

Session 3 Transcript

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

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PATRICK COATARPETER: Good afternoon, everybody. Thank you for joining the third session of the Training on Best Practices for Landfill and Organic Waste Management series. This training series is hosted by the US EPA (Environmental Protection Agency), SCS Engineers, and Abt Global – excuse me – who all have extensive knowledge in the solid waste management and biogas project development sphere. Today’s training session provides a comprehensive overview of the best practices for solid waste source separation to improve feedstock quality and reduce methane emissions. But before we get started, I’ll pass it over to Lydia Stubbs to walk us through how we can use the WebEx platform today.

LYDIA STUBBS: Hi, everyone, and thank you for joining. So, let’s go over some webinar software tips. First, there are two ways to connect with the audio today. You can either listen through your computer speakers or use the number that will be posted in the webinar Q&A panel. We will be using two panels for today’s webinar, the participant panel and the question and answer panel. Both of these panels can be found on the right-hand side of your screen. You may need to click the arrow next to the desired panel to expand and see all of the content. If for some reason one of the panels does not appear, navigate to the bottom right of your screen and click on the panels that you are missing. Live captioning is available for this event. To view or hide captions, click the closed caption button on the lower left-hand side of your screen. You can then click on the arrow to select your preferred caption language. Throughout the duration of the webinar, you can enter questions into the Q&A panel. When submitting questions. Please select all panelists from the drop down menu before hitting “Send.” This will ensure that all of the speakers see your question, and there will be an open discussion at the end of the webinar. During the open discussion, please raise your hand and we will call on you and unmute you. With that, I will pass it back to Patrick.

PATRICK COATARPETER: Great. Thanks, Lydia. So with that, I’ll introduce myself again. My name is Patrick CoatarPeter, and I’m an environmental policy analyst with the Climate Change Division in the Office of Air and Radiation at the US Environmental Protection Agency. My work on the biogas sector – or my work supports the biogas sector for the Global Methane Initiative (GMI), with the focus on reducing methane emissions from municipal solid waste management around the world. We have an exceptional panel of experts with us today like the preceding two days. First, we have Ms. Sandra Mazo-Nix, who’s a senior associate with Abt Global, with over 17 years of professional experience in municipal solid waste management, climate change, and greenhouse gas mitigation. Her primary duties at Abt Global involve spearheading solid waste management initiatives for diverse government agencies at both the national and

subnational levels, including US EPA, the Climate and Clean Air Coalition, and the Global Methane Initiative. Sandra will also be our moderator for today – Sandra will be our moderator for today’s sessions, excuse me. Ms. Dana Blumberg is the vice president of SCS engineers with 30 years of professional experience in civil and environmental engineering. And for over 20 of those years, she supported US EPA’s Landfill Methane Outreach Program and the Global Methane Initiative in many countries around the world. And we’re also lucky to be joined again by Dr. Hussain Ali, who’s a staff professional with SCS engineers in Richmond, Virginia. He earned a PhD in civil engineering from the University of Texas at Arlington, and has been actively involved in various projects related to life cycle analysis, methane emissions, and environmental policy development. Again, you can find their complete bios, the complete bios of our presenters in a document that was shared with all the registered attendees. Next slide, please. Thank you. So, just an overview of today’s session. We have a great agenda planned for today. First, Dana will present on the basics of feedstock management, upfront planning for organic waste facilities and management facilities, and working with large producers to address contamination. After that, we’ll have a 15-minute open discussion led by Sandra. Sandra will read the questions that you put in the Q&A box like we’ve done the previous days, and you can also use the hand raise function, and we’ll call on you to answer your question. I thought it was really helpful yesterday to hear from a couple folks who had questions or wanted some more insight into their question that they typed in the Q&A box, so please feel free to raise your hand. We’d love to open it up for discussion and make this as interactive as possible. And then after the discussion, Hussain will present on the basics of implementing household segregation, and then we’ll go back to – we’ll open it up to Dana and Hussain, and we’ll present some case studies diving a little deeper into the topics we’ll cover today and throughout the session. So finally, we’ll have another 15 minute open discussion at the end

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to answer any questions you may have. So, again, feel free to type your questions in the chat, raise your hand, whatever works best for you. We’re here to get you the information that’s helpful for you. So, thank you very much. I will pass it over to Dana.

DANA BLUMBERG: Good afternoon everybody. The last – excuse me. I’ve had a little cold here. The last couple of days have really been an honor, and I’m excited to get to be a presenter today. So first, like we started the other two sessions, just an overview on methane and the whole purpose of our training here is to look at waste management practices that reduce methane. So source separation is one of the great opportunities where you can actually capture that organic mass before it goes into a landfill, and you can better control the methane that comes off of those organic treatment systems than you can coming out of the landfill. And it also, as some of the other technologies, presents an opportunity to recover energy. Next slide, please. So I’m going to start off with an introduction to feedstock management. So, next slide. So, what is feedstock management? It’s actually managing the materials in an efficient way to minimize the amount that ends up in a landfill, and we want to look at opportunities to

optimize recycling, composting, and energy recovery from that process. The challenges are contamination, the variability in the composition of the organics, the quality and the economics, as we discussed yesterday, a lot about those topics, and also, logistics. Next slide, please. So first, we're going to go – I just wanted to briefly highlight how to site – your upfront planning of an organic waste management facility, so, next slide please. So, what are the key considerations for siting a facility? So obviously, you need to find land, and thinking through that, it's really land that's going to be accessible and close to your urban areas. And then also keeping in mind when you do site that land, you're not going to just need the area that is for the processing, but you're also going to need area for some other controls, such as the stormwater management, and you're going to need electricity if you're going to use anaerobic digestion (AD). You need a prepared surface for a composting. So, either a very highly-compacted gravel pad or an asphalt surface, and then you need a facility that you're going to receive and sort the organic waste. That area is usually the highest area that you can have odor potential, so you might want to consider where you site that on the site, where odors will go off-site. So, one thing that we like to see is maybe co-locating the organics management with your sanitary landfill. So when you're looking to site your sanitary landfill, think of maybe finding a site that has a larger area. And the advantages to that is that you already have the traffic for the waste going to the landfill. So then you would just have that same traffic pattern for organics. So if you have organics collection, it would just be going to the same place. And they also can share the infrastructure. So you can have one scale house with scales for incoming and outgoing. You can have one maintenance facility that can repair the equipment. Your office and locker rooms can be shared. And also, when you're doing the organics waste management, remember we talked yesterday about contamination. So as you can remove the contamination from the organics, it can easily just be moved over to the sanitary landfill. And you also have the opportunity for flexibility with the workforce allocation. So maybe one day you have more organics

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coming in than you have sanitary landfill, or waste coming into the sanitary landfill, or vice versa. You can move that workforce around, and cross-train them, and just have that more flexibility. And then you can obviously, combining your environmental controls such as leachate, stormwater, and your biogas system. So, you could share the flare if you are not – you haven't put an energy recovery facility in yet, the landfill and the anaerobic digester, for example, could share the same flare. Next slide, please. So here's just an example. This is a site in the US, and you can see on this that they have all different types of things. Up on the top right, that's where your incoming scale house is, and then you can see there's a leachate management facility, the landfill gas energy facility. And then down in the lower right -hand corner is where they have composting and mulch facility. And then also, they can share that same stormwater management that's over on the left. Next slide, please. So, what are the challenges in siting an organic waste facility? Obviously, that whole process, especially composting, you're going to have leachate production. So if you're siting it on a standalone

facility, you're going to need to accommodate that leachate. If you're signing it with the landfill, then you would be able to share that leachate management. And then also, considering siting the organics facility on top of an old landfill or an area that's closed. So we see this often in the US, and one of the things that you need to consider is that the landfill obviously is going to continue to settle. And so, maybe a hard pad such as an asphalt or concrete, it's not a good idea, but the compacted gravel where you could keep repairing, filling in holes is a better idea so that you still have a nice surface to work on. One of the things that – keep in mind that the sanitary landfill, as much as we try, does have some odor sometimes, and your compost facility will also have some odors, but with proper management, you can really reduce those odors. And so, one of the things about setting up the organics facility on top of a landfill is that there is more of an opportunity for the odors to escape the site because you're at a higher elevation, so just thinking that through also. Next slide, please. So, what are the benefits to planning for your facility up front? So obviously, the environmental benefits that we've talked about all week is reducing greenhouse gases by composting and anaerobic digestion. So again, removing the organics before the disposal in the sanitary landfill is the best way to reduce those methane emissions from landfilling. And then operational efficiencies, obviously, removing the organics will improve the lifespan of your sanitary landfills. Sanitary landfills are very expensive to construct, they're very expensive to operate, and airspace is gold, airspace is money. So, whatever you can do to reduce the amount that you put into your landfill, the better. So that includes metals, cardboard, paper, and then also organics is going to just – all it's going to do is increase that efficiency. And then community compliance, obviously, we talked about it yesterday, getting the public buy in. We're going to talk about that in some of the case studies later on today, and you want to make sure that all of these facilities comply with environmental regulations and have sustainable practices. Next slide, please. So working with large producers to address the contamination issues. So, next slide please. So, contamination, we talked a lot

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about that yesterday. It's the mixing of the different types of materials. So whether you're having paper in your organics, or organics in your paper, all of that is contamination. So when you're doing your dry recyclables, you don't want organics in that. When you're doing your organics management, you don't want your dry recyclables in there. Most of this presentation is going to be about some of the best practices to doing that. So obviously, when you have a large load coming in that is really contaminated, really mixed between organics and dry recyclables, sometimes, that load will just end up in the sanitary landfill because it's too difficult, and there's health and safety issues with the separation of those things. So, all that causes an increase of methane production and also hinders operation of your facility. So, contamination in either one of those streams just really causes a problem with operations. So, next slide please. So, here are some of the importance of preventing contamination. Obviously, there's a reduction in recycling efficiency. There's, as I just mentioned, an increased use of the landfill because a whole load may end up in there. And then also, that increases

emissions. There's a health and safety risk because, again, you have your workers that are having to separate those waste streams that are contaminated, and obviously, that costs money. And you have – when you have highly-contaminated dry recyclables, that reduces the market for them. And when you have highly contaminated organics, that reduces the marketability for that product. And then obviously, you want to look at the regulatory concerns of that contamination. Next slide, please. So, large producers are actually one of the best opportunities to start diverting organics from your sanitary landfill. So, sometimes – we're going to talk about two different case studies, starting with the household separation is a lot more challenging than starting at the larger producers. So, getting that – getting those programs set up is the low-hanging fruit, as we say. And so, today, I'm going to focus on four different large producers: restaurants, the educational facilities like universities and schools, farmer's markets, the wholesale producer markets, and commercial such as office space. And so, we're going to go through each one of those and what the contamination – what the best practices are and where contamination can occur. So, next slide please. So, the challenges are – and you'll see this throughout this whole section – is the awareness. So, the bulk producers that we want to target, they probably don't know that there's – if you decide to put in a policy that large producers have to divert their organics, that might be that they don't even know that you have that policy. So, education, and marketing that, and then actually providing some training, and we'll go into that a little more detail, and just letting them know that it's more sustainable. And then all of these, thinking ahead that all your large producers are going to have limited resources. So they have a main job to do. Right? They're running their business. They're running the markets. They're running the restaurant. So, they have limited resources. So, we want to, you know, make sure that they have that ability to implement the effective waste management strategies. And then employee training gaps. So, there's – you know, starting off with training the employees, but then think about new employees coming in, and that training has to be done on a consistent basis.

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Next slide, please. So, starting with restaurants. So, again, the back of the house in the kitchen is probably the best place. So, for restaurants such as fast food where you have your customers coming in, they are probably not going to do a very good job of separating their waste and their recyclables, and your bins are going to be contaminated, but looking at the kitchen and providing that education as staff is hired is your best opportunity. So, one of the challenges is that nobody – there's not one person in charge, so nobody knows who's supposed to take the bins out when they're full. Nobody knows where the bins are supposed to go. Nobody's really sure about which items go in which bins. So, those are some of the challenges. It's unclear, as I said, which items go in which bins. And then sometimes, we even find that the kitchen is very small. So, there's very limited space. So, the bins aren't going to be that large. So, again, who's responsible for emptying those bins? And then think, keeping in mind that outside the restaurant, these bins, maybe larger bins need to be accessible for the collection vehicles. Next slide, please. So, what are some of the best practices? So, setting up separate bins, one bin for

food scraps and compostable materials, and then another bin for your recycling packaging such as cardboard, plastics and other packaging materials, but keeping in mind that not all packaging is recyclable. So, again, you need to have a champion on site that knows which packaging is recyclable. Another opportunity for restaurants is to actually properly dispose of grease, and there's opportunities for recycling of grease. And then as I mentioned, staff training. Staff training and education is probably the most important thing, and designating one person or a couple people or one person per shift that is responsible for checking the bins, making sure that things are going into the proper bin, making sure that the bins don't overflow, and that they have to go out to the one outside, that maybe is where the collection vehicles will pick up from. So, those are I think the key thing, is to have the separate bins, to have staff training, and assign responsibility. Next slide, please. And then your educational institutions. So, here's an opportunity where maybe you can have both the kitchen and your customers, the students and the staff, separating organics. There's not a lot of turnover in students and staff. There's some, but not a lot, right? So, you can provide for that education, and especially students. Students are happy to do this work. They like sustainable practices and they feel good about doing things that improve the environment, but there's also that need for continuous education. And again, one of the challenges would be that there's no assigned responsibility. Another challenge that we see is sometimes, the cafeteria workers are not employees of the school system, but they're like a contract employee. So then there's the issue where the city or the school will need to look at that contract, amend that contract, or wait for a new contract and make sure that source separation is in the contract. That is an issue because it does cost a little bit more money. That is a consideration. One of the things, and even I get confused sometimes when I go to a facility that has separate bins, and I'm holding something and I'm thinking, "Which bin does this go in?" So, unclear signage is one of the challenges, and no designated place bin. The bins are in one place one day, another place another day. You want to have – consistency is the key to success there. And again, bins that are not large enough. So, right-sizing

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your bins is a key – is one of the challenges. And then when you're moving that material to outside for collection, is it behind the dumpsters where it can't be collected? So, you want to make sure that you have easy access for collection vehicles. Next slide. So, what are those best practices for educational institutions? So, having a waste sorting station. And again, the students are going to be all on board with this, so, they're easy. And then I like it when there's signs on every bin. And for example, putting pictures. So the cafeteria may have always the same milk carton, always the same container for sides or the trays that they use, so put those pictures on the bins. You have a picture of the milk carton. You have a picture of – maybe you have compostable flatware, you have a picture of that. You have a picture of what organic materials go into the organics bin. You know, napkins and paper towels are actually allowed to go in the organic bins, but most people might not know that and they put them in the trash bin. So one of the things also for best – for educational institutions is to use the reusable lunch

containers and utensils, and reduce those single-use plastics. Of course, that's a challenge if you don't have the proper dishwashing system in place. And if that's the case, then there are compostable food service items that they do usually cost a little bit more money, but that's an opportunity to divert, again, from the landfill. And then looking at in the school system. Obviously, there's a lot of paper, and so, ensuring that there's paper for recycling. So, you're only going to need that organics bin probably in the cafeteria. But throughout the school, you want to have separate bins for your dry recyclables versus your waste. And then also, there's an opportunity for the school to maybe do their own composting, like a backyard composting behind the school, and it teaches the children how to compost. And even some schools have a gardening program, so they compost their waste, and then they use it in that on-school garden. Next slide, please. So, for food and farmer's markets. So again, need for continuous education of the vendors and the customers. Again, there's no assigned responsibility. Plastic bags and packaging can get in those bins, unclear signs. Bins, again, are not large enough, and vendors disposing of unsold produce in the waste bins versus the composting bins, and then scheduling the collection after the market closes. So in the US, a lot of our farmer's markets are held on Saturday morning, and there's not always waste collection on Saturday. So then, you have a bin of organic materials that nobody's collecting. So making sure that if you do have those Saturday markets, that you do have collection that occurs after the close of the market. Next slide. So, what are those best practices? So having those large compost bins for the spoiled produce, providing those options for employees and vendors to discard unsellable spoiled fruit and vegetables. Separate packaging and organic waste. So, you want to ensure that the packaging materials, such as the plastic and cardboard are separated from the organic waste, so you have a separate bin for those. And educating the employees and vendors, you have to offer guidance to how to do the waste sorting, and educate them about composting and recycling options available at the market. So it might be a good idea for, you know, several months that you have somebody stationed at these bins to provide that education to the customers and the

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vendors. And you want to encourage your customers to bring their own bags or their baskets so that you reduce the amount of plastic bags and reduce that waste stream. And then, obviously, as I mentioned before, making sure that organics are collected when the market closes. Next slide, please. So, what are the challenges in a commercial facility? So, same kind of theme here. We want to continually educate the employees and the janitorial staff. And again, another challenge is sometimes, the janitor staff is a contract employee. And so, you want to make sure that that source separation collection is part of their contract. You want to determine the materials that are going to be collected from your building. One of the challenges, again, is no assigned responsibility, unclear signs on the bins, and again, the bins not large enough, and no designated area. Next slide, please. So what are the best practices at a commercial facility? So one of the things to do before setting up a program at a commercial facility is to conduct a waste audit. What do you have? What do you have coming out of that

facility? Is it mostly paper? Is it mostly of your dry recyclables, or is there a large opportunity for – is there a cafeteria in the facility? Is there a large opportunity for collection of organics? And then you may want to update that once you implement your program, then you want to go back and reassess your – do an audit to assess the success of your program. And that way, you have your dedicated waste streams. So now you know, “What is coming out of that building or that commercial facility?” Again, the signage on the bins, I love the idea of having pictures of common things that you found, and you can see what those are in the waste audit. Employee training. So, employees of the building and the tenant inside the building, or if the facility is owned by one company, the training of the staff, that has to be done on a continuous basis because of staff turnover. And again, the best practice is making sure there is a single person who is responsible for implementing the program and making sure that the bins are collected, they don’t overflow, that you can see if there’s contamination. “Oh, look, we have a lot of contamination this week. Maybe it’s time to send out another email, or a flier, or update our signage on the bins.” Those are the kinds of things that you want to continually assess. And then making sure that there’s designated areas for those bin collection, not moving them around, but making sure that everybody knows where these stations are. And next slide, please. So, in summary, you probably heard me say a bunch of times, designated bins. And so, one thing that is a good idea is to have different colors. And if you can see that lower picture, that’s like my favorite thing. So, you see garbage and it shows you some examples of what goes in the garbage bin. You see the recycling and all the different things that would go in that recycling bin. The composting bin, same thing. And then what would be – so, they have garbage on both sides. One thing to always keep in mind is wherever you put a recycling bin, make sure there’s a garbage bin next to it, because people will come up to it and say, “Well, it’s probably not recyclable, but I don’t know where it goes,” so they throw it in. And the same thing vice versa. If there’s a garbage bin, you want to put a recycling bin. So, having all of these containers in one designated area is the best practice. And these visual aids are my favorite thing. And then having those consistent training programs, and constantly updating your signage, and doing those assessments to see where there’s opportunity to either provide more training, or maybe the bins need to be right-sized. Maybe you need a larger garbage bin. Maybe you need a

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larger organics bin; just constantly assessing and looking at ways to keep your program successful. And next slide, please. So, I’ll turn it over to Sandra.

SANDRA MAZO-NIX: Thank you so much, Dana, for that thorough presentation about feedstock and waste contamination. We have 15 minutes for questions. So, I encourage everybody, all our attendees to please post questions in the Q&A, or if you want to, if you have a question that you would like to bring up, you can please raise your hand and we will unmute you. Okay, so we have a question. It says, ‘How to conduct waste audits? Please elaborate. And what should be the frequency?’

DANA BLUMBERG: Yes. So, a waste audit, what we do is we take sample bins and we dump them on a table, actually, and then we sort them into the different waste streams. So, you can have as many categories as you want, depending on the level of detail that you want. And then you weigh each of those, you weigh your initial sample and you weigh your different waste streams at the end. And it really is a place where you can say, “Oh my gosh. Look at how many aluminum cans have been thrown in the waste bin.” And you can say – and it gives you that information that we need a separate bin for these dry recyclables, and what size bin you need. So, I think that we go into – there is – EPA does have – GMI, actually, has best practices for waste audits, and I think Hussain is going to cover that.

SANDRA MAZO-NIX: Thank you, Dana. I’ll just add that basically there is a best practices and waste characterization, and also a tool that could be used. I encourage you to visit the GMI website to find that tool. And also, there’s a webinar also that was done on the tool itself, so you can get more information there. Maybe Dana, can you talk a little bit about the frequency of waste audit?

DANA BLUMBERG: So, I think at the municipality level, we recommend doing a four season audit. So, you would audit four seasons in one year, and then maybe wait five years and do another four season audit. So, it’s very – in the US particularly, it’s very seasonal of what the waste stream looks like. So, that is the best practice to do. If you only have the funds to do one or two audits, then maybe think about just what you see in your waste stream as those seasons that maybe have the highest opportunity to look at. So, maybe you have, after the holidays, you have a big influx of certain things. Well, that might not be a true measure. So, after a holiday, you may have a lot of cardboard, but the rest of the year, you don’t. So, you want to pick a time of the year that is normal, the normal time of year where the waste stream is pretty consistent if you can’t do four seasons.

SANDRA MAZO-NIX: Okay. Thank you so much, Dana. So, we have another question from Amir. He says, “Ideally, is the best solution to shift all waste at transfer station – material resource facility at the transfer station, and then transfer the waste to landfills in bale form? Maybe I’ll ask Amir if he wants to expand on this question a little bit. But maybe you can start answering the question, Dana.

DANA BLUMBERG: So, transfer stations are a great part, a really good part of an integrated solid waste management plan. And one of the reasons to have transfer stations is if you have your sanitary landfill a distance away from the city,

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so your sanitary landfills, a couple – several miles or even, you know, 60 miles away from the city, then you would want to have a transfer station because you don’t want to have those

collection vehicles making that trip. You can also have more than one transfer station in a city because they don't take up as much land as a landfill does. A transfer station is a good opportunity for moving the waste from the collection vehicle into a larger vehicle, and then that larger vehicle takes the waste out to the sanitary landfill. Some transfer stations also have a designated bin where they load their recyclables in a larger truck, and that truck moves the recyclables out to the materials' recycling facility. And then you could also have a separate designated area to move the organics to an organics processing facility. So a transfer station can be used for all of those things. We do see some transfer stations using compactors, but what a compactor does is maybe put too much weight into the truck. And so, in the US, it becomes not a legal weight. And so, loose waste actually pretty much puts a truck at capacity. So, we don't usually compact waste unless it's going on a rail. So, we do rail haul here. And in the instances where we rail haul, a compactor is a good idea. Now, baling solid waste, most operators really dislike the process. The balers break down, putting those bales in the sanitary landfill, there's operational issues with that. There's operational issues with how the leachate travels through the bale. It doesn't travel through the bales. It kind of finds these other places to go. They're harder to drill your landfill gas collection wells in. Most operators in the US that used a bale fill have moved away from that. So, I just caution you on doing research if you want to bale your solid waste. One good application for the bale fill is if you have a high wind area, like it's always windy, you're going to have a lot of flying litter, then maybe that would be worth the effort of a bale fill, but other than that, in the US, most operators don't like them.

SANDRA MAZO-NIX: Thank you so much, Dana.

DANA BLUMBERG: I don't know if I answered all the questions, but I think a transfer station is a really good tool that you can use to move your materials.

SANDRA MAZO-NIX: Maybe on this topic, since it's kind of – and I encourage everybody to ask more questions. We still have some more minutes for this discussion panel. I encourage you to take advantage of it to ask Dana more questions about contamination, also on feedstock or on segregation of waste. But talking about the topic of transfer stations and material resource facility, can you comment, Dana, on how a materials resource facility kind of is part of this integrated solid waste management? So, you can have waste segregation but also material resource facility. So, it's not one or the other. Maybe you can talk a little bit about that.

DANA BLUMBERG: Yeah. So, in the US, most of our material recycling facilities, we call them MRFs, are dry. So, it's your recyclables that come in, your paper, cardboard, aluminum, glass, plastic containers. And those are sorted using all sorts of technologies. So, some are just a conveyor belt where you have humans picking through. So one person is in a station and they are to grab all the plastic bottles. Another person is in a station, and their job is to grab all the aluminum cans. That's the simplest MRF. Then we have other MRFs that have these technologies that use these eddy currents that shoot the aluminum cans in one bin, and the metal cans are sorted by a magnet. The paper, a lot of times, the paper is still handpicked.

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Cardboard is usually handpicked. We have also these optical sorters. Those are expensive but super accurate, and they're looking for a particular material. So they could be looking for, again, aluminum cans, or metal cans, or whatever you set them up to look for. And by the end of the MRF, you have a stream of contamination. There's always people who put things in the recycling bins that aren't supposed to be recycled. So, those are left over at the end. And then you have all these different bins of material, and you hope that the aluminum can bin only has aluminum cans in it, and that it's as clean as possible. And then those different bins are then baled for sale to the market. Mixing the organics with your dry recyclables really contaminates both streams and is not a best practice. So if you are going to do organic diversion, it is highly recommended that organic diversion be done separated. So either separated as I talked about it at the large producer level, or Hussain is going to go over at the household level. And then we have a case study about large producers, and we have a case study on household level. So, you can see how those were set up.

SANDRA MAZO-NIX: Okay. Thank you so much, Dana. I don't see any more questions. Maybe I'll just ask you a last question before moving on with the presentation. Maybe, Dana, can you talk a little bit about – are there any differences between siting or composting facilities and anaerobic digestion facilities? Are there any recommendations regarding where they should be sited and what specific considerations need to be had to site those facilities?

DANA BLUMBERG: The anaerobic digester facility is going to have a smaller footprint, but it is going to require – it's a permanent structure. So that would need its own designated land. It could be co-located next to your sanitary landfill, but there is no opportunity to put an anaerobic digester on top of an old cell, for example. That is going to take a lot more infrastructure and it will – it's more expensive. Composting is actually pretty primitive. I mean, it's more sophisticated when you add the aerated stacks and you cover them, but it's still pretty simple, but they do have a larger footprint. Now, if you're just doing the turning type of composting, you need a really large footprint because each of those stacks takes several months, whereas if you're doing the aerated stack, you can turn that stack over. I think it's in a month. Hussain would know the answer to that better than I would. Aerated stack's going to take less land than just windrow composting. Anaerobic digestion takes less land than both of those, but the aerated stack and the windrow composting can be located on an old landfill cell that you cover, and you mitigate the opportunity for leachate to keep contaminating the groundwater. So, in other words, it would be covered with an engineered cover, and then you would have a pad on top of that, that you would need to maintain because of settlement.

SANDRA MAZO-NIX: Yes. Thank you, Dana. I would add that maybe with siting an AD or a composting facility at a landfill, you already have all the studies that went into the siting of it. So, most of the time, you don't have to do new studies. We have one more question that we

got from Rizwan. It's also talking about material recovery facilities. So, he's asking, "How effective are MRFs to separate mixed contaminated organic waste, and what improvements can be made?"

DANA BLUMBERG: Can you repeat that? So, how would it...?

SANDRA MAZO-NIX: How effective are MRFs at separating mixed contaminated organic waste, and what improvements can be made?

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DANA BLUMBERG: Yes. So if you have your – so, the whole waste stream is mixed. Like, you have the garbage, the organics, and the recyclables. Everything's mixed together. We call that a dirty MRF. That's just what they call it in the US. It's been tried a couple times in the US. It's super expensive. The product that you get at the end in either of the streams, either your dry recyclables or your organics, is usually contaminated. It's very human resource-heavy. So, there's a lot of hand picking. And so, you have a lot of health and safety concerns. It can be done, but it's messy work. And if you have a chance to set up your program now with a clean slate, I would not recommend doing it that way. I really recommend trying to push for getting your separation done by your large producers first, and then going to the household level. And as you'll see in the case study that we present later, the city of Chennai really implored the women to make that program successful. Like, they got like an army of women to get on board to get that household separation done.

SANDRA MAZO-NIX: I would add that even at mechanical biological treatment plants where you – the most program where you have organic waste separation at the beginning, but you still get some refuse with the hazardous organic waste, recyclables, and in that MBT plant you try to capture more of the recyclables, that especially the recyclables can be recovered. But that organic part, basically, it is recovered not to do composting or to do anything with it. But most of the time, it's just to stabilize that organic waste. So, it could be put in a landfill, but then it won't generate methane. That's like the purpose of it. So, the efficiency is actually low for organic waste, it's higher for recyclables since it is easier to separate those. And even those are – then you have to clean them up. So, there's some concept about that. So, we are at time for our discussion panel. So, I'll go ahead and hand it over to Hussain to continue with the presentation. Thank you.

HUSSAIN ALI: Thank you, Sandra. I'll be going over the Implementing Household Source Separation. Next slide, please. So like Dana has mentioned, usually the first step for a city is to start from bulk producers and then make their way to the households, because it's always a harder task to convince people, convince a whole neighborhood to do so because everyone thinks differently. But yeah, usually, the household separation starts with separating the waste into two streams. One is the wet waste that usually contains your organics, or the waste that

have higher moisture content; and then the dry waste, which is mostly the recyclables, like the plastic waste, or metals glass, etc. So, the significance for household source separation is kind of similar as to bulk producer. It really improves the recycling efficiency. The waste that ends up in the landfill is also reduced, which is the same for bulk producers. Having the waste separated does provide us different treatment options to go with instead of just putting the whole waste in one big landfill. Better source-separated waste produces a better compost, and since if the organic waste is dealt with either composting or anaerobic digestion, there is less methane production in landfills since there's less amount of organic waste ending up there. Next slide, please. So, here are some of the challenges with household source separation. The first is the low level of participation among citizens.

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There could be many factors, just a lack of responsibility or sometimes people just feel lazy in separating the waste inside their household. That's a big challenge. There's also lack of trust. Some people might just think that, oh, they're not going to recycle this stuff. It's all going to end up in landfill. So we really need to build up the trust among the citizens and to provide them awareness that doing this can help the environment. It can help the society, both in terms of environment and economically as well. And then there is sometimes pre-collection of recyclables by the informal sector. That mostly happens in the developing countries. Then there is unbalanced resources. There could be lack of expertise associated with how to deal with source separation. There's mostly inadequate budget, and there are some areas where the waste is not collected from. Another challenge that has been observed is the absence of policies that really work for source separation. So, one thing is the lack of policies, and then there is another challenge, which is implementation of the policies. You can have policies, but if they are not implemented, then those policies will not be successful. There is also a lack of public education and the lack of synergy or coherence between different sectors to properly manage the source separation. There's also one challenge is unavailability of waste characterization data. So if there is no waste composition data available, then it is hard to predict for the planners and solid waste engineers on which techniques or which technology is going to be useful for the specific city. And the last challenge is the non-availability of profit for the private sector. So if there is no profit in, for example, source separation and going for composting or producing biogas from anaerobic digester, then the private sector would not take part in these kind of activities, which will hinder this whole process. Next slide, please. So, now coming towards the best practices. First, best practices collection methods. Like we mentioned, in the case of bulk producer, we need dedicated organic waste bins that can really help in separating the waste. There should be curbside collection programs. For example, there could be collection trucks that comes in once a week or twice a week to collect dry recyclables like paper waste or plastic waste. And there could be community drop-off centers. So, for example, if I did my yard today and then I can just take that yard waste and drop it off at a composting facility, that can really boost that whole program. And then there should be a commercial partnership between the parks and the public works department. So, for example,

if there's parks in the city, they can directly partner with a composting facility or an anaerobic digestion facility, and their organic waste can directly go and end up there. So, the second best practice is availability of national and local policies and regulations, and monitoring that those policies are getting implemented. Like I mentioned in the last slide, development of policies is one thing, but then the implementation is one of the major things, since there are sometimes policies present, but no one is implementing them. The presence of the highly-trained staff and skilled professionals is very important, because if the staff doesn't know how to deal with some problems, then it becomes really hard to successfully continue a facility. And we

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do need to do a waste characterization study. These studies really help in deciding where to go, what is the way forward for a specific city or a neighborhood. And for that, we have our resource, which is the GMI's Waste Characterization Handbook and their Excel tool. We will go over that in detail in the upcoming slides. Next slide, please. So, continuing looking at the best practices, we do need to have offtakers. So if we are using the organic waste to produce biogas, we do need someone to purchase that biogas. We do need some businesses that rely on purchasing those biogas, and in case of composting, buying compost. Also, informal sector is a huge thing in many countries. And if we're going for source separation, we do need to integrate the informal sector formally into this waste management sector. Then there's good governance. I mean, if you want to run a facility, good governance is given. There also needs to be sufficient funding. Sometimes, what happens is like there's upfront funding so you can start a project, but then to continue that project, we do need to have a continuous source of funding. And for the waste management sector, that mostly comes from disposal fees or tipping fee. But one challenge here is sometimes, residents are not willing to pay that tipping fee. So, there needs to be a planning on how to get those fees out of the residents so that there is a continuous inflow of funding into the facilities. And then a public outreach and education program. We do need to educate the public, and we need to tell them why this is important, why we are doing this, and what kind of impacts it will have on the lives of all the residents. Next slide, please. So, here we are. Like I mentioned earlier, there is a handbook by GMI and an Excel tool. So, this is basically a handbook which is developed to help decision makers and solid waste professionals to plan and conduct waste characterization studies, on how to conduct it, how to collect data, and then using that data, how to plan, and implement, and improve waste management facility. The Waste Characterization Handbook basically provides information for city decision makers and provide them with recommendations to start an appropriate type of facilities that they need to make. So, for example, if you have data on food waste, paper waste, cardboard waste, what kind – how much of that is produced? You can use that to understand the impacts of different technologies. Like if we go with composting, what kind of impacts do we see on the environment? And if you go with anaerobic digestion, with this kind of waste, what do we see in biogas production and the emissions? This handbook also comes with an Excel tool. This Excel tool can be used to enter the data that is collected using the handbook, and this Excel tool will basically provide instant graphics to

visualize the data that is collected from the study. Next slide, please. So, here's a small example by looking at the waste from the city of Gujranwala. We can see that a huge part of the waste composition is organic waste. So if we do apply source separation in this city, we do expect 64% of the organic waste to go towards either composting

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or an AD facility, 1% of hazardous waste should go towards a hazardous landfill. The dry recyclables, like paper, plastic, and glass should end up in a recycling facility. And of course, you cannot separate all of your waste, so there is going to be some mixed or contaminated waste that should go towards the landfill. And in this case, the best case scenario is that only 11% of the waste is going to landfill instead of the whole 100%. Next slide, please. So, going towards the environmental benefits of source separation. I mean, if the organic waste is not ending up in landfills, that means there's low production of methane in the landfills. Then coming towards the second point, which is it closes the nutrient cycle. So if the organic waste is composted and then the compost is used back into the soil, that kind of closes the whole cycle of nutrients and also reduces the reliability on synthetic fertilizers. Source separation also helps in conserving water. If we are composting the organic waste, the composters help in the retention of moisture, which in turn conserves water. Next slide, please. So, any questions up until now?

SANDRA MAZO-NIX: Hussain, we're going to leave the questions for at the end.

HUSSAIN ALI: Okay, so we can go to the next slide. Okay, I'm going to let Dana take over the case studies.

DANA BLUMBERG: So now, we have a few, three case studies for you. I'm going to cover the first one, and Hussain's going to do the second one, and then I'll come back and do the third one. So, next slide, please. So, the first case study is called the Chetpet BioCNG (Compressed Natural Gas) plant. Next slide, please. So, this is a private sector investment, and the plant is located in Chennai, India. It addresses the local organic waste issue. So, the waste management service operates a facility, and they emphasize sustainability management in organics. The primary purpose of this plant is to efficiently convert organic waste into bioCNG, and the feedstock like I was mentioning earlier comes from restaurants and hotels, so it's from the large producers. So, next slide please. So, this facility has a capacity of 150 to 160 tons of feedstock daily, and one of their challenges is that there's 40% of the waste must be sorted by hand and by machine because of contamination. I see that as an opportunity for them to educate the people who are bringing their waste to their facility. So, it's an opportunity to go back to those large producers and say, "Hey, you know, what you're delivering to us is contaminated. Can we help you with setting up the program?" This plant then produces an estimated 3,000 to 3,100 kg of bioCNG each day, so it really is effective in transforming waste into energy. The gas is then sold to the Gas Authority of India Limited and various hotels. And I

also was reading that a lot of the restaurants were able to replace their liquid propane gas cylinders with this bioCNG, and then the workers noticed that it was a much more pleasant environment. The heat in the kitchen was a lot less, and it was just – they felt the health effects of using bioCNG versus liquid propane. So, at this facility, there's 80 employees

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that operate the plant and women are half of the staff. So, next slide, please. So, the cost to produce this CNG is about 116 Indian rupees per kilogram. The plant gets their revenue for – they charge an incoming tipping fee for the organic waste, and then they sell the bioCNG. So, they have revenue coming from both sides, and then they're also looking at opportunities for carbon credits. So, that would add a third revenue stream to the project. The bulk waste generators, they pay an incoming tipping fee of two rupees per kilogram to send their organic waste to the facility. And obviously, the environmental benefits are that they are diverting this waste from the dump site and resulting in decreasing methane emissions. And they're producing a renewable energy, which is much cleaner than the liquid propane that's being used by some of the local businesses. So, the operators right now are thinking that they're going to get a return on their investment within about four years, and the city of Chennai is planning to build another six plants with similar capacity. And just a little note. You see that picture? The EPA and some of its consultants actually took a trip to the plant, and this is a picture of some of the plant workers, and EPA and the consultants. So, it's a nice picture. And next slide, please. So, the next case study is going to be presented by Hussain, and then I'll be back.

HUSSAIN ALI: So, this study will go over the crop residue burning in Pakistan. Next slide, please. So this is basically a research article, and we wanted to present something where you can see an opportunity getting missed. We found this research article where they interviewed 200 farmers from 28 villages to figure out why they are burning or if they're burning the crop residue after harvesting. So, since it's a common phenomena that I myself have observed, it's I think a missed opportunity for using that crop residue for AD to produce biogas. Instead, burning it results in the production of black carbon. Next slide, please. So, based on the research article, it was found that almost 26% or over 26% of the surveyed area, there is a complete burning of crop residue, and in about 30%, there is partial burning. So, there's more than 50% of the area just for the city of Gujranwala where farmers are burning their crop residue in some form. There were some areas where there's no burnings occurring and they are using the residue for some other stuff like animal feed or something like that, or to use it for soil, for improving the soil. It's just they just leave it there so that some of the nutrients can go back into the soil. Next slide, please. So, some of the reasons why the farmers were burning the crop residues. The first thing is it quickly clears out the whole field. So, it's an easy thing for them to do. And instead of, like, clearing it, using something else, they just burn it. That saves them a lot of costs involved with clearing out the fields. They found that by burning the crop residues, it acts as a tool to keep the pests and weed away from those areas. Next slide, please. So, coming towards the conclusion. Some of the factors that were found

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related to the farmers burning those is the size of the farm, the length of the straw, if they own any cattle or not. Because if the farmer has a huge cattle farm, they can always use that to feed their cattle. There is a time constraint. If they want to quickly move towards the next thing, they usually just burn the whole thing. The distance between the farm, and where they can take the crop residue, and whether they are informed or not about the environmental impacts of burning the crop residue. We do need to provide them with environmental awareness, that burning this crop residue is not good for the environment, and it's also impacting their own health and the health of the whole community, the surrounding areas, and their greenhouse gas emissions associated with it. We need to encourage them to take the sustainable practices like anaerobic digestion and composting, which will result in the mitigation of greenhouse gas emissions which are associated with this crop residue burning. Next slide, please. So, I'm going to let Dana to come back and take over this case study.

DANA BLUMBERG: Thanks, Hussain, for presenting that case study on crop residue. Now, I'll present a case study on indoor waste management success. So, I misspoke the other day, I mean, a couple of minutes ago. This is the case where they employed the women. So, we'll get to that. I confused the two case studies. So first, some background. So, Indore is the largest city in the state of Madhya Pradesh of India. It has a population of roughly 3 million people, generating about 1,000 metric tons per day. Since 2017, Indore has consistently ranked the cleanest city in India according to the Cleanliness Survey conducted by the Government of India as part of its Clean India mission, a nationwide campaign launched by the Government of India in 2014. To track the progress and impact of the mission, the Government of India began conducting surveys across 73 cities in 2016 and now covers over 4,000 cities. The key parameters assessed in the survey include waste collection and transportation; processing and disposal; open defecation; information, education, and communication; and capacity building. Indore's top ranking is attributed to its advancements in sustainable solid waste management, which not only enhances public health and protects the environment, but also reduces methane emissions. The city's waste management success provides valuable insights and serves as a model of cities around the world. Next slide, please. Why it isn't always this way. Before 2016, Indore struggled with waste management, a common issue in many rapidly-growing cities in developing countries. Citizens were not required to separate their waste, and waste collection was infrequent, disorganized, and unsystematic. The open dumping of waste, overflowing public garbage bins, and animals feeding on waste was a sight, as depicted in some of the images here. The open dumping of waste, overflowing public garbage bins – I'm sorry. The state government nearly took control of Indore's waste management system in 2016 because of how poorly the waste was being managed. Next slide, please. So, I'm going to walk you through the keys to success that Indore followed which can be replicated by other cities.

So, we're going to go over each of these five things. Next slide, please. So, the first is leadership buy-in. The first key to success in leadership buy-in. As I mentioned in the background, Indore was in a situation where the state was considering taking over its waste management system. In response to this, the newly elected mayor of Indore and the newly appointed commissioner of Indore Municipal Corporation (IMC) undertook a comprehensive process to transform the city's waste management system. The IMC set a goal to achieve 100% door-to-door

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collection and segregation at the source. To achieve this goal, IMC increased enforcement of existing waste separation policies, increased public awareness, participation on waste separation, and invested in modern waste management infrastructure to divert organics from the landfill. These actions demonstrate the first keys to success, leadership buy-in, which created an enabling environment for Indore to process waste more effectively and reduce the amount of inert waste disposal at the landfill and open dumps. Next slide, please. The second key to success is active engagement and participation of citizens. To understand the root causes of why households were not segregating their waste, IMC hired an NGO (Non-governmental organization) to conduct a survey. The survey determined that residents were unhappy with the municipal services beyond waste management. There were potholes, there was non-working street lights, clogged drains, and they just didn't trust the IMC. To build trust with the citizens, IMC launched a phone application called 311. That allowed citizens to provide feedback to the city service or report problems. For example, you can upload an issue, select a category of the issue such as overflowing garbage, write a short description, and submit the issue.

The issues get resolved within 24 hours or they are escalated to a senior officer until they are resolved. It's that commitment even more than the app itself that rebuilt the trust with IMC. IMC also launched multiple communications campaigns to educate the public on waste segregation and household composting. They engaged over 800 self-help groups made up of more than 8000 women to spread awareness about the importance of source separation and cleanliness. I love that. Next slide, please. The third key was pilot testing. So, in January 2016, IMC began their door-to-door collection pilot project in 2 out of 84 wards. A ward is an administrative area of Indore, with an average population of 20,000 to 50,000 people. From this pilot program, IMC learned that door-to-door collection is a viable method for eliminating open dumping. Furthermore, they learned that timely collection created confidence and built trust in the citizens. The success of the pilot project helped the door-to-door collection gain leadership buy-in and led to an expansion to 10 wards. By the end of 2016, IMC achieved 100% door-to-door collection covering all 85 wards. Next slide, please. IMC invested in several infrastructure upgrades that improved efficiency of Indore's waste management system. These include, first, they partitioned collection vehicles which ensure that the waste remains separated, uncontaminated throughout the transportation process. The vehicles are typically split into sections for wet or – such as organic waste, dry waste, and there are separate bins

that are attached to the vehicle for hazardous waste and e-waste. People separate into these sections as they dispose of the waste outside their house. Next, they opened an integrated command and control center which enables optimizing collection vehicle routing plan and allows for real-time monitoring of all the collection vehicles. Third, they have a modern transfer station which enables collected segregated waste to be aggregated in large containers before being transported to processing facilities. IMC set up 10 transfer stations throughout the city, each fully mechanized, with the capacity to take 150 to 200 metric tons of waste. Once dry and wet waste containers are filled, they are lifted by hook loaders into dedicated vehicles for transportation to a final processing point. Wet waste. The wet waste is sent to the bio-compressed natural gas plant, which converts the wet waste that would otherwise decompose and

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emit methane at landfills into biogas, which can be used for energy, cooking, clean vehicle fuel, and Indore's 15-acre bioCNG plant was developed by Ever Enviro, a public-private partnership with IMC with processing capacity of 550 tons per day. This bioCNG plant is the largest in India. Then recyclables are collected and sent to a MRF, which are facilities where dry waste is sorted into recyclables and inert waste, as I mentioned earlier. Recyclables are then sold while the inert waste is sent to landfills. Finally, IMC constructed two six-acre sanitary landfills for disposal of inert waste. Reminder from day one training that sanitary landfills are engineered waste disposal sites that mitigate methane and minimize environmental impacts of waste disposal. Next slide, please. So, how did they finance this? IMC used a variety of financing mechanisms to fund the capital and operational cost of its new solid waste management system. IMC financed the capital cost of large infrastructure projects such as the transfer stations, the bioCNG plant, the MRF by securing funding from central, state, and local governments, as well as corporate social responsibility funds. The bioCNG plant and the MRF are operated on a public-private partnership model. IMC raised funds to pay for the operational costs, including labor, fuel, utilities, maintenance, and other related costs through revenues from the waste collection fees, fines for noncompliance, and selling the waste products. Next slide, please. To learn more about the lessons learned, you can visit the globalmethane.org website. And next slide. I think we have come to the end for questions.

SANDRA MAZO-NIX: Thank you so much Dana and Hussain for those thorough presentations. So, again, we are at the time that you can ask questions. We do have really good questions already, but I do invite our attendees that if they want to post their questions verbally, we will unmute you so that we can have a discussion. But I'll start with the first question that we have in the Q&A panel. So, the first question from CEO BWMC says, "So why are we focusing on reducing methane production instead of capturing and utilizing all methane produced from landfills?" Maybe Dana, you want to take this one?

DANA BLUMBERG: Sure. So we do know that the methane can be captured from a landfill and then utilized for energy, but we also know that there's a lot of fugitive emissions that occur during that whole process. So, we estimate that we can really, with a really well-run landfill, at the highest technology, pretty much capture about 85% of the methane, and that's an estimate. So, there's still methane emissions no matter what. And the energy recovery projects that take place at landfills are not always cost-effective. Sometimes, they need grants, tax credits, other types of funds to make them work. Really, keeping those organics out of the landfill reduces those fugitive emissions, first of all. And secondly, you don't need to spend the money on a landfill gas energy project that may not be profitable. Hopefully, that answers your question. If the landfill already exists, clearly, we want to capture those methane and we want to use it for energy. But if you're starting from the beginning, the best practice is to think that through and not have those emissions coming from the landfill. And also, prior to closing the landfill and putting the cap on, you're going to have emissions of methane. Those open cells are really hard to capture methane. That whole time that you're filling that cell, you have fugitive emissions.

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SANDRA MAZO-NIX: I would add also that with organic waste segregation, if you do use it for anaerobic digestion, then you would be able to get, capture more of the methane because it has a higher efficiency than landfills. That's important too.

DANA BLUMBERG: Absolutely.

SANDRA MAZO-NIX: So, we are talking about reducing methane, but we're also talking about if you're going to want to recover methane from the organic waste, then maybe AD is a better process. It has higher efficiency. I also encourage if you have a follow up question to our answers, to go ahead and raise your hand and we'll be happy to unmute you. Let's go ahead to the next question, and this one is about the case study in Chennai. It is from Rizwan, it says, "From 150 tons of feedstock, only three tons of gas is being produced, which is a 2% conversion only. Why is it so low and what is the time duration for the whole process?" So, maybe, I don't know, Dana, if you take this question as well.

DANA BLUMBERG: Maybe I can find that question over here. Well, I mean, the gas is compressed, so I – this would be a good question that we could provide a follow up answer from – well, I mean, Hussain might know the answer, but we can also ask the speaker from yesterday, Erik Anderson. He is our anaerobic digester expert. So, I would prefer to – Hussain, do you want to try and answer, or we can ask Erik?

HUSSAIN ALI: I think we can ask Erik, but I might add that we usually measure gas by volume but not by weight. I don't think converting the weight of the waste to comparing the weight of

the gas is the conversion that we should be looking at, but I think we can ask Erik on a deeper insight.

DANA BLUMBERG: Sure. So, we'll follow up with our written answer on that.

SANDRA MAZO-NIX: Thank you so much, and definitely I will mention here that all these questions, we will actually follow up with written responses as well. You will have also that as well for future reference. So, we have a question about residue. Maybe Hussain you can take this question. It says, "What could be the sustainable method of residue waste collection from the areas, as usually crop burning is happening in rural areas which are spread and vast areas, which makes the collection expensive?" So, how can this crop residue be collected given that it's in areas that are so spread?

HUSSAIN ALI: So, what I've seen in the US is once the crop is harvested, they use the harvester, and there's an attachment which is a specialized attachment for residue collection. And that attachment, what it does is it lines up the residues in windrows, just like in windrow composting, there's piles of them like long lines. Then you can run a baler on top of it, which converts that into bales. And then those bales are easy to transport. So you can just send them to an anaerobic digestion facility, or you can sell them in market to be used as animal feed.

SANDRA MAZO-NIX: Okay. Thank you. So, we have a question about the Indore case study. It says Indore has a population of around 3 million people, which generates around 1,000 tons of waste per day. This translates to 0.34kg per capita of waste, which is somewhat lesser for such a population city. Is this due to the waste source degradation that is happening?"

DANA BLUMBERG: I would assume that, but again, we can confirm that.

SANDRA MAZO-NIX: Yes. Okay. Thank you. And then there's also another question about whether the informal sector was incorporated in the Indore project.

DANA BLUMBERG: That's another really good question that we will follow up on.

SANDRA MAZO-NIX: And I would say yes. My preliminary answer is yes, that they basically did reach out to NGOs that are working on waste to basically help them with the whole project.

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And then there's another question. Amir has his hand up, so can we unmute Amir? He has a question written, but he had his hand up earlier, so maybe we can unmute so he can ask his question verbally. Hello. Good afternoon.

AMIR: Question is, regarding how much is recovered from waste processing treatment? How much income in terms of percentage? My perception is main source of income in this sector is only household waste treatment. Just like to environmental friendly, it's not economically beneficial. What's the point of view on that issue?

DANA BLUMBERG: So, I'm trying to understand that. So, are you talking about... So the households are paying what we call a tipping fee or for collection services.

AMIR: Yes.

DANA BLUMBERG: And yeah, so that may cover the whole system or the city may be supplementing that, so – because the city has such a high goal of being a clean city, but we can confirm that and we can get back to you on that. That's a really – that's actually a really good question, and it would be nice to know how much the tipping fees are covering the whole system and how much is having to be supplemented.

AMIR: Yes.

SANDRA MAZO-NIX: Yeah. We can also ask whether there is income revenues from the recovered materials as well that are collected.

DANA BLUMBERG: Right, yeah. The recycling they're going to produce to market and the bioCNG is going to produce an income, but sometimes, it needs to be supplemented, so it's a good question.

SANDRA MAZO-NIX: Amir, do you have any more questions? Okay. Seems like we don't have any more questions in the Q&A or in the – and nobody else has their hand up. Maybe let me see if I have a question. Maybe I'll ask Ali, regarding the segregation at source, at the household level, do you have any recommendations for hazardous waste, what happens with that waste? Like, paints, stuff like that that people also have, that is also waste that is generated at the household level?

HUSSAIN ALI: Yeah. The recommendation here would be first, there needs to be guidelines on what gets considered as a hazardous waste. And once you have the guidelines, you need to identify that waste in your household. And once you've identified that you have hazardous waste, it should be separated right from the source. I'm not sure if there's any hazardous waste landfill drop-offs or curbside pickups in Pakistan. What should happen is now you do have hazardous waste, you've identified it. Now, you just take it and drop it off at a hazardous landfill. So, I think that should be – and then there should be awareness among people as well, you know, that this waste is harmful if it ends up in the regular landfill.

SANDRA MAZO-NIX: Okay. Thank you so much.

DANA BLUMBERG: Just to add, some municipalities in the US will have a designated area where residents can drop off such type materials, and some municipalities also will have four collection events a year where they'll bring in the different types of trucks, like a truck that collects paint, a truck that collects electronics, a truck that collects all those household chemicals that you don't want to have in your household anymore, and medical waste, and things like that. So they'll have an event where they'll have stations and the residents can drop off those types of materials at these events four times a year is one thing. And then a lot of municipalities will take advantage of their landfill site, or their MRF, or their transfer station to also provide a drop-off area for those things.

SANDRA MAZO-NIX: Thank you, Dana. Yeah, it's very important to keep

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the hazardous waste out for any type of recovery, either organic waste or recyclables. So, that's one thing. We have a question from Walid Kushari. So, maybe we can unmute him so he can ask the question verbally. Hello?

WALID KUSHARI: You mentioned waste segregation at source. Now, I was a resident in the UK for about ten years and they started this waste segregation at source back in Milton Keynes back in 2005. And it took an educated corporate city like Milton Keynes a good period of five years to come to terms with segregating that waste, because I used to live there, and every other – twice a week, we used to have waste collection. And every other week, I used to have one of my bags left behind because I put the wrong waste in there. So, considering putting a waste segregation facility for at source, or putting the onus on the residents of the community in a country like Pakistan, how do you propose we should train our residents to get on with this program? Or if you want to build a sanitary landfill site and you want waste-segregated source, what sort of awareness do we need to bring to the masses to get into terms of that program?

DANA BLUMBERG: That's a really good question, and I think what you described is a typical response and a typical scenario, that it does take a long time to get everybody on board. And so, as I mentioned, looking at your – starting with the large generators and starting there to capture some organics will have a good impact. And you do that for a little while so that you can learn how to manage organics. And then you – like the city of Indore did, you start with pilot projects. And as you mentioned, maybe some of the higher educated areas is where you would start, and then getting people on board. And then the opportunity at the schools where you're – in the US, we've always thought, oh, if we get the children on board with recycling and source separation, they can go home and help the parents. That's been kind of a model that we've had. I'm not sure how successful that is, but we do think that the children catch on and they have more enthusiasm about it. So, I think it takes a while. And like what you said, we call it lid flipping where you flip the lid of the garbage tote, and look inside, and see if there's any

violations. And then you put a friendly sticker like, “Oh, oops, you didn’t source separate correctly,” without penalties at first, just sort of nice reminders. And then eventually, there could be some sort of penalty or compliance structure that you set up. But I think that what you described is accurate.

SANDRA MAZO-NIX: Yeah. I would just add that in a program that includes – it starts with, you know, I don’t want to say low hanging fruit, which is basically you start with the institutions, the educational, where it’s easier to segregate the organic waste and the recyclables. You start a program with that. And also, you run the pilot project, like Dana mentioned for the household. At the same time, you start the education part of it, the outreach and understanding what are the perceptions and waste from the public, and also in some cases, independent how densely populated the areas are, you might also start thinking about how a community approach will work best. So, there’s several things that could be done at the same time to really get to maximize and have an efficient organic waste or a waste segregation program. Walid, do you have a follow up question or...?

WALID KUSHARI: That’s fine. That works.

SANDRA MAZO-NIX: Thank you so much for your intervention. Amit, do you have an additional question? You still have your hand up.

AMIR: Thank you.

SANDRA MAZO-NIX: No? Okay. Thank you.

[01:45:00]

We have a question. Rizwan had a question on the Q&A, but he also raised his hand. So, let’s go ahead and unmute him so maybe he can make his question verbally. Hello?

RIZWAN: My question is for Hussain. He actually presented the idea of these AD plants from – residue waste from crops, so I have a little more interest, as usually in this season, in these months, we have smog issue in Pakistan, of which these crop burning has major contribution. So, that’s why this idea has presented an appeal to me and hopefully to my colleagues as well. So, that’s why I want to ask the exploration regarding this, and I want to ask that of what capacity these AD plants from these waste could be self-sustainable, as financial issues are much more important to us than environment at the moment from Pakistan point of view. One other question is that this crop burning is in for specific time limit. For example, in this month, October and November, there is crop burning about from 15 to 20 days. And after that, in the month of April or May, there is also crop burning issue. So, these are the specific time limits where crop burning issue we are facing. So, what will happen to these AD plants in during off

season? And during those season, what could be done to keep running those AD plants? So, that's why I have this follow-up question for you. Thank you.

HUSSAIN ALI: Okay. So, when you talk about self-sustainable, I got the idea that you want to talk about in economic sense. So, as far as my experience, ADs would need a lot of incentives for them to be self-sustainable because the biogas produced by the ADs is usually at a higher cost compared to the biogas available. Coming towards the second part, so yes, for the AD's aim for agriculture waste, there is going to be some off seasons. So, there are multiple things that can be done. One thing could be the waste storage. So, whenever the waste is in the bale form, you can store it and you can – AD can only run a specific amount at a certain time. Usually, you have to input the waste and it takes about 30 to 40 days, and then you input the new batch so you can store the bales for some time. And then if that option is not feasible, then there's always an option of using some other way since AD is the same. It's the same thing, it's a big cylinder where you digest the waste. So, during the off season, if you don't have any agriculture waste coming in, you can always go for the other organic waste. And another thing that can be done during this off season is the maintenance of the AD. So for most of the agriculture waste during the off season, when there is not much waste coming in, there's the maintenance and all that stuff happens during that time as well. I think hopefully that answers your question.

SANDRA MAZO-NIX: Can we unmute Rizwan in case he has a follow up question?

RIZWAN: No, thank you. Yes, I got some answers, and this area also needs further exploration. So, thank you for this.

SANDRA MAZO-NIX: No, thank you. We have another question that just came in. It's a long question, so bear with me. "What collaborative initiatives can be implemented in Pakistan to bring together key departments such as food, environmental protection, and waste management in a unified approach to achieve long-term environmental sustainability?" Currently, waste management companies bear most of the responsibilities. What strategies could help integrate efforts of all relevant sectors to create a more cohesive and impactful environmental framework. I'm just going to basically rephrase this question.

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What collaborative initiatives could be implemented? Bringing in different key departments in a unified approach, and then it mentions that the current waste management companies are the ones that are bearing their responsibilities. What could be done to help them integrate efforts, all relevant efforts?" I don't know. Dana, do you want to take this question?

DANA BLUMBERG: Sure. What a great question. Wow. Wouldn't we all like the answer to that one? What I'm understanding is that waste collection is done by private sector. And so,

getting their buy-in to say, for example, have separate segregated trucks where they have different sections of the truck. I think, you know, meeting with stakeholders of course is important. Finding out what they need to be able to accomplish that, and you know, coming up with a plan that would be – you want it to be win-win. So, you want the city to win. You want the collectors to win. So, maybe as you know, the collection fees might have to increase or that the city subsidize collection. Keeping in mind that if they do separate collections, like one route would be for waste, something going to the sanitary landfill, one route would be for organics, and one route would be for collecting recyclables. That's all increased revenue for them, because now they're doing – they're tripling the amount of times that they're doing their route. Now, of course, the tonnage is going to be the same, so they'll be able to fill up a truck. It'll take longer to fill up a truck and be able to do longer routes, but still, they will be increasing their workforce and increasing the services that they provide. So, understanding that they would be needing to have higher compensation is one thing. And then working with – let's see, the other stakeholders, environmental protection, yeah, they have to be in the room to – they're the experts. They know what they want as far as the regulations and what compliance would look like. And then the food departments, maybe the private sector, restaurant association or something like that. So, just kind of gathering all the stakeholders, having a vision for what you want the city's system to look like, and listening to what the stakeholders would need to get that to be accomplished, I think, is step one. Hopefully, that was answered. Sandra probably has some ideas too.

SANDRA MAZO-NIX: Yeah. I would just add that, to have an enabling framework and to have possibly policies that would help you. To have a comprehensive approach, you would probably need, you know, start thinking about circular economy, where you actually have the different materials that could be recovered. So, from the organic waste, from the recyclables. And then once you start kind of thinking of a policy, like Dana said, have a lot of engagement from the different stakeholders, listening to what are the barriers that they find, and really have this collaborative approach to having a better policy and seeing how it could be implemented. I think that would be the best way forward. But yes, definitely stakeholder engagement, and really listening to everybody, and trying to find solutions that could benefit everybody.

DANA BLUMBERG: Yeah, that was a really, really good question. Very thoughtful. Thank you.

SANDRA MAZO-NIX: We don't have any more questions and we're almost at time. I would encourage everybody that if you have any more questions, please send this to us. We'll put out the link and email address where you can send that to. So maybe, can we have the next slide, please? So, here are some references that you can go into here, the waste characterization handbook that Hussain mentioned, but there's also other resources that we have actually looked at for this presentation. So, I'll go ahead and pass it over to Pat to conclude this session. Thank you.

PATRICK COATARPETER: Great. Thank you so much. Thanks for that

[01:55:00]

wonderful discussion session. Great questions, great responses. Thank you very much, and thank you everybody for the amazing presentations as well. Very, very useful information. I just wanted to thank everybody again for joining us today. And as I've noted the last few days, if you have any questions, please feel free to reach out to us at the email there on the screen, biogastoolkit@epa.gov. And as Sandra mentioned a couple times, we will be also providing written responses to the questions asked verbally and entered into the Q&A just so we can circle back and make sure you get the information that you need. But if you have any additional information or have any additional questions, please feel free to reach out. But yes, thanks again to all of our presenters. Thank you for the wonderful discussion and questions, and we will see you all again tomorrow for the fourth session in our training series that's going to be focused on measurement reporting and verification. And we'll also be opening it up, hopefully, for a longer question and answer session, so we can make sure we get you all the information we need before we wrap up this training session. So, thank you again, everyone. Have a wonderful day. Have a wonderful evening. Ciao.