the same way. They have their own set of protocols or methodologies that you can, you know, that identify different types of projects.

One of the things that I've noticed on this joint, it's called the joint crediting mechanism, I believe, is that these--whereas like something like the gold standard will just have a general methodology for, let's say, landfill gas collection. The methodologies in this joint crediting mechanism appear to be kind of country specific. And so, yeah, again, I'm still--this is all new, but I think there's a process by which, you know, countries kind of put together a methodology

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for, you know, how they would achieve the carbon credits, and it's going to be based on something like the gold standard, the verified carbon standard, some of those existing methodologies. They will--and then I believe the idea is, however many carbon credits, carbon offset credits that get generated from the project, get split evenly, with Japan taking about half the carbon credits for their own, so they can use for their own emission reduction targets, and then the other half stays with the project and within the country. So but yeah, I wish I had more information, but it's very new to me as well, so I'm still learning about it.

RIZWAN JABBAR: Thank you, thank you. That will be all from my side. Thank you.

SANDRA MAZO-NIX: Thank you, Rizwan, for your questions. So we still have like five more minutes for questions. Any other questions from the audience? If not, then I'll pose a question, which I think is very interesting. Maybe, David, can you talk a little bit about how can countries go ahead and set up an MRV system, like similar to what the US is doing?

DAVID COOLEY: Yeah, absolutely. So, you know, an MRV system, you know, similar to the one that the US has put in, first of all, you need a policy in place. So the US Greenhouse Gas Reporting Program that Lucas talked about, there was a regulation in place. And so he mentioned, you know, any facility that generates more than 25,000 tons must report their emissions to, you know, to the US EPA. And so that's a regulation. And so, yeah, you need that sort of policy incentive to say that, you know, you have to collect this data. So it doesn't have to look exactly like the GHG reporting program in the US. But to set up an MRV system, you do need to have some sort of policy in place that kind of requires people to participate, because if not, there's no real incentive for countries or projects to collect this data and report it to anybody. Now, that can look different ways. So in the greenhouse gas reporting program, that is just a regulation that says, if you're a facility above a certain size, you have to take this data and report it back to us. It could look slightly differently if there is, for example, kind of a loan or a grant or other kind of financial incentive program operated by a government. It could say, well, if you're going to, you know, get financial assistance from the government, then, in order to participate in this program, you have to collect this data and report it, get it verified. So, yeah, but there needs to be some sort of incentive in place for that. And then there also needs to be just a set of rules. And, you know, that policymaker handbook that we mentioned on the GMI website sort of lays out what that looks like. But it would have to be what types of data need to be collected, how often do they need to be collected, how often do they need to be

reported, what are the rules around verification? What gets verified? So all of those need to be established. There's lots of different kind of models of how this has been implemented in different places, but, yeah, I think a good place to start would be looking at that resource on our website.

SANDRA MAZO-NIX: Thank you, David. A follow up question similar to the question that Rizwan had on the open source greenhouse measurement models, for the UNF Triple C, can any model be used to estimate emissions, or are there approved models that have to be used in order to model the emissions?

DAVID COOLEY: There are--well, it depends on what you're doing. So if you're putting together a greenhouse gas inventory that you're submitting to the UNF Triple C, there are guidelines. There's sort of IPCC, the Intergovernmental Panel on Climate Change, IPCC guidelines on how you measure and model the emission reductions. Oh, there's another model that it's not--so IPCC has a model that, you know, you can use to model emissions from the solid waste sector, but it's not project specific.

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It's more country specific. So it's kind of that higher level, like, tier one level. Whereas a tool like SWEET, which follows the same IPCC methodology but gives you more subnational kind of city level or even project level data, would follow that. But, yeah, there are specific guidelines that the IPCC has put out of how you calculate emissions from the solid waste sector. And they have--there is a spreadsheet tool that IPCC has put out that you can use. So I don't think you can use just like any model. But if the model does say that it's, you know, based off of the IPCC methodology, then you could use that.

SANDRA MAZO-NIX: Okay. So when the verification, when they do the verification and they look at the model that was used, they need to make sure that it does follow IPCC guidelines.

DAVID COOLEY: Right. Right. And the other thing is, like, again, it depends on what you're trying to do. So, for example, if you're getting carbon credits, the rules of the program that you're participating in might specify you have to use this model or you have to use this set of equations or whatever it is. So it really just depends on the program that you're in.

SANDRA MAZO-NIX: Okay. Thank you so much. Look, a similar question for you for the GHGRP, what is the model that our facilities have to use? Is that something that is given by the US EPA?

LUCAS NACHMAN: Yeah. So there's different equations that we use as we calculate the emissions, but, yeah, they call them the--there's I think there's different HH8 and HH6 equations that you would use based on what your system and everything that calculates based

on waste in place and items like that. But that is part of the program. I don't know for sure how our--when we put stuff together, we have our own internal spreadsheet that uses those and runs those and basically mimics that model. But there are models available, I believe, for that program, too. So.

SANDRA MAZO-NIX: Okay. Thank you so much for both of you for your answers. So we have come to the end of the Q&A session, but if you guys have a—if the attendees have any more questions, I encourage you to save them for the next session will be at the end. So we'll have at least 30 minutes then to answer my questions. So please save them or go ahead, type them in the Q&A box, then we'll go ahead and proceed with the presentation. Thank you.

DAVID COOLEY: Okay. So we talked a bit in that the Q&A session about different tools for measuring methane. Excuse me. And so, yeah, so I'll be talking a little bit more in detail about some of the GMI tools and resources for methane measurement. So next slide. Okay. So GMI has a number of tools and resources available. I'm going to talk a little bit about five separate tools. So there's the waste characterization tool, solid waste emissions estimation tool or SWEET, landfill gas screening tool, anaerobic digestion screening tool, and organic economics organics tool. So I'll talk a little bit more about each of these tools. And then, in particular, we'll go through an example of kind of how you might apply a couple of them, which is the solid waste emissions estimation tool and the anaerobic digestion screening tool. So next slide. Okay. So the first tool we'll talk about is the waste characterization handbook, and that is a resource that GMI released earlier this year. And really with that is it's a kind of a step one resource to say, you need to understand, well, what's in your waste stream, because having that data will help you. It is really kind of critical in terms of understanding what are the methane emissions associated with my waste stream. So this handbook is a sort of a step by step guide in terms of helping decision makers and solid waste professionals plan and hand sort waste characterization studies. So what that means is you go to the landfill, you sort through the waste, and you get a really good understanding of is my waste stream, you know, 50% food waste and 10% paper and 20% plastic

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or whatever it is. And so you, you know, this explains kind of how you develop those kinds of studies, you know, how you go and actually implement something like that in the field and how you collect the data that you need, so that you have, like I said, a really good understanding of what's in your waste stream, because if you don't know that, then it's sort of hard to understand the methane emissions. So this guidebook or handbook gives all that information, and it comes with an Excel based tool that you can use to enter the data that you collect. So the next slide. Okay. So the next tool is one we've mentioned a couple of times. It's SWEET. It's a solid waste emissions estimation tool. It's oh, and I should say upfront, all of the tools that I'm talking about are free. We try to make them as user friendly as possible. There's training materials that go with most of them, that they're all free, and you can download them from the

GlobalMethane.org website. So SWEET is an Excel based tool. You use it to quantify the greenhouse gases and other pollutants from the waste sector, and it's, you know, you can use it for multiple things, things like creating GHG inventories, establishing missing baselines, and then also you can use it to analyze different potential policies. So you can run scenarios in it where you put into the tool information about the amount and the type of waste generated. So something like the waste characterization that you had before, that's going to be really an important input into SWEET that is to say, okay, if we're generating, you know, say we're generating, like, one kilogram of waste per person per day. And then you enter the amount of people in the area, and then you need to know how much of that is something like food waste or paper or other organics that's going to decay and generate methane. So all of that goes in. You can use that in SWEET to understand your baseline emissions. And then you can also run scenarios where you say, well, what if we divert, you know, X number of tons of food waste or green waste from the landfill, or what if we add a landfill gas collection system, or what if we, you know, close a dump site and open a sanitary landfill? How does that impact our overall emissions in a local area? It's really kind of geared towards, like, city level information. So, but yeah, and what it tells you, the outputs of the model are really the emissions from the solid waste sector, including CO2, black carbon, methane and other pollutants shown here. Next slide. Then another tool that we have is one called the Landfill Gas Screening Tool. And really what this is meant is to look at what is the potential feasibility of landfill gas to energy projects at different sites. So it is a kind of first--sort of first cut, first order analysis of how much landfill gas a site could generate based on the waste in place, the height of the landfill, the age of it, all of that, how much waste, how much landfill gas could that site actually generate. And it can be used to kind of do sort of a screening tool. The idea is that it's a screening tool. Do a screening analysis to say does this site generate enough landfill--generate enough bio gas to make a landfill gas energy project feasible and sort of what type and what size of project would be feasible at the landfill. And so, yeah, this is sort of a first analysis to say, is this project even feasible, is it worth it? And then, you know, you could use other tools to do more in depth analysis afterwards. So next slide. All right. Another similar type of screening tool that we have is called the Anaerobic Digestion Screening Tool. And this one estimates if you have a certain amount of feedstock, so if that is anything ranging from animal manure from the agriculture sector, crop residues, food waste, kind of

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garden waste, various other kind of organic waste products that you want to send to an anaerobic digester or anaerobic digestion project, what is the amount of bio gas that you could potentially generate from those feedstocks? So that tells you how much bio gas would potentially be generated from the project, how much digestates. So the amount of kind of leftover material that can be sometimes sold as fertilizer, how much of that would be generated, how much energy potential. So if you are going to take the methane from the anaerobic digester and turn it into energy, either generator or renewable natural gas, how much can that be generated? And then what are the greenhouse gas reductions from that kind

of project? So, yeah, again, this is a screening tool to say if you've got, you know, X number of tons of food waste or animal manure or whatever it is, you can enter that into the tool, and it'll say, well, here's about how much bio gas that would generate, and then you can kind of use that to estimate, is that potential project potentially feasible? Next question. All right. And then the other tool that we have is called organic economics, or organics for short, and really it's actually a set of two different Excel tools. One is focused on compost facilities and one is both focused on anaerobic digestion facilities. But these are really geared towards looking at the financials of kind of either the composing or the anaerobic digestion project. And they're really meant to help analyze the economic feasibility of a project. And so you enter in data on things like capital costs, labor costs, revenue from selling either bio gas or compost or tipping fees that you get from a project, and then it will tell you kind of things like the net present value of the project or the internal rate of return. So you can use that to kind of evaluate, you know, the financial feasibility of the project. So it's really kind of an accounting tool to say, okay, with all of the costs, including capital costs, operating costs, and all the revenues that you'll get from the project, what is the overall financial feasibility, you know, financial picture and potential feasibility of the project? Next slide. Okay. So those are just sort of five tools that I mentioned that are geared towards bio gas. EPA has multiple tools and resources and reports and things like that. And there is--we've gathered all of this into a website called the EPA Bio Gas Tool Kit. And it's got I think currently something like 47 different resources and tools out there. And so there are--you can go through there, and it covers the agriculture, solid waste and wastewater sectors, so you can kind of filter to find what you're looking for easily. But there's a ton of information and tools in this EPA bio gas toolkit. And so and it is really geared towards projects in all different phases. So everything from kind of predevelopment, just getting started and learning the basics of things, to screening and doing kind of pre-feasibility analysis of tools all the way up through development, construction and in operations and maintenance of facilities. So lots of different tools in this bio gas toolkit. So and then what we'll do now is go through kind of an example analysis using a couple of those GMI tools. So yeah, next slide. Okay, so this example is going to be focused on a city that is trying to meet some organics diversion and methane reduction goals. So, you know, let's say, all right. The challenge, city leaders have recently conducted a citywide household and commercial waste assessment and determined that out of 370,000 metric tons of waste generated annually, about 244,000 tons of that food waste or about 60% of it is based off--is food waste. And so what the city leaders

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have decided is they want to divert at least 20% of that organic waste, around 50,000 metric tons per year, and they also want to reduce methane emissions from the waste sector by 10% by 2050. So that that's sort of, like, you know, the target that they've set for themselves. And there could be various reasons for doing that, but, you know, this is what they want to do. They want to divert at least 20% of the organic waste and reduce methane omissions by 10%. So next slide. So there's a couple of different tools that GMI offers that could help them plan for how they would achieve those targets. So one is SWEET. So, you know, you can enter in,

you know, I mentioned you can run different scenarios in a tool, and you could say, well, what if we divert that waste to a compost facility? What if we divert it to an anaerobic digestion facility or, you know, some other type of landfill facility? So you can use SWEET to kind of run those different scenarios. And then depending on the outcome of that, you can use some of the other tools, like, for example, the anaerobic digestion screening tool to look at other potential projects. So, like, you know, well, we'll kind of talk about how these tools sort of fit together and certain analyses. So yeah. Next slide. Okay. So with SWEET, you know, you can run different scenarios. And, in this case, let's say the city ran three different scenarios. One is to implement a citywide composting program, excuse me, to divert 50,000 tons of food waste per year to a compost facility. The second would be to divert that 50,000 tons to an anaerobic digestion facility, and then the other one would be to just say, well, let's just not divert any food waste. We're just going to improve the landfill gas capture, and we're going to improve the efficiency of that at around 2%. And so the chart here shows, you know, a sample output from SWEET showing the different outcomes of those different scenarios. And so you can see the sort of yellow orange line at the top is the baseline, the business's usual emissions, and those just kind of keep going up as the, you know, waste keeps entering the landfill. If they implement the landfill gas capture efficiency, the red line shows, well, you can bring those admissions down somewhat, but not, you know, a lot. And then if you end up diverting 50,000 tons, you know, per year to compost or anaerobic digestion, though, you can sort of bend that curve, the BAU curve down quite a bit. You know, it's still increasing, but you're, you know, you're still getting emission reductions over what you would have gotten from the business' usual case. And what we can see here, too, is that in this particular case, anaerobic digestion is giving slightly higher benefits in terms of emission reductions to--compared to the accomplishing facility. So in the end, in this example, the city decides to pursue an anaerobic digestion system. Next slide. Okay. So then if that's the choice is to say, well, we want to run an anaerobic digestion facility, they need to enter food waste into--or they need to, you know, enter this data into the anaerobic digestion screening tool to say, well, how much bio gas could we generate, and then that this tool also gives you an estimate of the amount of emission reductions that you get from that project. So to run anaerobic digestion screening tool, you really need just kind of a couple of basic inputs. One is what's the type of waste that you have access to? In this case, it's just mixed food waste. And then what's the amount? And so we're going to say it's, you know, a little over 68 kilograms per day of mixed food waste. And then in terms of the bio gas production, it's telling us that it is

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going to give us about 38,000, almost 39,000 cubic meters of bio gas production per day and about 26,000 kilograms of digested production per day. So these are all kind of outputs from the system of bio gas that could be used for energy and digesate that could be used for compost or fertilizer. So, yeah. The tool provides--and the tool provides the bio gas production in kind of a range of low to high, because it is a model, and it's not going to give you a perfect estimate, but, yeah, it gives you sort of that estimate of the amount of gas generation, and then

it also gives you, you know, some potential energy generation, so electricity production, natural gas production or, you know, even if you're going to sell it for cooking fuel or home heating fuel, things like that, of estimates of how much energy that could get generated from this bio gas. Next slide. So, yeah, this is just kind of a sample scenario where a city is trying to achieve its emission reductions and waste diversion goals using a couple of the GMI tools, SWEET and the AD screening tool combined together, to kind of do this analysis of, you know, what is a potential project that they can implement to achieve those goals? In this case, it was, you know, SWEET determined that there was--they could potentially receive the best benefits from an anaerobic digestion screening tool or from an anaerobic digestion project. And the anaerobic digestion screening tool showed then here's roughly how much bio gas and how much energy generation you can generate. So next slide. You could, you know, then even take this further. So looking at EPA's organics tool to say, you know, well, what are the costs and revenue and the overall profitability associated with the anaerobic digestion project? And like I mentioned, we have this bio gas toolkit that has, you know, dozens of resources to kind of facilitate bio gas projects. So next slide. I think that's it. And I think we're going back to Sandra for another discussion period.

SANDRA MAZO-NIX: Yes. Thank you so much, David, for that comprehensive presentations. We do have--well, actually before, I encourage everybody to submit their questions via Q&A or raise your hand. We do have one question now about from CEO BWMC says how 68 kilograms of feed stack could produce 26,460 kilograms of digestate, figures given in the example?

DAVID COOLEY: Yeah, I think there might be a typo in there. I think that's supposed to be tons and not kilograms. So, yeah, I think that's--sorry about that. There was a unit typo in there. I think that's 68 tons per day, not 68 kilograms per day. Apologies.

SANDRA MAZO-NIX: Okay. Thank you so much, David. Do we have any other questions? Maybe CEO PWMC, do you have any follow up questions for David? Go ahead.

CEO BWMC: I think his lecture and presentation has covered almost all aspects and gave us very much useful information regarding the bio gas assessment and bio gas or methane related produce planning and its consideration and decision making on such projects. Many thanks.

SANDRA MAZO-NIX: Okay. Let's see if we have any more questions. Nothing. Maybe I'll dive into some more questions that I have. Maybe, David, can you talk a little bit about how does SWEET compare to other emissions tools like IPCC?

DAVID COOLEY: Yeah. Good question. So, yeah, IPCC does have a spreadsheet tool that estimates emissions from the solid waste sector, but it's at really more of a higher level. It estimates kind of national level emissions from waste generation using some,

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you know, so within IPCC, there's different tiers of methods. Tier one is sort of the simplest approach using kind of basic assumptions about the amount of methane that that's generated from waste. And so, the IPCC tool is more kind of at a tier one level using kind of really kind of country specific or, you know, country level data. Whereas SWEET is one thing is it's focused sub nationally, so more at a city scale or, you know, even potentially at just an individual landfill scale so that you can look at specific emissions at a specific facility. And then another kind of key difference of SWEET and some other tools out there is it tries to give you, well, one is that you can run scenarios with it. So the IPCC tool, really it's just an inventory tool. It says, well, what are my omissions from this facility? Whereas SWEET you can say--it does that. It tells you your baseline emissions. And you can also run scenarios to say, well, what if I divert, you know, 50,000 tons or what if I, you know, increase the efficiency of my landfill gas collection system? It will tell you, you can very easily run that within SWEET, and it'll kind of compare the emissions under the different scenarios, and you can look to see, well, what different scenarios will give me the most emission reductions. And then another thing that I didn't really go into before, but it's worth mentioning is SWEET tries to give you sort of the complete picture of the greenhouse gas emissions associated with the landfill gas or landfill operations. And so that includes things like emissions from equipment and collection trucks and things like that. So, the transportation that goes into the waste sector is also included in SWEET. So, it gives you kind of a total picture of the overall greenhouse gas emissions associated with solid waste sector.

SANDRA MAZO-NIX: And follow up question to that, in the IPCC tool, can you add multiple, like, for example, if you have a composting facility, if you have several landfills, can you add all that or is that--

DAVID COOLEY: I think it's more like kind of really sort of basic assumptions. So things like what's the amount of waste per person generated, how much of that is going to a landfill, and then it kind of, you know, uses that sort of information to estimate the overall emissions. But you don't enter in facility level information about--so I think you can say generally about how much waste is going to compost or to other things, but you don't enter in, like, facility level information about how much is going to each different facility and adding things up kind of in a more granular way like that.

SANDRA MAZO-NIX: Okay. Thank you so much. We do have a question from Tayyaba Akhtar that says can we have another training specific to the tools kind of workshop for learning purposes and to have insight of these tools. So maybe I'll pass that Pat to see.

PATRICK COATARPETER: Yeah, thanks. That's certainly something we can provide. We can be in contact after the training series and identify which tools specifically we'd like to dig a little deeper. But it is something that that we provide on a regular basis. So be happy to do that.

SANDRA MAZO-NIX: Thank you, Pat. So, we don't have anymore. I encourage everybody, again, if you have any questions about the tools or any of the other materials covering in this session today, MRV, also the MRV example from the US, also, please go ahead and you can make them now. We can also try to respond to some of the questions from previous sessions if you want. If you still have, like, if you have, like, you thought about a question and you're like, oh, you know I should have asked this. If you want to ask it now, you know, we can definitely try to answer. The experts that joined us the past days are not here, but we do work in the waste work, in the waste center, so we might have some idea on how to answer those questions. Meanwhile, if you take thinking about any more questions, I'll ask another question to David. David, on organics, so the organic economics tool be used to estimate financial viability of several plans? So can I basically say, oh, I'm going to have several composing plants or several AD plants, they're going to be decentralized. Can I use all that information and put it into organics?

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DAVID COOLEY: That's a good question. I don't know that you can put different facilities in there, but you could have multiple kind of copies of the tool, if that makes sense. So each one would be looking at, you know, a different facility, because each facility is going to have its own kind of capital costs, its own potentially operating costs. But you could sort of put those together into kind of multiple versions of that tool, and then look at the overall picture from that.

SANDRA MAZO-NIX: Okay, thank you. Maybe you could talk to a little bit about how SWEER has been used around the world. Maybe you can give us some insight on that.

DAVID COOLEY: Yeah. Yeah, SWEET has been used at this point, by I'd say more than 50 cities to just analyze, you know, different impacts of the waste sector and to look at the baseline emissions and to analyze scenarios of emission reductions. One somewhat recent study was done in--it was in Africa. I'm trying to remember the country. I think it was Ghana, by the World Health Organization, looking at reductions in open burning and the reductions in emissions from reducing open burning of waste in those facilities and sort of specifically the reductions in black carbon and particulate matter, and they calculated the health benefits of that as well. So, showing, you know, that reducing open burning and implementing more sustainable waste management systems would provide tangible health benefits to the local population. There was another case where we've used SWEET to analyze the potential reductions of diversion of food waste from entering the landfill in Serbia, and that was used to kind of justify the expansion of an accomplished facility in the city of Novi Sad, Serbia. And then currently right now it's being used in Indonesia by a group called Altera that is doing something similar to kind of analyzing the emission reduction benefits of implementing a program to divert food waste from entering the landfill and diverting it to compost.

SANDRA MAZO-NIX: Thank you. So I'm glad you brought up this issue about open burning, because there's a key thing that happens in Asia. So when municipalities have started to think about how to diminish open burn of waste and then send all that waste to a landfill, then it's good to start thinking about what are the implications of the methane and black carbon reductions, and then also using SWEET to kind of seeing what alternative scenarios or measures would, you know, would actually reduce the methane emissions or the black carbon emissions. Okay. I don't have any more questions, and I don't see any more questions from my audience or my participants. I don't know, I think maybe we could go ahead and conclude then, if they don't have any more questions.

PATRICK COATARPETER: Yeah, that sounds good. I'll just encourage folks to follow up with us, if you have any other questions, and also follow up if you'd like additional trainings on the tools. We'd be happy to provide those, and we can get those scheduled. But I think that'll wrap us up for today. So, thank you, Sandra, for facilitating the discussion and to David and Lucas for the great presentations today. Thank you to all the attendees and participants this week as well. This concludes our training session today and the training series on the best practices for landfill or landfill and organic waste management. We appreciate all your questions and discussions throughout the week. We hope it's been--we hope you found all the trainings useful, and we know that we're just scratching the surface of a very large technical sector. So, we'll follow up with written responses to your questions, sessions recordings, transcripts, and PDFs of the presentations for the whole week, but please also feel free to reach out with any further questions or follow ups. You can email us at biogastoolkit@epa.gov. And I also invite you to visit the Global Methane Initiative website for additional information on the topics covered today. David mentioned the bio gas toolkit, it's a really rich compendium of

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lots and lots of different tools and resources, lots of examples of how the tools have been used in the past and the tools themselves. So please feel free to peruse the website and get familiar with it and reach out with any questions and follow up on additional training if that's what you want. So, thank you very much. We really appreciate it. Please, again, to help us improve the training, please fill out the feedback form that will pop up on the screen as your session ends. So from all of us at EPA and GMI, thank you very much for your participation this week. We really appreciate the opportunity to provide the training. Thank you all.

SANDRA MAZO-NIX: Thank you.