



Global Opportunities and Strategies for Addressing Landfill Methane

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Matt Hamilton:

I think we can get started. Hi everybody. Thank you for tuning in. We really appreciate you taking the time to join in today's webinar. I'm Matt Hamilton and I work for the government of Canada. I'm also Co-chair of the Global Methane Initiative Oil and Gas Subcommittee, with the United States and Ghana as Co-chairs.

Thank you so much for tuning in. We've got some really good presentations lined up all around the subject of the opportunities and strategies for addressing open dumps and landfills around the world. Before we get going with the presentations, there are some messages we are going to share at the start from Abt Associates. Did you want to go ahead, Katherine?

Katherine Rush:

Yep, thanks Matt and thanks everyone for joining today. I'm going to go over a few brief webinar software tips before we get started. First, there are two ways to connect with the audio today. You can either listen through your computer speakers, or you can use the number that is posted on this webinar slide.

All lines will be muted for the duration of the webinar regardless of the audio method that you choose. We'll be using two panels for today's webinar, the participant panel and the question answer panel. Both of these 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 the content. And if, for some reason, one of them does not appear, you can navigate to the bottom right of your screen and click on the ones that you are missing.

Throughout the duration of the webinar, you can enter questions into the Q and A panel. So, when asking questions, please select all panelists from the drop-down menu before hitting send- as this will ensure that all the speakers can see your question.

The questions will be moderated at the end of the webinar during the Q and A session. The final materials including the slides and the recording will be posted to the website. So, with that I'll pass it back to you.

Matt Hamilton:

Thank you so much, that's really useful. We'll get started with our first presentation. Today we've got Aditi Ramola talking to us. She's a technical director at the International Solid Waste Association where she manages international projects and partnerships with the U.N., provides assistance to ISWA's working groups, and helps to develop innovative projects globally to further strengthen cooperation with ISWA's partners and international organizations.



Her skills are particularly focused on solid waste management and environmental issues. She holds a master's in environmental technology and international affairs from the Vienna University of Technology. She has several years of experience in the private sector, including at Caterpillar Incorporated before joining the United Nations industrial development organization in the climate policy and networks unit.

Aditi is also passionate about science education and was the founding member and lead of the ISWA young professionals group initiative on education. And as the past chair of the ISWA professional group. In 2016, she helped launch the regional ISWA young professional group in India. So, Aditi please take it away.

Aditi Ramola:

Hi everybody, it's a real pleasure for me to be joining you today at this session on global opportunities and strategies for addressing landfill methane. And before I start, I would like to thank the teams at GMI and Climate Change Canada as well as the U.S EPA for coming together with ISWA to organize this four-part series.

And I would also like to thank the team at Abt Associates for all the help and support that they've given for facilitating this webinar. Before we get into the topic itself, I'd like to introduce the International Solid Waste Association (ISWA).

ISWA, believe it or not, was founded in 1970 and it's a global independent non-profit association that promotes sustainable, comprehensive and professional waste management globally. And it's also promoting a transition to a circular economy.

We are a member-based organization and we're open to individuals as well as entities and organizations as well as Institutes from all around the world that are working on the topic of waste management. And we work on a range of issues within the waste management sector through our working groups and task forces.

For instance, we have a working group on planet and waste organic waste management, healthcare waste management, recycling and waste minimization landfills, et cetera. We have 10 such working groups and several task forces that are set up to address topics that are cross cutting along general thematic lines or areas.

And one such task force that we have is a task force on closing open dump sites, and I'm going to talk to you more about this during my presentation. And just to end the slide, our general secretary is based in Rotterdam in the Netherlands. And if you want more information about the work that we do, and the projects that we carry out globally, you may visit our website at <https://www.iswa.org/>

Next slide please. Moving into the topic of solid waste and why I've put that in brackets is because it as opposed to liquid or water waste, we'll be talking more about solid waste and currently estimates and studies suggest that over 2.5 billion people lack access to basic waste services.

When I say, basic waste services that's just collection or any kind of treatment and so on. Between 30 to 40% of the waste that's generated globally is openly dumped and burned and finally leaked into the waterways and the environment- which then reaches the oceans.



You can see pictures that I've put up on the slide. These are actually pictures that are quite common in the global south. And what we know from estimates and studies is that waste generation is expected to increase over the next decades.

And most of this projected increase in municipal solid waste generation is going to be due to a combination of GDP and population growth, and it's going to be different in different parts of the world. So, depending on the context is going to show different trends. But essentially, this is what it's going to be.

And a more in-depth analysis of this is going to be launched in a report next month. Um, in proper base management essentially is. Improper waste management essentially is linked to a lot of challenges- and so if we go to the next slide, please.

We essentially see that there are health impacts. There are also impacts on the environment. There is not enough clear data on how much open burning takes place because it's a very localized practice, but widely practiced across the globe, at least in the global South.

And it obviously happens due to a lack of waste infrastructure collection services. These open dumping and open burning create serious health impacts as I said. For people who are living in and around these sites but also communities that are working at these sites for their livelihoods.

And it affects the livelihoods of many people, millions of people around the globe. What kind of pollution does this lead to? We have water pollution. There are emissions of toxic greenhouse gases as well as social pollution and so on and so forth.

Open burning of waste, particularly that happens. This is a picture that I've taken. In open areas, it releases also harmful chemicals, such as dioxins and furans because this is burning happening at low temperatures. Black, carbon, and other particulate matter is being released into the air.

So, there's a whole gamut of ill effects and impacts of open dumping and open burning. And, as I mentioned these also release open dumping, especially when there's organic waste in the in the dump sites. There is a release of greenhouse gas emissions, for instance, methane. This exacerbates climate change.

Moving to the next slide, please. I want to quickly talk a little bit about meeting the focus of our discussion today. Some key facts about methane... It has a half-life of approximately 9.1 years in the atmosphere. So, when you compare it to CO₂ it's a much shorter timeframe and therefore it has a much larger effect for a brief period of time.

And estimates suggest that the global warming potential of methane is up to 28 times that of carbon dioxide molecule for a 100-year timeframe. But when you start looking at it in shorter time frames, like, 20 years, for instance, the values are anywhere between 72 and 105. Let's take an approximation of 84 and that basically tells you that reducing methane is extremely crucial for us to tackle climate change in any meaningful way.

Next slide, please. From the point of view of the solid waste sector, you can see these 2 charts that are coming from the Climate and Clean Air Coalition and UNEP's publication from 2022, it was essentially a global meeting assessment 20:30 baseline report. It says that, bearing in mind lots of uncertainties, they have a whole model that they essentially used.



It tells you that, agricultural and energy sectors are comparable in magnitude to each other and have roughly, almost twice the emissions of the waste sector, which, in this case is, including both the solid waste and the wastewater sectors and methane represents about 19% of the global greenhouse gas emissions. Livestock is about 32%.

They say that 18% of all human derived median emissions come from the waste sector again, both the waste and water sector. And as I mentioned earlier the sector emissions from both the solid waste and the wastewater are projected to grow and they are intricately linked to population growth and economic development.

But one thing to keep in mind is that the emissions from the solid waste sector are set to be growing much more rapidly, both in tons per year, as well as the percentage of emissions within the wastewater sector.

This implies that addressing waste methane or methane from the waste sector gives us tangible opportunities, and it also is imperative for us to tackle climate change. A study by World Bank has suggested that by deploying the best available technologies, methane emissions from the waste sector can be reduced by up to 80%.

Moving to the next slide, please, I want to quickly talk about a working group on landfills. ISWA's working group on landfill focuses on the design, construction, regulation, management of landfills, both in high income countries as well as low-income countries.

And when I talk about operations and management, this includes closure, post closure issues (let's say you're closing a dumpsite or an old landfill), including groundwater monitoring leakage treatment, landfill gas management, the quantity and the quality of the waste that's being landfilled and so on.

It's a working group that manages and discusses topics for the whole gamut of landfill management essentially. What I put on the screen are all the publications over the years. Well, not all, this is not an exhaustive list, but quite a few of the publications that we've had over the decades.

When I was doing my research on this topic, I found out that our working group has been talking about dumpsite closure and landfill gas management and capture for decades. Actually, since almost 2006 was the 1st report that I found, which is associated with open dumping.

Even back then the initiative supported moving away from open dumping to practices where waste is contained and covered and also reducing the environmental impact so the environmental impacts of waste disposal and dumping. So, that's the paper on the left that you see.

I think on the attendees list, I saw some of the participants who are actually part of these studies way back in 2006 so thank you for all your work. The other papers that you see here, you probably can't read the screen's too small. It's a key issue paper on the role of landfills, and the transition towards resource management. There's something about landfill aftercare, there's the waste



health report, the tragic case of dumpsites from 2014, road map for closing dumpsites 2016, climate benefits to due to dumpsite closure 2018 and so on and so forth.

The latest report that we worked on is the impact of management choices on landfill methane emissions. That was released at the Expo Hall Conference in 2023 last October.

This is briefly about the work on landfills that we've been doing through our working group. And if you go to the next slide, I'm going to talk a little bit about the task force on closing dumpsites. As you can see the, the topic was being discussed at ISWA before we formally launched this task force.

This task force came into effect and was formally set up in 2018. It's currently an international partnership that is led and facilitated by ISWA. We are always looking for partners who are thinking along the same lines as ours, or who are interested in the same dumpsite closure issues.

The closing dumpsite task force accomplishes its work through site visits, through technical assistance, scientific research, capacity, building and so on. Whichever municipality or jurisdiction that we are working with, we try to help them with technical knowledge as well as help them with their contact specific issues.

The main aim and goal of this initiative is to enable the jurisdictions, which could be cities, could be national level governments, or even sub national level governments. With support that's needed for the closure of these dumpsites and moving along the waste hierarchy in a coordinated and cohesive manner in order to mitigate essentially meeting emissions and black carbon emissions that are coming from open dumping and burning.

We propose best practice solutions that work in 1 place to another. To see if that can be fitted into their context. And our goal is not only to play an active part in the closure of dump sites, but also to ensure that the final closure is going to be supported by good infrastructure, by integrated waste management or master plans.

Also making sure that there is going to be institutional and administrative capacity to carry that out and also financial resources and social support and which I'm going to talk a lot more about in the next slide. Social support for the people who are owning their livelihoods by working and living in and around dumpsites.

With this initiative they're going to support municipalities and governments who are looking to make positive steps towards closing dumpsites in favor of more sustainable alternatives. Across the whole, as I said, integrated sustainable waste management hierarchy.

Finally, closing these dumpsites is not just about fixing waste problems. It's a matter of protecting public health and the environment, as I mentioned, the ill effects of open dumping and open burning and of course, improving the quality of lives by helping move away from these unsustainable practices.



Next slide please. Before we start talking about closure, natural gas capture, and so on- we cannot manage anything that we don't measure. You must already know if you're working in the field that data related to waste management is very hard to come by especially quality data.

It's very essential to do baseline studies for the regions or municipalities, or jurisdictions that you want to work in, and in this regard, we've worked with 2 tools. 1 I haven't said anything about on the slide. It's the U. N. habitat tool, which is like a baseline data collection tool, which tells you about the waste flows within the region that you're working in.

And then further we use the solid waste emissions tool. This is a tool that was developed by the US EPA under the Global Methane Initiative, supporting the climate and clinic coalitions work.

It's an Excel based tool. That quantifies emissions of methane, black carbon, as well as other pollutants from the waste sources. And it essentially allows you to set up a baseline scenario, compare alternatives, and also analyze specific policies of projects for those potential emissions reductions.

It also helps you track progress over time if you put the right data into the Excel sheet. If you want to know more about this excellent tool, please visit the website, and you can find it on the clinic coalition's website, that's where I usually point people to. But I'm sure it's also on the GMI website.

I was having a discussion with Tom last night and I remembered that yes, we have actually applied suite to several sites in the past, for instance, starting with the Estrutural dumpsite in Brasilia, Brazil which was closed in 2018. We also applied it to the Rautenweg-landfill in Vienna, Austria. And the Hiriya landfill in Tel Aviv, Israel, and the Ras Al Ain near Lebanon, which James is going to tell us a lot more about in his presentation.

We would like to apply it in the future to Banyuwangi in East Java, Indonesia as well in Tabanan which is in Bali, Indonesia and Chengalpattu, Tamil Nadu, India. These 3 locations, because ISWA has been working for the past 3 years on another project, called Clean Oceans to Clean Communities.

We've done baseline data collection and assessment already for all 3 sites. It's now a matter of actually putting it into the suite tool redundant to get better data about emissions, estimations and quantification about what the potential for emissions reductions are in these sites.

Please move to the next slide. This is just a more fun slide. The reason I'm asking this question is because lots of people that we talk to in the global South, when we tell them that we have a task force about closing dumpsites. And they look at us and they are like- but where do you want to go? Can you close the dumpsite? But then what next?

Because that's mostly what they know. Their default is sending their waste to dumpsites. A more accurate description of what we are trying to do, would be closing down sites and moving up the waste hierarchy.



Or even more descriptive and accurate would be closing dumpsites and moving to an integrated sustainable waste management solution. But as you can see, it will be very cumbersome to put this on any kind of social media platform.

So, until we find a better alternative, it's going to be hashtag, closing down sites. But we are, if anybody has better ideas, please do write to us to James or me. And we'll, we'll be happy to take your suggestions.

Next slide please. Now, I just want to talk about briefly about the considerations that we need to take when we want to close a dumpsite. And it's a complex process, but essentially, in principle there are 3 available methods.

You can close the dumpsite by covering the waste. So, it's in place, you just put a cover and of course a lot more than that. 2nd would be closing by removing that waste from the site, and mining it, remediating it, evacuating it, putting it somewhere else. A lot of this is being done in India currently. And 3rd, you would do it by upgrading the dump to a more controlled site. Or perhaps a sanitary landfill.

These are the 3 in essence ways in which you can close a dumpsite. The option that you choose is obviously going to be based on the study of the site itself and taking into consideration sustainability as well as affordability because it's not cheap at all. And looking at the local context.

While also remaining cognizant of the fact that the real improvement is going to be in relation to the environmental impacts of that dumpsite. Whether it's actually going to be improving or not by closing that dump side. Sometimes out of those 3 methods 1 should be also careful and keep in mind that sometimes the most technically, advanced solution might not be the best option for that particular site.

Obviously, a feasibility study a very detailed technical analysis, has to go into place. And so on, so the key principle should be keep it simple. It should be sustainable in the local context and you're trying to maximize in line with the performance or minimize the environmental impact.

As we saw the ill effects of open, dumping and burning, there are obviously several benefits of closing dumpsites and upgrading to more sustainable waste management systems. When you look at the environmental benefits, you can, of course, have reduced methane emissions or greenhouse gas emissions reductions.

Open dumps usually tend to catch fires, so, of course, black carbon is reduced, reduce pollution of air, land, fresh water. So on and so forth. When you are closing the site, you're hopefully moving up the waste hierarchy.

So you're reducing, of course, our reliance on raw materials. There's also the effect on public health and the quality of life again through evolution and so on. Your neighborhood is cleaner. You don't have an open dump that you're looking at every day. So on and so forth, so the benefits are plenty, but 1 has to be aware and cognizant of the fact that closing a dumpsite or a closure of the dumpsite is a very complex process.



Which needs to be properly planned, including thinking about technical aspects, environmental aspects, economic aspects, as well as social considerations. And before you can actually close the dumpsite, you need to have an alternative waste management system in place otherwise another dumpsite is going to pop up eventually in another place.

You also need to have adequate institutional capacity and last, but never the least political consensus. If there is no political will, it's never going to happen. And so when we talk about technical considerations, I'm not going to list the whole thing, but one has to always look at the, of course, the short term solutions, but also the long term management of that closed site.

Whether it's looking at, if there's going to be leakage coming out of it after you close it? Are there going to be gases released? Are you going to capture those gases? How are you going to maintain stormwater and clean water during the closing process as well as after the closing has happened? What are your sealing systems going to look like? The long-term rehabilitation maintenance of the site itself.

Financial considerations also have to be taken into account. Because, as I said, it's not a cheap process is quite complex. And especially if there are hazardous materials that are present in the site already, which is the case of several sites here in India, especially the mega sites.

Because those were the primary way of waste disposal. And so they have sometimes mercury, sometimes, other hazardous materials. And so the funding for that remediating closing needs to be taken into account. Sometimes it needs quite a large amount of money, which could be in terms of grants or loans.

The social aspects I want to delve into a little bit because what tends to happen is that with growing concerns about these dumpsites being in and around living spaces around towns and cities. The pressure to close these sites are increasing and these processes usually happen extremely quickly and hastily, and sometimes without the consideration for, as I mentioned before the, livelihoods of waste pickers and people living around those sites.

I want to just mention briefly, you remember I mentioned the Estrutural dumpsite in Brasilia. I'm always not saying it right, but they closed that dumpsite in 2018 and experiences from Brasilia and other parts of the world are showing us that inclusion of people living around the sites who are, depending on their livelihood on those sites. Are extremely crucial to plan for and should be part of the whole management and closure plan.

And the dump site in Brasilia was closed in 2018, as I mentioned, it was operational since 1960. There were several notices, sent along the decades. There was major environmental concern, because it was next to a river, very close proximity to a river, which was a water source for Brasilia as well and about 40,000 household or waste pickers were living around that side.

And despite many closure orders in 2015, the new mayor who came in he basically said let me take a step and close the site. What they did was, they basically had a comprehensive plan. They identified several issues that needed to be addressed and almost about 17-18 government agencies were involved in this in this plan.



And they also included like an epidemiological study to look at the waste picker community and essentially integrate them into the process. For helping them basically transition from working at that site to working in more controlled facilities, recycling facilities and so on.

There's an organization called Diego. They were also involved in this study as well, as the whole monitoring evaluation of this closure of the site. Participatory platforms were set up as well for people to give input and they were given more educational opportunities, and they were also given health benefits.

Essentially, because when they were working there, they didn't have any PPE. But when the transition happened, they were, of course, given better equipment. Of course, not to say that they were not any hiccups. There were challenges in the beginning, but eventually, it was a success story and the process demonstrated how governments can address these concerns or environmental concerns as well as social concerns which include livelihood protection when they do such closures.

Several lessons have been learned, and hopefully similar cases can be applied to different parts of the world that are looking to close their dumpsites. And I had the good opportunity James, as well was there to hear about this story firsthand from a 3rd generation waste picker at COP28. She was at our panel. And she told us about exactly the steps that were followed and how it was a success.

Next slide please. This all goes to show that closure can be one step. Once that processes is in place, management of landfill gas is going to be a key issue during the operations of any dumpsite or a landfill. Whether it's an engineer landfill or open dump, because if there's any organic material that reaches the site, it is going to be generating methane anaerobic conditions.

And if you talk about landfill gas as approximately 50 to 60% methane, and then you have CO₂ and other trace gases and other compounds in trace quantities. But again, 50- 60% methane so that's 1 important thing to remember.

I won't talk too much in detail about this whole process. There will be, of course, other webinars. And James will also mention briefly. But the points that I have on the slide, I just want to briefly say that in 2019, IPCC the Intergovernmental Panel on Climate Change they refined their guidelines to include a higher fraction of Degradable Organic Carbon for easily degradable carbon and lower for Degradable Organic Carbon for less degradable carbon.

What that means essentially, is that a large part of methane reduction potential can be expected right at the beginning when the waste reaches the site. IPCC made this amendment because they found strong indications that methane generation is higher than they previously thought shortly after landfilling- so after the waste reaches the site, and lower than they previously had assumed in later years.

All goes to show that if those capping systems and those landfill gas treatment capture systems are not in place- it's difficult to get good quality gas out of it. Landfill gas can be controlled using several techniques.



That can include containment, extraction as I mentioned, which you can see on the screen, through vertical gas extraction wells, or even horizontal extraction wells. You need to make sure that the leakage levels are low. So, maintenance of those leakage levels. And then, of course, providing a bio cover. That's something that our working group is working on currently.

To provide an oxidation zone above the cap and so on. That sounds great, except that the capture and utilization is technically and financially challenging for many communities. It leads to sometimes inadequate filling of landfill gas projects. If there are policies in place that encourage methane capture by incentivizing, say landfill gas utilization, or maybe favoring it as a fuel transportation fuel, or cooking fuel, or whatever. If there are policies in place to offer tax benefits for these kind of technologies, thereby making it a valuable energy source, then people can actually make those projects a success.

But for these kind of projects to be success, control measures have to be effective and maintenance is key. Which is again expensive. It's not always that municipalities can actually afford these landfill gas capture and use projects, especially in low and middle income countries. I know that in the U. S. there are several hundreds if not thousands of successful cases taking place and the US EPA analyzes which other sites could be a potential for such a project.

But I'm talking about low and middle income countries. What should they be doing then? That takes me to the next slide. And here, I want to talk about organic waste management strategies. Because what's the next best thing? Right? You're hoping to not have any organic waste in the landfill or dumpsite in the first place. Because the organic waste in the landfill is what's generating the methane.

To have a comprehensive organic waste management strategy to prevent such waste from reaching landfills or sites. Several key steps need to take place 1st and foremost. If you hear from the chair of our working group on biological treatment of waste and vice chair as well, we're always advocating for separation. We need to encourage households and businesses to separate organic waste from other waste streams and its the cheapest way to do it.

Then, of course, having a proper collection and transportation, having a dedicated system, just for organics, ensuring that it's transported to appropriate facilities, whether it's composting plants or if it's AD. Whether at community level or wherever. Another cheap way or effective way would be to promote composting as a primary method for organic waste treatment.

It can be done at a household level. It can be done at a community level. It can be also be done at a municipality level through large scale composting facilities. Always try if feasible to keep the waste as close to source as possible.

And so this is just the rule of thumb, but all levels of treatment are possible here. Then we come to AD, which is bio gas plants, utilize AD to convert that organic waste into biogas, which can be used as a renewable energy source, as I said, if you purify that biogas further, you can get transportation fuel as well.



Lots of cities and municipalities in India are doing that as well. And then you also get digested, which can be used as a soil enhancer. And for all these things to be effective, and to work properly, you need to have proper policies and legislations in place. Last, but not the least there needs to be a market for these products from these processes.

So, whether it's for compost or whether it's for digestate, or whether it's for the biogas. To ensure economic viability and sustainability that needs to be thought about, before setting up these systems.

For these strategies, of course, there needs to be a good system in place between government and industry and obviously the public as well. Essentially, we are the data points that need to need to work on. So separation right? It starts at home. I want to go into my final slide.

I think I'm already over time. I'm sorry. So just final conclusions. Final remarks. What I mentioned, so far, is that methane from the waste sector is intricately tied to development. So it's GDP as well as population growth and that's set to rise in the coming decades.

So, without any kind of collective, concerted action, emissions from the sector are going to rise which is not going to bode well for climate change and so on and so forth. So mitigating methane emissions from our sector, which is a solid waste sector provides opportunities for action and addressing climate change.

And finally, as I mentioned in the organic strategy, we need to have waste segregation. We need to implement strategies for organic waste management as well as when feasible and possible financially- viable management with gas capture or dumpsite closures.

My final slide is going to be just a list, not exhaustive at all, but some key websites where you can get a lot of information and good resources for if you're working in the field these are some good starting points. But there are lots of organizations now working on these. Waste management and methane on the way sector issues. And I hand it back to Matt. Thank you so much, Matt back to you.

Matt Hamilton:

Thank you. That was quite a good tour through a lot of what ISWA's been doing and some, some useful information about the problem we're facing and some of the solutions. So thank you so much. That was a great talk. I think we'll carry on with James presentation now. I see some good questions coming up in the in the Q and A. Okay, so that's great. We'll, get some answers later on in the session and so, let's move forward. If we could load James's presentation.

So, James Law's, vice president at SCS engineers. He has over 35 years of experience in civil geotechnical, engineering and solid waste management industry on both national and international projects. His experience in solid waste facility, design, and management include landfill bottom liner and leachate collection systems, landfill final cover system, landfill gas collection system and equipment and procurement for overseas.



Solid waste, transfers facilities, aerobic bioreactor, landfill, mediation and leachate recirculation evaluations in obtaining R. D and D permits. He is an honorary member of the international solid waste Association. Chair of the ISWA working group on landfills and the task force on closing dumpsites global initiative.

He is also a member of the solid waste association of North America, which is a national member of ISWA. He is currently licensed as a professional engineer in multiple states in the United States of America. He's also certified as the board certified environmental engineer in sustainability by the American Association of Environmental Engineers and Scientists, and also accredited as a LEED, AP, D, and C by the United States Green Building Council. So, James over to you.

James Law:

Thank you, Matt, for your introduction and thank you Aditi for doing an excellent job in introducing ISWA and what we do at ISWA. 1st of all I would like to thank you guys for organizing this particular event. I think it's a very important topic to talk about these days, especially with everybody's focusing on climate change and with the dumpsite and methane, interrelated to methane emissions as well as what we are doing on the day to day basis.

I think Aditi covered a wide range of topic introducing the topic here. And I will just give you a quick outline here to show you what we'll be discussing in the next half an hour or so.

Some of the topic, I will not touch a lot, but I will focus on the long term solutions specifically on the final power systems. And hopefully, it will then lead into a discussion on the case study that we did in Lebanon. So why is closing dumpsites a global priority?

Look at some of the published data. To my right, the pie chart that basically indicates that about 70% of the global waste goes to either dumpsite or control or sanitary landfills. So, 2 thirds of the waste goes to some sort of a dumpsite landfill environment. Depending on what you are looking at. The World Bank published at 33% in ISWA we are little bit higher, which is 40%. Basically says that 40% of the waste goes to the open dumpsite 40%, or 70% on the previous statement. And then they are mostly coming from 90% of the low-income countries.

ISWA refers to the global South. It's a significant number. And ISWA is an international organization. And there is a lot of work that we need to do here in order to make a significant influence or impact to the climate change. This is a map Atlas that ISWA published back in the 2014- 2015 window.

We identify 50 largest and dangerous dumpsites around the world. Bear in mind 50 is not a real number. 50 is a number that were the dumpsites that responded to our survey request. I'm pretty sure that the real number is probably 10 times more than that.

Internal downside statistics- globally we have over 50,000 dumpsites. There are over two million people working on the dumpsite. Whether that is a waste picker or workers. But it's a big number if you look at it as a whole picture here.



And then in red, I pointed out that in just the 1st part of 2016 there were about 750 people killed at a dumpsite. Whether the dumpsite collapsed or slow failures or due to fires or anything related to that matters.

Dumpsite is a very dangerous environment to be in by itself because waste is power up uncontrolled manners. In engineering training, we call it unstable. It is a dangerous structure humans created. So, we need to kind of really try to take care of that.

And now, as you see, I try to circle some of the site name. There are, at least to date I believe that less than 10% of that dumpsite that we identified that is actually closed. This can lead to can we call this a global emergency in terms of health of climate change? That we actually needed to push people to do something about it?

So that's a question I like to pose to you guys. COP28 that happened few weeks ago in Dubai. This is the 1st time ISWA hosted a waste and resources pavilion because we were there a few years ago and there was nobody talking about waste.

But yet there is a lot of literature out there saying that, hey dumpsite is the 3rd largest greenhouse gas generator. So how can nobody do anything about it? Right? This year we took a more proactive actions, and then we were able to find enough sponsor to support us to have to have our voice heard at a COP28.

And now given that it is a dumpsite situation and dumpsite does generate a lot of methane gas it is a low hanging fruit that we can address. If you close the downside, that certainly can come up with the numbers by going through the modeling process to say, hey, how much methane emission reduction that will results and then in the case study later on, I will show you that what we did a couple years ago.

And now the issue I mentioned earlier, that instability is a big, big issue. And especially now that we also talking about going in and doing some bio mining and this sort of thing. So we really need to look at this thing very closely. So that in order to avoid unnecessary health issue and loss of life.

These are the pictures that kind of example of when the slope fails, it can really become a huge problem. The 2000 landfill in the Philippines, when it failed, it killed few hundred peoples. Just amazing the picture tells you people live very close to downsides so there's no, no way to escape, right?

And then the dumpsite is very common. So if we do nothing scenario what is the implication if you look at the picture here? The dumpsite is very, very close to, like, a top pictures there those are people living in the apartment complex.

It's basically, several hundred meters away. It's very close. It is a concern regarding to a global health and environmental issue especially for people living around or on the dumpsites.



Last month I was in Nigeria, they have about 1500 waste picker on a dumpsite. So it is an issue that we need to address. Now, other issues regarding air and plastic pollution. As you can see the lower pictures there, there's a lot of plastic at the dumpsite.

It's just like we have here too, even sanitary landfill here we have a lot of plastic. Especially if you're near a river or waterway marine will become a problem. I don't know what is going through your mind, but when I look at this picture, and actually, I would, I was the one who took the pictures and I can make a stand and say waste is about people you know.

There are some basic human rights that is being violated. Just like, we are all entitled for clean air waters and food. And but then why nobody look at waste issue closely and do something about it? And I sort of encourage people who are in the decision maker of governmental level, high level official that you really need to tackle this problem.

Without actions with the dumpsites the greenhouse gas emission, I think, by next year is about 8-10% emissions, and by 2050, I am pretty sure the number will be much higher. I just wanted to point that out. Then, Aditi already talked about our publications.

These publications are a very useful tool for people who wanted to consider to realize what kind of climate benefits that we are going to have. As well as the road map actually have an entire section chapter in there talking about technical challenges and solutions. Which I will be talking about here in this presentation.

But I will skip over to talk about financial socials and other aspects that you could probably go to ISWA website to download it. In 2019 we also revised a guidelines, which we call it the landfill operational guidelines. It's the 3rd edition. And that will give you a pretty good account of how to properly operate landfills.

And it's a pretty comprehensive documents that I also encourage you to get ahold of that copy and then you can get a pretty good view of what needs to be done. Last, I guess a year and a half ago ISWA also released a book: The Waste Crisis.

This one's specifically trying to provide a roadmap for sustainable waste management in developing countries. It could be an interesting reading for some of you guys. I will go through all of this because I think these are the key phases for a successful project, say closing a dumpsite.

As you can see a lot of items Aditi already touched on. I will probably focus on one or two items. There are a few points that I would like to point out is that given that this is a dumpsite operation it's very difficult to obtain reliable, accurate, waste data. Such as how many tons are placed in the ground, because to do gas modeling, you need those data.

A lot of the time you had to do interviews of the people that work at the landfills and hopefully, you'll find someone who knows the history of the landfills then you can try to come up with some data that makes sense to you. The other thing about waste dumpsite is this.



As some of the picture I showed earlier that the common thing of the dumpsite is very tall very steep. And it is very difficult to close a dumpsites because of those features. And so you must have a comprehensive waste management plan in place already. How are you going to close a dumpsite like many years before that?

So that at least you can try to shape, even though you don't do compassion on the waste, but at least give you an opportunity and do less work when the time comes to close a dumpsite. I will try to flatten the slope as much as you can. And then try not to get into a situation that the slope is not stable so they can not really get equipment on top.

This is a list of technical problems and challenges that I thought is relevant for dumpsites situations. And, as I mentioned earlier, that dumpsite usually, you just dumped the waste and then you may have that. Those that push it off and level it off and there's no control or compression, apply compression, et cetera and there's no daily cover.

Usually, I mean, you go to the dumpsite you look, you can see hundreds of meters of waste completely exposed. And then guess what when you have rain, come down all those rain penetrate infiltrate through waste.

Slowly leaching down the bottom and go somewhere else, because dumpsite usually does not have the bottom lined systems. And the other features that is common in dumpsite is fires and there's no stopping it. Whether it is internal combustion, or whether it is due to the waste pickers try to get some copper out of the wire.

They will set on fire trying to get the metals and in the process they could easily set fires at the landfills. Dumpsites usually have no control over what kind of waste they're receiving, and there's no record of it. So, it could be anything. So, if you're going to do some kind of a landfill mining project, et cetera you may run into sort of a thing that you need to deal with so this is something to keep in mind when you're planning.

You need to be able to handle that and then when the situation arises you need to be able deal with it. I think one of the biggest problem with dumpsites is that there's no security fence. Therefore, you encourage scavenging at the site. Waste pickers probably not easy to control and it is a big social issues there. I wouldn't say much here, but maybe other speakers for the series can touch on the social aspect of it.

The leaking treatments, obviously, there's none in place and so is the odor control or gas management there is probably none. And I think the only opportunity you may have is to try to put in some kind of gas collection system after closure.

Which we will be touching a little bit on that and then hopefully we'll address. Stir in some interest and then other speakers in the remaining series can actually dive deeper into it.

Dumpsite being a dumpsite there is no engineering measure plannings in place. Usually we refer to bottom line the system or the leachate system at the bottom. There is some opportunity to do that if you expand the dumpsite next to it. Which we'll talk a little bit about that.



Now these are the list of site enhancements strategy that I can think of. And I think the very first one is if you're operating a dumpsite right now you can certainly implement immediate site improvement. Because if you try to improve your site condition it is always less work to do than when it's time to close that particular dumpsite.

On the 3rd line down, I mentioned about if you have a gas collection systems, you can pretty much catch a 60 to 90% of the methane. And bio covers probably around 80%. And then the other strategy is waste diversion and composting.

Try to divert the organic matter out of the dumpsite. That definitely would reduce the emissions of the dumpsite. Landfill mining is another strategy there, which involves reducing waste volumes. And potentially recover some resources.

For future, methane emission, you can certainly eliminate that part of it. And probably one of the most important reasons why people do landfill mining is to reclaim land. Especially if you are in the high, real estate values areas, that may be one of the reasons why people do that.

Now, in terms of some other innovative technology, such as specifications and use of drones for landfill monitoring- this technology definitely offers new ways to reduce or utilize methane gas emissions.

Now I won't be talking about long term solutions collect methane gas using effective final cover system and combine with a gas collection system. At a dumpsite situation you could put an active or passive gas collection system, because the whole idea here is to reduce the methane admission to the atmosphere.

And collectively, if you have a system that can collect gas and put a flare off is better than releasing methane in the atmosphere, which is 20+ time more prudent than the other side. So now if you have a collection system in place it can also control potential subsurface gas migration underground. It would also control the pressure that is built up within the waste mass itself.

And, of course 1 of the beneficial utilization of the methane gas is to hopefully you can pipe the gas to a gas energy plant. It depends on how much gas when you consider different options. So internal long term solutions, there are three methods of closing up dumpsites.

And the 1st, 1 is something to do with closure by upgrading and otherwise you upgrade the dumpsite into control sanitary landfill environment. And the second one is in place closure. It's basically put in the final covered system on top of that.

And the 3rd thing is completely removing waste from the dump and this part the other terminology is mining or bio mining, would it be quiet? So these are the 3 longterm solutions. And let me get to the 1st one closure by upgrading is... I'm not going to read everything from here, but at least I'll give you, you guys probably going to get a copy of this so you could read details if you wish.



But basically is the existing dumpsites, you put a low purple cap over it, and then you put vegetation over it and then you would install some kind of basic gas collection system and it could be passive or active system and it depends what you want to do. With the gas.

And obviously if it's active system, you can actually reduce the greenhouse gas. If you just passively collected it's discharged in the atmosphere. So that doesn't do you any good other than control fires all the other issues I talked about earlier.

Now when you upgrade a dumpsite, obviously you have an opportunity to grow some waters and also regrading the surface so that leachate generation is kept to a minimum. Now let's say adjacent to the dumpsite you have a piece of land that is available. And this is where you can try to design a control sanitary landfill.

Which means you putting the liner systems and leachate collecting systems, and then the new waste will go there while you try to do something with the old dumpsites. So 1 key consideration is it is useful to do things in a sustainable manner.

And try to use local construction methods and materials because then you are minimizing costs, but then you're maximizing the environmental improvement and performance. And it's probably easy for the local people to adapt to it.

Now, in place closure, which is probably the most common 1 when we talk about solutions. So, we basically install a permanent final cover system over it. And then you, you also would install a gas collection system. And whether it's passive or active, it's really, depending on how much gas is remaining gas generation volume is in the waste mass.

And also how all that waste is because some dumpsite is very old and there is very limited amount of methane gas coming out of there, so you probably don't want to put a super active gas collection system. You try to collect a small amount of gas then you don't really get the most out of it.

Now, when you install a final cover system, obviously these are the 4-5 items that I listed there that you realized the benefit right away, which is you basically reduce the waste exposure. When going offsite and then you can minimize the risk of fires with people scavenging the waste.

You have better control of surface water and therefore reducing the leachate generations. By putting it cover system over the entire site you have better control of odors and gas migrations. This is assuming that you have some kind of gas collection system that applies a vacuum to it

They have plenty of examples out there, but common passive in use is usually converted into a park or ball fields. Removal waste methods, I think this is probably the least on my list to do here because it is very involved.

If you try to decide to see through the waste and try to basically trying to segregate the waste and the different materials and then. Now, the question we had to ask is where this material going to go? Is there any takers?



If there's no takers, that means you've got to stop house somewhere else instead of 1 location right? So, something that we need to think about when we do this sort of planning is the real estate value is so high that all the cost put in to remove the waste and disposal of it is far, far more than the cost of doing the work.

So, you can put in a high rise or condos so they get more out of it. At the same time, you can clean up the site. So it is a happy ending there. I don't think I need to go through this in details because it is a pretty comprehensive planning that you need.

And then the safety of doing landfill mining is very important. Because many things, when it's in the right mix between 5 and 15%, you could have it could explode. So you've got to be very careful with it.

Now let me in the remaining time I want to talk about the project that we did in Lebanon. This is the 1st project that we partnered with CCAC to come up with a better gas emission estimation using a sweet tool that Aditi mentioned earlier and this is probably the 1st time that we applied this tool on the project.

The duration of this project is kind of long, because bear in mind, we have COVID happening in between so none of us can travel to Lebanon. So, a lot of a lot of ways done online, and we're fortunate enough that we have, we know enough ground people, ground champion that can go out and collect data for us and make this study possible.

We also did a 3 days training workshops, back in June 2021. And then our final report and videos were completed in November 2021. Followed by a webinar to present the final reports, and that's like a pretty comprehensive products that we get out of this project.

One thing, I want to mention here with this particular project that because we do have reliable, site specific data that we collect on waste volumes ISWA also has a detailed integrated waste management system plan in place and so we know what they want to do.

And therefore make the scenario that I'm going to present to you in a few slides later that made sense because one of the thing is that how much waste and when did they burn? Right? It's all discussed in their integrated management plan. Which is, is a good thing to have.

I wanted to apologize this is a very nice video, but it cannot be played here on this platform unfortunately, but we will try to send you a link on how to get it from the ISWA website. Hopefully you can enjoy the video we created.

So basically there are 5 scenarios that we look at, in terms of our gas emission estimation for this Lebanon project. The 1st BAU basically says business as you should do nothing. Okay. And then this scenario is compared to the next 4 alternatives.

The 1st, one S1, is okay, we'll remediate the landfill, the dumpsite and notice the years because the study was done in 2022, when you remediate, we're assuming that the dumpsite will remediate in the 3 years window. It will be capped by 2025.



So some of the number and trucks that come out later on, it's a spare man about this years now. And then 2nd is we'll remediate the dump site. And then we will also develop a new landfill, and the new landfill will be ready around 2023.

The third option is to do all the above. But we got to implement a phase 1 diversion of waste. Up to 40% and this will be done around 2025. And the last option is basically S3 but we say okay instead of 40% diversion, we're going to bring it up to 52% and then see what happened.

This is the results of the modeling using SWEET as you can see the BAU which is do nothing scenario is the or orange line, on the very top line. And then every, every other lines with different colors below it is 1 of the 4 alternative.

The bottom line is the brown line, which is the S3, which is basically waste diversion is 40%. And that cannot be the best alternative. And in tables, compared to the baseline scenario it is, 2025 as you can see right after immediate site- you can have 30% reduction, right away just by doing that.

Then in 2050, the overall is 61% reduction for scenario 3, which is diverted waste 40% of that waste and so as you can see some of these numbers are pretty significant. If you chose to do something and not do nothing. Our conclusion is that a larger greenhouse gas emission reduction is achievable and it would definitely have a significant impact in terms of climate change. By doing, you know, closing dumpsite, building new sanitary line view and diverting 40% of the waste for composting and recycling.

I believe this report is on our website also it can be downloaded. I won't go through this particular slide because Aditi already touched on that. And we were at COP and then this mayor showed up and then we had our president pull me aside to take a picture with him so.

Conclusion, closing of dumpsites is requires an alternate waste management system. We cannot just go and tell people, hey, close it, but you don't really provide where the new waste is going to go. Right?

So either you start doing sanitary landfills or you can consider other waste management systems, such as sorting a source and then send different kind of material to different places. And it's just a way that we're missing for the local economies. I think we are always trying to say to people that, you can certainly consider the most advanced solutions. But then it may not work for you. It may not be the right answer for you.

And sometime the simple and sustainable solution is probably is a better one. But then you had to consider your site specific condition, and your political and social environment. Changing something is very difficult. It's all about mindset, right? And with that, I think, Matt, I think this is my final slides already.



Matt Hamilton:

Great thanks very much, James. That was great. And I appreciate everybody hanging in with us. We went through the presentations and there are some questions, James and Aditi that we've received, and I thought, maybe we have a few more minutes here. We could try to address some of them.

What are the questions, or I guess themes of some of the questions around modelling using SWEET tool versus, like, measuring actual releases and these kinds of things and where, where are you, James and or Aditi on the kind of when measurement is needed or better than simply kind of using models for, for whatever phase the process, whether it's design or, you know, monitoring or whatever.

James Law:

Okay, I can start and you can add Aditi. I guess with the technology that we have these days, I think drone is a good tool for at least for us to use to try to figure out how much waste is in the dumpsite, I mean, I'm going to talk specifically about dumpsites now.

Because first of all, they don't have how much waste they receive and then but at least the using drone that gives you some kind of volumes and then we could probably come up with estimating some kind of density to come out with something that makes sense to feed into the models.

The other thing is they have quite a few models out there and I feel like sometimes you had to consider the fact that what you were going to use the information for. Then you can decide on which model you can use. And the, most of the available, like, IPCC for instance this is all free and sweet, the resemble is a SWEET model it's all free to download from the U. S. EPA website for download free and you can use that to come up with pretty good numbers.

And unless you have really accurate site data you had to do quite a bit of guessing also and then, depending on how experienced you are using those models, or at least the theoretical background of the model itself is kind of important. Aditi did you have something to add? I kind of run out of things to say.

Aditi Ramola:

Yeah. Well, thanks, James, so I just wanted to mention obviously we didn't have time to go into it like. There's a lot of satellites monitoring, greenhouse, gas emissions data now, and this was in conversation with one such company to see whether we can work together on the closing dumpsite task force. I saw 50 little not a presentation, but she showed me I gave her some coordinates on Google Maps way back in December, and she promised to come back with data.

One of the dumpsites was the site in Chennai and another one that we're working in Banyuwangi and another one in Chengalpattu. And she came back with data, it was so cool to see over the 8-9 months that the satellite had been getting, so Chennai was big enough, 325 acres that it was actually measuring that data.



And she showed me concentrations. She showed me how the wind patterns are affecting the median flows and so on. So, going back to the question, as James explained, we've been using, of course, analyzers and drones and so on. James uses that for his work. Fight on a daily basis, but with the closing dumpsites taskforce, you're also looking to take some help from the satellite data. Which seems really interesting.

Matt Hamilton:

It's definitely an evolving space I can just add to that, in Canada's case we've spent, the governor of Canada put a lot of investment into improving our understanding of the measurement approaches for like, for whether it's for monitoring gas capture systems or simply trying to estimate what landfills may be emitting. So it's definitely an evolving space, I think US EPA is in the same category in terms of trying to improve their understanding and use of the technology. So, I think the measurement's going to become more important over time.

But certainly the modeling and everything gives us a starting point. As James said. Following along from there what strikes me about this conversation we're having is like, things are bad, right? Like, we can see from the data there's a lot of challenges with waste.

But are they also getting better? Are things bad but are they also getting better? In other words, do you see more projects coming along that are trying to address these larger emitters, or do you have a sense of that? Or is it are we stagnant? Is it declining even in fact, our action in this area where are you guys with that?

James Law:

I have a little bit of mixed feelings about this question and trying to figure out how to respond to this. Because we also running into a situation. I mentioned in my presentation about mindset to get people to change how they behave is very difficult, at least in our generation.

Maybe the 2-3 generations after when we provide enough education to them, they'll realize, hey, it's better to do sanitary landfill and not dumpsite operations. Okay. So, we, we run into the situation that people move away from dumpsite operations. But then, for whatever reason, they move back to dumpsite operations.

Just because, you know, few stakeholders didn't want to play along because too long of a hall or, you know, they don't realize much benefit of doing that. So, you know, I think some of the top point we have that we didn't really go into deep into it because stakeholders involvement day 1 of any project is very important.

At least you get them to buy in and then they stick to the plan. So then I think then you'll see some significant improvement moving in the right direction. I think I can say this, because I see enough dumpsite operations around the world at this point that some of the dumpsites are really heartbreaking.



You just cannot believe that you can have 1500 people everyday living on the landfill trying to make a livelihood out of it so. Something more can be done, but we as an organization, we have limited resource. I wish someone who is listening out there will give a few million dollars to this project to improve our current waste management situation worldwide.

Matt Hamilton:

Maybe on that topic of who pays basically the financing part about it. In the projects you've seen move forward who is who is kind of covering the cost? Is it the local governments? Is it national? Are there sources of funding where when you connect these dots, like we're talking about the social, the environmental and everything lines up. Is there sources of funding that are helping bring it forward from there?

James Law:

Aditi do you want to start first?

Aditi Ramola:

Sure, so these bigger projects. What we've seen is multilateral development agencies, or big banks. On those when it comes to closing a very big dumpsite, moving to a landfill and so on. So going to high your bills go into his funding question. It can, you know, there are so many ways to fund these kind of projects.

Not easy, but of course, national governments could be one, it could be in terms of grants and aid coming from, as I said, multilateral development agencies, multilateral organizations like the UN. But also, giving you the example of India because this is where I'm living right now.

We've also seen public private partnerships really play a big role. So a big company that's managing waste in several cities is perhaps looking to showcase their technology. In India, I don't know, it's 1 of the questions that came in. In India, what we've seen is that a lot of old legacy dump sites are being bio mined. It's probably an oxymoronic word, bio mined, because there's nothing bio much remaining in that and also not many recyclables.

We've been skeptical. But people have been trying to convince us otherwise. A lot of that is happening and there's funds in that, because cities and municipalities don't want legacy dumpsites within their boundaries.

Funding is coming again, as I said, from public private partnerships, where a private company says, hey, we get rid of your, we'll make it disappear. Okay. Will you give us some money we put in some of our own? But then the more innovative things that we've been discussing, also at COP, which, of course, our presentation didn't go into too much.

Was carbon credits and green financing and at the COP we discussed something called methane credits. Because as we saw in both our presentations, methane as a molecule is a much more



potent as a greenhouse gas contributor than CO₂. Perhaps there has to be a distinction between projects that are actually working to mitigate methane as opposed to just carbon.

And there, if you look at the Paris agreement, it has article 6, which talks about voluntary mitigation. Like, basically countries are allowed to trade carbon between themselves. As a way to reaching the nationally determined contributions. So that's 1, hopefully, you know.

A pathway for people to get funding into these kind of projects, closer projects when you make the case for methane mitigation. Then market based mechanisms can come into play and that's where the funding can come from, too.

There are many ways, but as James mentioned, we've found a challenging too, as a task force to get funding for this. I think the task force is harder to fund. We need to get projects on the ground. And that's going back to Derek's question, whether, you know, things have changed since 2018. We are seeing things change and we see more and more players acknowledge that these things have to be done.

James Law:

Yeah, I think that's a great place where we'll have to end it. Actually, I see that we're coming to the end of our time. But yeah, I called the sentiment there that it seems to me in all the years, I've worked on this that I've never seen more attention on the issue of waste sector methane.

Therefore, you know, if we can keep that attention, but also get some of those resources directed at solving the problems. We can see all kinds of other benefits right? Social benefits other environmental benefits. So, like there's a let's say it's a methane moment, but hopefully, it's the waste management moment. Let's see. If that can be true.

So, I want to think everybody. Um, I think Katherine Rush, did you have a final slide? Yeah so there it is, pardon me, on the screen you'll see those in attendance upcoming webinar date is coming soon.

If I could kindly ask you folks attending today, if you found this interesting, you found this helpful, if you could think about who else in your network might also find such an event useful and maybe next time you receive a message about our upcoming webinar, you could forward it to them.

And so we could kind of grow our network a little bit further. I guess with that, we'll close the session. So thanks very much.