Melissa Klembara: Okay. Hello, everyone. Welcome to the 2021 Better Buildings Better Plants Summit. Thank you for joining us today. We have a wonderful session prepared with some fantastic speakers, and we are going to introduce you to them in just a moment. Before we dive in, there are a few housekeeping points I'd like to cover. Please note that today's session is being recorded and archived on the Better Buildings Solution Center. We will follow up when today's recording and slides are made available. Next, attendees are in listen only mode, meaning your microphones are muted. If you're experiencing any audio or visual issues at any time throughout today's session, please just send a message in your chat window located on the bottom of your Zoom panel. I'm your host, moderate Melissa Klembara. I'm with the Department of Energy's Advanced Manufacturing Office.

If we could go ahead and move to slide three I think that will sort of where we're at now? So yeah, that's who I am. So you're seeing me in double vision right now. A little bit about me. My background, I've worked at the Department of Energy for about 17 years now. I'm currently in the Advanced Manufacturing Office where I work on a large portfolio in the energy-water nexus space. So you'll be getting a theme of discussion today about the accelerating technology innovations in the water space, and that's something that we've been thinking deeply about in this energy-water nexus crosscut at the Department of Energy.

So today's agenda, if you can go to the next slide please. Oh, sorry. Quick note, so let me just quickly go over today's agenda. So I'll be giving you a quick intro into the energy-water nexus space and how DOE is thinking about it. And then we're going to have some presentations from Prakash Rao at Lawrence Berkeley Lab on the industrial manufacturing wastewater and a big impactful report that we funded in the Advanced Manufacturing Office. And then we'll hear the industrial perspective from Cleveland-Cliffs and General Motors, and then we'll move on to some kind of linking between this industrial municipal perspective with the Water Research Foundation.

The kind of overall purpose of this session is to kind of look where the industrial sector can really be sort a proving ground for technology, new technologies in water treatment. So there is a bit of a symbiotic relationship between industrial and wastewater treatment sector. And so we're kind of like exploring those opportunities and that potential for industrial wastewater treatment and municipal wastewater treatment and where there's sort of the

Venn diagram overlap in that symbiotic relationship and reducing technology risks.

We are excited to announce that we're using an interactive platform called Slido. Maybe you are already familiar with Slido, but please go to www.slido.com and you can use the hashtag or event code #DOE. So once you enter this event code, please select today's session title in the dropdown menu at the top right: Accelerating Technological Innovation in the Water Space. If you'd like to ask our panelists any questions, please submit them in Slido at any time throughout the presentations. We will be answering your questions near the end of this session. You can also like other people's questions and those will rise them or bring them to the top when we get to the end and we have time for our panel discussion. If you have any issues with using Slido, just message our tech support in the chat function.

Okay, so in the next slide I'll give an overview. So I already went over kind of the agenda for today. So in the next slide, I just want to give a quick overview of what we're doing at DOE in the energy-water nexus space. A lot of people ask, you know, why is DOE doing anything in the water space and it's because there is this, you know, interconnectedness between energy and water. There's a lot of embedded energy in the water that we use in kind of treating it and moving it long distance, and there's a lot of embedded energy in wastewater that we can recover and there's a lot of potential in recovering that and making the wastewater treatment facilities net zero or close to that. And there's a lot of water that we use in energy production, whether that's utilities or oil and gas or in, you know, hydropower. And so there's a lot of interconnected nature between energy and water.

And so in the top right just to quickly kind of package the types of things that we do at the Department of Energy, we do a lot of research development and deployment to increase water availability and improve the lifecycle impacts of water and the circularity of water. And we're doing this through programs such as the National Alliance for Water Innovations which is looking at desalination or kind of using nontraditional sources of water and making those more available. We're also looking at recovering resources from wastewater and the recent FOA that we had in the Advanced Water Resource Recovery FOA where we selected 16 projects, and we're also looking at addressing sort of emerging contaminants in the space of water and wastewater treatment.

And the acronyms that you see in the lighter blue square are different types of programs that are working collaboratively on addressing some of those areas. We also work in the bottom right and you're going to be hearing more about these programs today. In the bottom right, we work a lot with stakeholders to address technology adoption and workforce goals. I mean that's one of the main themes of Better Plants and Better Buildings is to really do voluntary programs for technical assistance and workforce development. And so we have a lot of strong collaboration going on within the Advanced Manufacturing Office on developing tools that can be used by industrial and wastewater treatment facilities to improve water efficiency and energy efficiency. And we are working with other programs on kind of how we can collaborate on how they're thinking about data and visualization tools as we look at energy-water systems and how to kind of optimize resiliency between those systems.

And in the bottom left is a lot of that sort of resiliency work that we do that, you know, the Water Power Technologies Office thinks a lot about when we're thinking about how our water resources can be managed for hydropower and the risks when we have climate change to that water power being available and other water resources being available and looking at cyber security or security issues that can affect not only our energy infrastructure but our water infrastructure and various kind of risks to the electrical or wastewater treatment systems or water infrastructure because of those.

And in the top left, just to wrap it up, there's a lot of work that we're thinking of doing on how can we improve the circularity of water. Today we rely on large centralized water infrastructure for moving water long distances and treating it and it's very linear. Then we use it and then we treat it again and then it goes back into our watersheds. So how can we think about like the EPA is doing on improving water reuse and making more sustainable water infrastructure for the future? And then how can we think about as we make potentially huge investments in our water infrastructure through the American Jobs Plan or what infrastructure bills might come out of Congress, how can we think about being smarter about building out a 21st century water infrastructure that's modernized, decarbonized, and more climate adaptive? And how do we help communities make those choices of what investments that need to be made now or what research still remains to be done so that we could make those improvements in our water infrastructure to be more sustainable?

So yeah, so in a nutshell that is kind of how we're thinking about energy-water nexus and kind of a quick snapshot of the different types of things that we're doing. So I'm gonna kind of shift gears now and we're gonna kind of dive into sort of the agenda of talking a little bit more about the symbiotic relationship between industrial wastewater and municipal wastewater sector. And first up, we're gonna have – if you can go to the next slide please?

So the series of our presenters is going to be Prakash Rao from Lawrence Berkeley National Lab who's going to talk about this impactful report that we're doing with the Advanced Manufacturing Office. Prakash works very closely with the Advanced Manufacturing Office and our Strategic Analysis team and kind of thinking through what the potential in energy-water nexus space is, especially in the industrial wastewater treatment space and was a big contributor actually on the desal bandwidth study that became very important in a vision for what impact we want to have in desalination in the energy-water desal hub that we're doing with the National Alliance for Water Innovations that's actually led by Lawrence Berkeley.

And then we're going to Rishabh Bahel present, co-present with Kiran Thirumaran at Oak Ridge National Lab. They are going present on a case study that actually I think the National Alliance for Water Innovations is sponsoring with Cleveland-Cliffs on the steel industrial area for industrial wastewater treatment. And if you can go to the next slide? And then we're going to have Al Hildreth present on various General Motors programs that they're doing that are seen as a best practice in the industrial wastewater treatment space.

And then we'll wrap it up with Christobel Ferguson and Erin Partlan, both at the Water Research Foundation. They have a nice kind of sit at in a position where they see different types of new emerging technologies and the technology risks involved in the municipal and industrial wastewater treatment sector, and they have a nice presentation that sort of looks like at the symbiotic relationship in the industrial/municipal wastewater treatment space and where there's some emerging technologies that might be of interest in that space.

So next slide, I believe. So Prakash, as I have previously mentioned, he is going to go into a presentation on this big impactful report in the industrial wastewater treatment space. Prakash comes to us from Lawrence Berkeley National Lab where he's a research scientist with the Building Technologies and Urban Systems Division. He conducts R&D and analysis in the potential for reducing energy consumption and water use impacts of the US industrial sector while maintaining its productivity. He received his doctorate in mechanical and aerospace engineering from Rutgers University and his bachelor's in mechanical engineering from Carnegie Mellon University. So Prakash, I'm going to hand it over to you.

Prakash Rao: Thanks, Melissa. Begin the next slide, please. So I thought I would start off today just by giving a little bit of context on manufacturing water use just globally within the context of the watershed itself. So what we have here is like a flow diagram, like a schematic of the manufacturing plant at a high level and how it sits within the local watershed and the local community and how it interacts with the water. So a lot of numbers going through here. I'll try to quickly walk through it.

If we think of number one and number two and number three, that's talking about where do manufacturing plants typically get their water and it could be a variety of sources with number one being the municipal supply. So just like at your home or your office, you're purchasing water from the city or municipality. That's one source of water. Another source of water is their own what's called self supplied. So whether it may be a lake or a stream or a river that they might be sited next to and pulling water from that water source and using it for their processes. And then number three is any sort of onsite collection, whether it's a groundwater collection or extraction, excuse me, rainwater collection which is not very pervasive in the industrial sector yet. But as we'll talk at the end, there are some companies looking into it and doing it. Taken collectively, one, two, and three kind of represent all the water that – the various water resources available to a manufacturer that we see manufacturers are making avail of.

I think it's important on the bottom left you'll note that in this image we're documenting what other sectors might be competing for this water; and unlike energy where you can transport energy long distances, water is a little bit harder to transport given to its weight. It's just a little more expensive. It requires more energy. So you're really kind of best positioned to be using the water within your local area. And as such, that does kind of minimize the volume of water you might have available to all of the sectors; and not just the sectors as they're listed here – power generation, residential, commercial, et cetera – but also just the fish need some water and the land needs some water and the plants need some water so the ecosystem and the environment. So kind of thinking about the manufacturing plant is sitting in the context of sharing water supplies with all these other users of water as well.

Now as we move into the right hand side, the little box there is a really high level schematic of what might happen in a plant once the water is pulled in. If it needs onsite treatment before, whether it's the self-supplied water needs some sort of filtration or whether it's the municipal water needs to pulled out to ultra-pure water which is, you know, right there basically distilled or zero PPM. It might go through onsite water treatment before it proceeds to the various processes in a plant whether it's cooking, whether it's cleaning, whether it's quenching, whether it's steam processes with boilers. You have cooling systems which is a huge use of water, especially that self-supplied water. And then ancillary services, whether that's domestic water irrigation for the landscape or pollution control. Several uses for water.

Once the water is used, it leaves the plant and it may leave the plant, I should say. Five is another source of water which is reuse water we should talk about a little bit which is really an important way to sort of mitigate some of these water shed impacts, improve water conservation. But if it's not reused, then it moves on and could be treated onsite before it's disposed of depending on what the permits say or what's in the water. We will talk a little bit about that in a couple of slides. And once it goes through onsite treatment, it can go back to the river or the lake, wherever it came from. It might go up into the municipal wastewater treatment plant for further treatment, or some of the water might not just go through the onsite treatment at all and just go straight to municipal and that's ten there.

And the last two areas of water I wanted to just talk about is evaporated losses where there's a cooling tower so that's where the manufacturing plant might use the water, evaporate it, and then it's out of the watershed, unavailable for others in that watershed to use. That's called a consumptive use. Eleven is another consumptive use where the water might be in an embedded product, think bottled water, and that's being shipped out of town and out of the watershed. So that's to give you kind of a high level review of how water might be used in a manufacturing plant, where it's gonna get it's intake water from, and what's going to happen to the water once the manufacturing plant has used it. Next slide please.

So if we look at how much is on that one, two, and three, the water intake, this is from, I think it's 2010, one of the estimates showed about 21,000 million gallons per day is used for the manufacturing sector which is about 6 percent of our all water resources in the US is for manufacturing. Now that might not sound like a lot, but I think of the map on the left is showing concentration. So if we kind of look across the map and each of those little – it's identifying the counties there. So each of those little geometries, I guess.

And if you look at there, you see some really high concentrations in some places like Lake County in Indiana, Brazoria County in Texas which is right by Houston. These have very large concentrations of manufacturing water intake. And while it's 6 percent nationally, in some of these counties, about 60 or so, manufacturing water is actually about 75 percent of that county's water intake. So it's really spatially important, as we mentioned before, it's really hard to transfer water long distances. So these manufacturers are really a very important user of water within the communities in which they live.

On the right hand side, you can kind of see the data chopped up a little bit differently where it's looking at state by state. Indiana, Louisiana, and Texas are one, two, three manufacturing water users. But perhaps more interestingly, I guess, is what sectors of the economy are using – manufacturing sectors are using water. And there, you know, 95 percent of manufacturing water use actually sits within five sectors. These are all estimates, I should qualify. But the paper industry is the highest at 29 percent of the manufacturing water followed by primary metals which is steel/aluminum 26 percent, chemicals, petroleum, coal products, and food. Those five sectors constitute 95 percent of manufacturing water use in the US. So it's about 20 percent of the sectors are using 95 percent of the water. Next slide please.

So that's looking at the intake. Now, if we look at the exit, the wastewater and that's where the interaction with the municipal plant might happen, whether it's on the technology side or whether it's on the sending wastewater to the municipal plant for treatment. The left hand side what we've looked at is just based on permits and the names of the things, the contaminants in the wastewater that need to be treated in the permit. So there's very water chemistry savvy people will note that some of these listed here are actually test methods for an indicator. Some are actually chemicals. But it's what's on the EPA permits.

And we wanted to show this just to kind of outline how's municipal water different than manufacturing water, where are there differences? We need different technologies and different approaches. And where are there commonalities where what they're disposing is similar, what they need to treat is similar?

So that Venn diagram in the middle there, you can see things like BODs, nitrogen, phosphorous, alkalinity, oils and grease, dissolved solids, suspended solids. Those are common so they're going to see common wastewater treatment methods within the two sectors, municipal/manufacturing to treat those. The manufacturing also does have some specific contaminants that you don't always see in the municipal sector and that's on the right hand side here. That's a nitrate compounds, ammonia, sodium, et cetera as you can see there.

And as we think about the treatment processes, when we looked at the technologies used, you kind of broadly break them down to three categories. There's physical processes, chemical processes, and biological processes for treating these wastewaters; and some are common with municipal and manufacturing wastewater treatment. Some are not. Some are less common. So when you have physical, these could be things like distilling the water or evaporating it, use separations. You got membranes. It could even be just skimming which is a common I think across both sectors. You could also have chemical additives or where you're flocculating or precipitating out the water and then maybe skimming it or doing things like ionic exchange or electrocoagulation. Those are pretty common in the manufacturing sector.

And then the one you see in both is biological. So it's using bugs to break down some of the compounds, whether they're aerobic and they like air or anaerobic they don't like air depending on your process and what you're doing. You might be using biological treatments to treat some of those BODs and things like that, which again is common. So you can see, you know, some of the biologicals and some of the physical ones might be in common. Some of the chemical ones might not be in common in terms of the treatment methods. Next slide please.

So thinking about what we could do, so water conservation, water management and what really drives this. So the common refrain I think we hear is water is pretty cheap and that kind of hampers efforts to conserve water. But what we've started to consider this and this from the WRI, Water Research Institute's Aqueduct tool. The way they look at risk – they look at water risks and they start to quantify it in terms of physical risk, both quantitative and quality. So there's not enough physical water like volume of water or the quality of the water is too poor to be able to use for the purposes that the watershed needs.

There's other risks too. There's regulatory and reputational risk. The regulatory might be imminent regulation on the water, whether it's limits on ground water usage or just limits on how much you can pull from the lake or whatever it might be. There's also reputational risk which is a little bit harder to put your finger on, but that's the idea that you're kind of giving a community license to use water. And at any time that community can revoke that license through their community action or things like that. So you want to be good – there's a drive to be good stewards of water to kind of avoid the reputational risk and of course just be good stewards of water.

And if we think about what we can do on the right hand side and I'll try to wrap up quickly because I think I'm going over time here. It's kind of a fancy graph with the box and whisker plot. Don't worry about the details. I think some of the idea here is that as we think about risks, as we think about water conservation, think about what are some easy things we can do where we need technologies and maybe some places where think we need technologies and we don't need technologies. We're actually using the right things right now.

I think the right hand side, what it's showing you is as we look at that onsite water treatment at manufacturing plants, many plants are already treating water before they dispose of it. And if we look at what they're treating the levels to, again based on permits, and we look at what the water quality requirements are for manufacturing processes, you start to see for certain contaminants, the manufacturers are actually already treating water to a level suitable for use within their plant. So it might be just piping it back into the plant and finding a place to use it in the plant, but it's being treated to a level.

The technologies are there. The energy is being consumed already to treat the water because they have to do it to dispose it, but you can loop it back for reuse. And so the chemicals, petroleum, coal, primary metals, pulp and paper, textile sector we just show here which chemicals are being treated to levels, broadly speaking, across all permits that we looked at. Water reuse is just a matter of you're already doing 50 percent of what you need to do. Now it's a matter of just piping it back. Next slide please.

And just to highlight some of the great things our partners are doing in the technology space, Nissan and HARBEC we're highlighting here. They're two partners in the Water Savings

Initiative with Better Plants. Nissan has optimized their rinse – sorry – their pain shops optimized the rinse systems within those which is a huge energy and water user within the manufacturing footprint at the facilities. Spending $600,000.00 they're able to reduce their water use in the rinse system by 65 percent, almost 50 million gallons a year right there just by optimizing how the paint plant uses water and being able to reuse more.

And we talked about rainwater harvesting. HARBEC is a partner. And both of these solutions are on the Better Buildings Solutions website. They are investing in rainwater harvesting. They've been able to save 800,000 gallons per year through digging up rainwater ponds and using it to offset cooling power loads. And cooling towers are running great. No concerns. I know there are concerns about doing it by some, but their cooling towers were running great, and they're also saving on their fire insurance with the ponds provide another fire safety. So with that, I think I'm probably a little bit over my time. So I'll just wrap it up and thank you for your time and look forward to any questions.

Melissa Klembara: Yeah, thank you, Prakash, that was great. So teeing up the next talk. So we have Rishabh Bahel from Cleveland-Cliffs who is working really closely with Kiran Thirumaran at Oak Ridge National Lab on a case study for their facility. Just a little bit of background quickly. Rishabh Bahel is currently he is the manager of Utilities and Energy Conservation, and in this role he leads the plant's efforts for energy conservation and management.

Kiran is at Oak Ridge National Lab where he's been really involved in Better Plants for a long time because I think he was part of the Industrial Assessment Centers when he was at his university. But he's part of the team, the Better Plants team that has supported the development of numerous tools and resources for industries. That includes the Plant Water Profiler and a lot of the in plant training that we do to help with energy and water efficiency in industry. So Kiran is also involved in the National Alliance for Water Innovations and is supporting the activities that Oak Ridge is doing for that consortia. So Rishabh and Kiran, I'm going to hand it over to you.

Rishabh Bahel: Thank you, Melissa, appreciate it. I'm so glad we are presenting right after Prakash. Prakash kind of gave a summary of what we're going to be talking about and then throughout our presentation we will try and go into a little bit more details. And again, as we say, we are going to be talking about ideas for water and wastewater management. Yes, our focus on this presentation would be on the case study that was done in conjunction with Better Plants and the NAWI; but we want to cover a lot more about water management and water conservation, especially since Prakash mentioned that we are responsible for 26 percent of the water for this country. So a lot of onus on us. With that, we'll get into the next slide please.

So again, where we are right now. So this particular presentation and slide is focused on a Cleveland Works site in Cleveland, Ohio. So a little bit history about the Cleveland site. This site has been in business for 108 years. We approximately have 1750 employees. We have great partnership with our local union and most of the steel that is produced here is marketed includes automotive, construction, converters, and tubular. We are leader in automotive market, and approximately 50 percent of production is for auto people, and 60 percent of the steel produced in this plant is shipped within Ohio. And in 2019 we made three million tons here, and as we all know 2020 wasn't the best year for any of us, but we were still able to produce 2.3 million tons of steel. With that, can we go to the next slide?

So now we're going to get a lot more into terms of understanding the water management and water usage. So as Prakash already mentioned that we do use a lot of water and kind of bring it down a little bit more, for steel making it's a very water intensive process. We are using 28.6 meter cubed per ton of water as an estimate for the steel industry for water parts. So these three examples that you see here are just three base examples of where water is using. You're using water for quenching at the hot rolling. You're using water at the hot rolling coiling and the cold rolling. But there are other areas where waters are getting used a lot is let's say our powerhouses where the boilers are consuming the water from steam production, at our blast furnaces, at BOFs.

But the main issue is that we are using a lot more water throughout our system. And out of which what Prakash was saying that three are the main areas that we are pulling the water from and that is totally true for our case as well with municipality at number one and shared river sources at number two. For us, the shared source of water being in the Ohio region is the Cuyahoga River and we rely heavily on pulling water out of that. But again, have to be in order with compliance with the NDPS permits and other stuff. So we treat it and bring it back into the river.

So 6 percent of the water that we are consuming in this plant is municipality and 94 percent of the water is from the shared source of water. As I've already mentioned, there's a lot of water that has been utilized in the plant. So we are using a higher percentage of water from municipality, that's had much revenue that we're giving to the city. So you have to kind of look at that cost of water and stuff when we are utilizing water and using that in order to figure out projects about water management. We can go to the next slide.

So kind of going back again to what Prakash mentioned, wastewater treatment. We are here using our water. It is going through a number of processes, as I mentioned in the slide prior. And when this water goes through these processes, this water is no more municipal water or shared source water. Now it is processed water; and when you're discharging processed water, it has to go through certain treatment processes, certain classification processes before it can be discharged.

Prakash did mention that you can send it to the sewer district which is like your city municipality treatment system. But most of the contaminants and stuff that you would pick up from a steel mill or for a manufacturing site, these are not contaminants you would see to a normal water treatment plant just because they're not really equipped very well to handle this. So plants like us, we built our own wastewater treatment plants.

At Cleveland site, we have six wastewater treatment plants. And the one that you are seeing pictures of is one of our bigger water treatment plants. And in here we have different systems for the metal removal system. That essentially is taking the water that is coming from back from our metal system. The oil removal system is essentially where the water is interacting with oil and the water that is coming back is bringing oil along with it. And now those two systems are kind of going through their process of treatment, which again, uses chemicals, which uses a different type of flocculation, the skimmers, the vacuum filters because the end goal is to bring it back to a compliance level where we can discharge it back into our shared sources of water.

And again, we do have that system that there are a lot of run through system so you'll discharge this. Like Prakash said, yes, we are using a lot of water that is being processed and then being discharged into the river and it is usually a better quality of water than we are pulling out of the river just because we are treating it at that level. So there are projects in place to kind of pipe it back and can have a closed loop system. So we have some run through and some closed loop. Our process, our continuous process, our continuous calculation, our continuous determination is to ensure that we are able to find all these water sources that we are treating and bringing it to level that we can totally replace all this sources of municipality water and replace that with all the shared water and have that closed loop systems and only be bringing in water for our make-up system because most of our systems such as has cooling towers involved in them.

As we all are aware, with the cooling towers you have a loss of at least 20-25 percent in evaporation and especially when you have blast cooling towers those losses go up too. So in order to satisfy those make-up water requirements, we want to ensure that we are using our river waters which are going through prior treatment before we make them interact with that processes because water quality is of utmost importance to our processes. We need to ensure the quality of the product that we're producing is meeting our customer demands. So therefore, we really take it very important that all the water and stuff that is interacting with our processes is at a certain level. And similarly, when it is going back into the place where we put this water, it is at that same level as well. So with that, we can go to the next slide and I'll hand it over to Kiran for these next four slides, please.

Kiran Thirumaran: Hey, thank you, Rishabh. Good morning, everyone. So Rishabh gave a really good overview of the facility and the types of like processed water being used and the wastewater treatment that are being done. I'm going to be concentrating a little bit on some of the work that we have done at Cleveland-Cliffs over the years as part of DOE's various efforts, right? So as part of the Better Plants, we did a water assessment at Cleveland-Cliffs a couple of years back and right now we are working as part of the National Alliance for Water Innovation to do a technoeconomic assessment of the wastewater treatment systems.

So what you're seeing here is one of the results of the water assessment that we did. So as part of the water assessment what we basically did was baseline the water consumption at the facility which involved creating this water map that you see. So pretty much like trying to understand where water is used, how much of it is being used, and how it is being treated and eventually being discharged, right? So Rishabh gave the numbers like 94 percent coming from river water and like 7 percent coming from the city water, right? So we were trying to track how much of that is being used in the process and eventually being discharged. We also identified the true cost of using this water. This becomes relevant, as Rishabh, mentioned when they're evaluating like projects for water conservation, right? So true costs meaning we are trying to understand not just the direct cost paid to the utility but also the indirect costs of treating that water, pumping to its point of use, and all the costs associated with that.

So what you're seeing here is, again, the water map. Since city water was/is kind of like the direct cost component, most of our work with Cleveland-Cliffs and in the facility has been around city water. So city water you can see here is at the bottom left, like 7 percent of this and if you kind of like follow it along, you will see most of that water is being used in the hot mill and cold mill operations. So that's kind of like where most of our efforts working with Cleveland-Cliffs has been. So the water is used in the cold mill and hot mill operations and some of the processes that Rishabh kind of like gave an overview of and eventually it gets discharged to the oily waste treatment and metal removal system directly and Rishabh spoke about, right?

The bottom right kind of like blows out that oily waste treatment and the metal removal system a little bit. Oily waste treatment system is predominantly like some physical pretreatment followed by coagulation and flocculation in settling tanks. So they do use a lot of chemicals there before it was being like discharged, the clean water being discharged to the river, right? And the metal removal system, that is a lot of like neutralization because of the acidic nature of the water coming to these systems followed by aeration and eventually clarification, right? So what we did once we did understand the baseline water consumption of the facility is we dug into these water treatment systems a little bit more. So next slide please.

So we were able to use some of the tools that are being developed by NAWI, so National Alliance for Water Innovation. And we were able to kind of like model the cost components of these systems, right? So what you're seeing on the screen is kind of like an initial results from those analysis. We find the principal treatment for both the systems are big chunks of the cost components of principal treatment for oily waste being the flocculation and coagulation step, right? And so we were able to go through it a little bit more detail. In fact, we were able to like identify how much of the component is coming from chemicals, how much of it is coming from mechanical systems, so on and so forth. So that's the technoeconomic analysis that we did as part of NAWI.

So from these assessments and from these analysis, we kind of like were able to understand the system better, trying to understand where the cost is for these like water being used and for the wastewater treatment; and we were able to come up with some opportunities for the facility, right, that I have in the next couple of slides. Next slide please.

One of the things that we identified straightforward opportunity because, as Rishabh mentioned, they are treating the water to point of to a quality that is on par with the city water that they're getting, right? But still, they do discharge it to the river. So one of the opportunities was to recycle the water leaving these oily treatment and metal removal system and being used back in the cold mill and hot mill operations; and that would offset Cleveland-Cliffs' city water use and at the same time reduce the facility's dependence on the municipal infrastructure, right?

Another opportunity is with respect to condensate recovery in quenching. So steel and slag uses a lot of water to quench; and if the appropriate conditions are there, if it is being done indoors, there's an opportunity to recover some of that condensate, right? If we are able to like set up a roof infrastructure, there's a possibility to recover some of this because, again, like condensate is going to be like pretty clean water if you're able to like recover it. So you'll be able to use that water for any other applications instead of drawing in new water for your facility. So next slide please.

So some of the other recommendations we came up with as far as the assessment, one is with respect to reducing the chemical uses so that the existing system, all the flocculation, coagulation systems that are done are done using chemicals. So one of the opportunity there is to reuse the chemical consumption, either by like using a new water treatment trains and Rishabh is going to be talking a little bit about some of the new technologies they're considering exactly for these purposes, right? So that is one opportunity.

Another one is maybe like using byproduct chemicals, right? So that are chemicals being produced in the steel making process itself which could be used in the water treatment system without adding in like additional chemicals, right? So maybe for PH neutralization, some of the high alkaline stormwater that comes in contact with slag would be used for example. So that's another opportunity to be explored.

Another recommendation for Cleveland-Cliffs to potentially look at and even for wider integrated steel manufacturers is to look at embodied water, right? So embodied water is the water being used in the processing, moving, and storing of product. So if you're using product in a useful way, then you're putting this embodied water to good use. So for example, like steel is a primary product that is embodied water in steel, but you are using that steel for your purposes. So that's a useful use of the embodied energies. But at the same time you also have like byproduct waste from the processes, for example, slag that still has some embodied energy, right? So if you're just discarding that slag, then you're not putting that embodied water to good use. So one way to kind of recoup that embodied water would be to use slags in like say some construction or things like that, putting it to kind of like a recycled use instead of just landfilling it. So that's another opportunity in the iron and steel space for folks to consider. So yeah, with that, I would turn it back to Rishabh.

Rishabh Bahel: Perfect. Thank you, Kiran. So again, as Kiran mentioned, the true cost of water. That's one important thing that we have understood with our partnerships with DOE, the partnership with NAWI is that you really – when you're looking at water conservation project, when you're looking at water management, you really have to use the total cost of water in justifying your case and in putting that in for ROI. So one of the true costs of water, the biggest component of that was pushing through this true cost of water was chemicals because, again, the amount of chemical treatment that we have to do in order to make sure this water is within our permit level before we can discharge it into our authorized discharge into the river, we saw that chemicals was a big cost.

So we have been spending a lot of time in figuring out what could we do to reduce our chemical spend and increase our water reuse throughout the site. And with the limited time constraint we have on this presentation, we are going to talk about one of these opportunities and technologies that we are currently looking at and also we are involved with Better Plants' pilot program where they are looking at seeing if this technology would work for our site too.

So this thing is called electrocoagulation which already has been mentioned by Prakash in his slide, but it has been one thing that hasn't been utilized a lot in the steel industry. So it's a very highly electrochemical approach for the treatment and removal of contamination from water, and this process destabilizes suspended emulsified or dissolved contaminants in aqueous medium by introducing electrical current onto the medium. And what happens is when the water is going through this system, it is also inducing a PH shift which kind of makes it towards more neutral. So because PH levels is a very critical part of the permits too. So we want to make sure that the water discharged into the river and stuff is within that compliance.

So what we are trying to do with this system is when your electricity is going through that water and making this chemical process happen, your flocculation is occurring by itself. Again, chemicals are doing the same thing but now with electricity and not any more moving parts, you're able to use the minerals and stuff already present in your water to work for you to treat your water. And now when it goes through the secondary parts of your wastewater treatment which is your filters, your filter process. The water coming out is really, really good.

And the figure that we have here is essentially what you would have in a typical system if you don't already have a water treatment plant. That it will start right on the top right corner of the screen. The processed water will enter and go through a surge tank and you see – actually, I'm going on the wrong side. But yeah, from the bottom left side. Processes water, it goes through your pre-filter because you want to take the big sediments out. You don't want that to go in your electrocoagulation and clog up the stuff. You go to the sludge tank so that you have a nice flow going through your EC tanks, does its stuff, goes to the clarifiers. The heavy sediments float up. You can take it out, and then through your filter press the water is nice and clean. So again, to give you a nice representation we'll go to the next slide.

So this is essentially a good example right there. And this is what Kiran was talking about with that oily wastewater and stuff. Again, if you're a steel mill, oily wastewater is a regular thing that you see. On the top left corner you will see that's what essentially comes out of a system. You run it through electrocoagulation. It starts breaking down like that. So you're already seeing the flocculation has started taking place in the water, and the things are – the oil is going on the top. The heavy stuff is falling on the bottom. And then you use your vacuum filter or filter press, whichever system you have available. And in this case we used a vacuum filter, and you can see the treated and filtered wastewater at the utmost requirement.

Again, the sludge that is found with this EC is readily settleable and it is easy to dewater comparing to the conventional allomorphic hydrochloric sludges. And usually this floc is much larger and contains less bond water so therefore can be separated faster by filtration. And also, now that you've separated oil, you could even reuse that oil and sell it to another person for using and reclassification. And with this sludge, sometimes the material of the sludge is really good that you can sell it for construction and other purposes. So now essentially just by treating your water correctly, you're creating other useful elements that can be utilized by other industries. So that's why we really like this process and we are really trying to pilot it out further and see what we can do with it as the time goes forward. We'll just go to the next slide. I know we're running short of time.

So in conclusion, we'll just say water is a constrained source as both mentioned clearly by Prakash in his opening stuff; and as Melissa mentioned about the water and energy, they are highly correlated, the water-energy nexus; and as we have spoken a lot about, we are a water intensive industry. So we are taking the initiative because it is important not just for us but important for the places where we are operating. It gives us that license to operate and we continuously innovate and need to see what are the other innovations mainly happening outside to stay on track with water management and stay on track with water conservation.

Again, it will not be possible if you do not have the great partnership with Better Plants, with National Alliance of Water Innovation and other DOE partnerships. And again, I'll still give a shout out to my technical account manager Sachin Nimbalkar who has always been good in bringing us these new opportunities and stuff that Better Plants has been working on and connecting us with people like Kiran and Prakash and Susan and the many over there so that we can learn from them and can create technologies and papers that can be shared and discussed with other folks. But I appreciate it. Thank you, and I'm looking forward to more questions. Thanks.

Melissa Klembara: Okay, thank you, Rishabh and Kiran. So we are running really tight on time. I'm just going to do a quick intro to Al who will be giving a 15-minute presentation. Then we have the Water Research Foundation folks, Christobel and Erin who will also be giving another 15-minute presentation. So I'm just going to ask the presenters to try to keep on time. I don't know how much time we're going to have left for QA at the end, but we'll try to get through the presentations and hopefully have maybe time for one or two questions. So Al is a leader in water and energy efficiency and has been leading the thought leader at General Motors. So he's going to walk us through some of the important programs that General Motors has started as a best practice. So Al, take it away.

Al Hildreth: Thank you. So here's kind of the topics. What I want to talk about is water security from an automotive OEM perspective. You didn't see our name up there at the beginning as one of the big water users; however, many of our suppliers are large water users. And so we are very interested in water security. We'll talk about who cares. I'll review some benchmarking information, look at our footprint. I love treasure hunts because they're lots of fun. So we do energy ones. We do water ones. And then since supply chain is so large, I'll show you a few engagements that are out there. And then lastly, I'll leave off with some actions that we can take but probably won't be able to get into too many of those in detail but leave them with you. Next slide please.

So General Motors are members of the UN Global Compact. We just recently signed the CEO Water Mandate. And so it's something that, water is embedded into our business plan; and we have a goal out to 2035 from 2010 to reduce 35 percent of our water withdrawal. And so why is it important? I mean if you look at these statistics, they're huge numbers. You know, people without access to clean water, couple billion without access to sanitary facilities, a million deaths and lots of children at stake. So I think that kind of sets the stage. I really like the graphic from the UN Global Compact which kind of takes, looks at it from a circular perspective of drinking water. You have to have it to live. Ecosystems and really brings it around to good governance and finding ways to reduce water withdrawal. Next slide please.

So who cares? Again, our investors asked us to respond to CDP Water, so I know they care. Our customers, we have fleet customers that asked us to respond to CDP Water as well. You know, employees obviously need access to clean water and sanitation. And the communities, obviously very important to the communities. One example of, you know, who cares about this is the folks in Mexicali. They voted no on a beer factory because, you know, they said the Colorado River used to be flowing here and it's not anymore. That's one example of the water security. Next slide please.

So this is some benchmarking information. This is courtesy of the Automotive Industry Action Group. Number of suppliers and OEMs working together on corporate sustainability as well as quality and other issues. This was from a study a few years ago. You know, I think Rishabh, someone talked about, you know, surface water is the largest source. Well, typically again we don't use a lot of water. So you see municipal use is about 83 percent for automotive OEM. So it does change kind of the perspective of whether you're a high volume user or not. Next slide please.

And the cool thing about that was it kind of showed us that we have some high plants, we have some really low ones when we talk about zero liquid discharge which is one of the examples I'll use. But all of us were not too far off the average. So I think everyone is really informed and feels this is very important to us. We'll go through these in detail. Actually, I think they were already mentioned a number of them but measuring is extremely important, right, because that's the only way you can make improvements and measure whether it was successful or not. Just some basic things, you know, using job presence sensors to control freshwater rinse inputs. So when a vehicle is not in place, you don't have to rinse it. Stop the sprays. That saves a lot of money, especially when we look at the true cost of water, which I'll talk about in a little bit. Next slide please.

So here's kind of GM's water footprint. And you see pretty small in comparison to our total footprint. Two percent in operations which is what we have good control over. But supply chain is huge, you know, 76 percent. And then within that 2 percent, typically our pain shops are the highest water users. So you have to rinse a body and you gotta add chemicals to it, and so that's an area that we typically will spend a lot of time at. Our nonmanufacturing is pretty small and assembly plants, et cetera, pretty small water use. But supply chain is our largest impact and we'll talk a little bit about that. Next slide.

So I talked about treasure hunts. Water treasure hunts are a lot of fun. This particular site had a lot of people on it. Had 9,000 people and a design center, a couple assembly plants, offices, et cetera. So and I think the message in this one that made it successful was the fact that we used the total cost of water. So the plant had done some studies in the past. They kind of knew where some leaks were at. They knew the paint shop was large user, and so we helped them and put some numbers to it. Did a water balance which is really kind of the first thing you need to do as was discussed earlier.

And we came up with the fact, you know, to heat the water was more than, you know, the cost for the water and the sewer together. So this particular country has a really high natural gas rate, and I knew that because I lived there for a while. And so we really focused in on the fact that, okay, that can cut your payback in half, right, which is really good. So we found some opportunities and the plant is in the process of implementing them. Next slide.

So the true cost, why it's so important is, again, water is fairly cheap. So if I had time to do a poll, I'd ask you where do you think in the world that water from our perspective, where we have assembly plants and manufacturing is the most expensive? And you'd probably say, you know, like China or Mexico or some place like that. But it's really the Great Lakes State of Michigan where I live. It's just the highest cost that when you include sewer cost into it. So we have some great opportunities here where we have a lot of manufacturing and kind of middle America.

But you know, most raw materials that businesses use require water. And so you can kind of see the different regions where water scarcity is. That should give you more incentive. So even though the water may be cheap, you can't run without it, right? So you have to do something like water reuse. You know, we find that Mexico where we're water stressed. It's not a matter of a cost of doing business. It's a matter of doing business or not doing business. So really important to look at water security. Next slide.

And so someone mentioned Aqueduct Model. We use this to identify extreme water stress and then supplement it with kind of the local knowledge as well. So we have three plants in Mexico, two joint ventures in China that are on the water stressed higher than 80 percent list and then about 46 suppliers in Mexico. So you kind of see the hotspots there in the world where you'd expect them to be. Next slide.

And so our supply chain again is large impact. You know, 800 million cubic meters or about 320,000 pools. So anywhere that you're water stressed, you typically will have to do some sort of either recycling or, at this particular facility in San Luis Potosi out kind of in the desert area, we use a zero liquid discharge technology. And so what that means is I don't really have to worry about the contaminants leaving the site because they don't leave the site. All the water is reused. The only losses I have are in evaporation.

So if I want to reduce my water even further, I can do some conservation techniques, things like that. But I could reduce evaporation too. So once you get to a zero liquid discharge – and that's about maybe, you know, 70 percent of the water just gets reused and maybe 30 percent of it evaporates it. But really important system for water security, right, because if the wells are stressed and they're typically 600 meter deep wells, then you really need to do something different than try and take water out of the well all the time. Next slide.

This is kind of a picture of the impact and you can see the body steel is up there in the 29 percent, seats 22 percent. Total interiors, if you add those up, about 40 percent. So those are pretty high hitters. The thing I like about the lifecycle analysis and our supply chain is the fact that it can tell me where the water's used in the tiers. So you mention kind of tier two, tier three, you know probably are steel suppliers and others are probably in those tiers. And you can see that's kind of the biggest impact is in those. So I can't just go to my tier one suppliers and say, "You know, reduce your water." That's a small percentage of what I have to do.

So I have to kind of work upstream. It may be related to the kind of processing that I'm asked to do like for dyes and carpets and things like that but electricity is a huge portion. Look at that, 48 percent of the total industries responsible is from electric power generation. You know, next is cotton farming. So renewable energy will help. You know, that can reduce overall if we meet our goals from a country and a global standpoint, that's going to help reduce water as well. Next slide.

So I mentioned dyes. Here's kind of a great example. Conventional textile dye is really water intensive, like 20 gallons per pound. And so you know, some companies have developed a waterless dye. That's a huge, huge advantage and can really help me in my total supply chain reduction. So you see here, you know, zero water. That's really kind of the best kind of processing that we can do. Next slide.

So I'm not going to be able to go through each one of these, but take time and look at them. They're kind of really interesting. And sometimes just showing this to people and talking to them about it, they change their behaviors and that's really kind of what it takes. So you know, might not be able to get rid of leather shoes and everyone loves cheese, but you know, probably things like single use water bottles, you know, 24 pack. Look at how much millions of gallons of water in a lifecycle based on that. It's huge. And so there are some things that we can do from a personal standpoint as well as extend into our company for water reduction. So figure out what your water footprint is and pick something that you can do to reduce it. Next slide.

And just a little bit more on plastic water bottles. You know, this is one thing when I started seeing the statistics a while back, I just decided I'm not going to use single use plastic water bottles again, and I switched to other more sustainable methods. But yeah, this says an aluminum reusable bottle is carbon neutral at four times the reuses to a single use plastic. So it really makes a lot of sense not only from a water standpoint but also from carbon neutrality and decarbonization. Next slide.

Again, I can't go through all these. They're a lot of fun to talk about. You know, turn taps off when you're not using them. Use an aerator. Run dishes and clothes when full. All these kinds of things are great, great tips and really don't cost you anything. Next.

So I don't know if we have time for this. I'll leave this to you whether you have time for the video. If you don't, we can just send them the link and they can look at it. This is a really cool video though. It's the first day at a town in Madagascar that's got running water. It's hard to kind of contemplate if you've grown up and you got running water in your house and elsewhere. So I'll live that up to you, Melissa, either way.

Melissa Klembara: I think we have time.

[Video plays]

Al Hildreth: Thank you. And so I think that sums up why water is important. To see the look on those folks' faces to have clean running water is just really amazing. So thank you very much. I think I've left a few other links for those and others in our slides, and we'll go on to the next presenter.

Melissa Klembara: Great. Thank you, Al. Yeah, and thanks for zooming out a little bit, too. I mean I know we've been leaning in on municipal and industrial wastewater treatment, but thanks for providing a little bit of a bigger picture perspective of the impact that we can make as individuals and even bringing in the environmental justice aspect of why it's important to provide clean water and make sure we're good stewards of the environment in the sustainable water, water recycle that we're doing in industrial and municipal space. So next up we have the Water Research Foundation that will be presenting on kind of going back to the symbiotic relationship and some of the technologies that share there. I think Prakash touched on a little bit earlier of that kind of Venn diagram overlap between industrial and municipal sectors.

So Christobel and Erin are both with the Water Research Foundation. Christobel just recently joined I think the Water Research Foundation as the chief innovations officer. So her focus there is on supporting the implementation and innovation of new technologies to solve complex problems facing the water resource sector to enable utilities to mitigate risk and improve performance. And Erin has been at WRF where she has a background in researching membrane filtration in conjunction with novel activated carbon to target micropollutant removal. And so she has a lot of good experience on the R&D side of membrane filtration and water technology analysis. So with that, Erin and Christobel, take it away.

Christobel Ferguson: Great. Thank you very much, Melissa, and it's a pleasure to be here. So I'm going to start off the presentation and then I'm going to hand over to Erin partway through. So what we're going to talk about is really how can we accelerate the uptake of innovation in the water sector? So next slide.

For those of you who maybe are not so familiar with the Water Research Foundation, I thought I'd just give a quick overview of who we are. We're a not-for-profit organization and we conduct water research on behalf of our subscribers who are based on over six continents across the globe. We currently have a research portfolio of approximately $73 million which represents 210 active projects. And these projects are funded by subscribers and also leveraged through federal and state and private grants. So we have quite a number of co-funding organizations.

And our subscribers are mostly utilities so all across the water sector, so wastewater, drinking water, reused water, desalinated and stormwater. And we also have consultants and manufacturing subscribers as well. And we deliver a program of applied research and innovation through a number of research and innovation programs, and I won't go through all those different mechanisms. But suffice it to say, we are focused on the most pressing needs of the water sector. So next slide.

And the area that Erin and I work on is really the innovation end of the research, I guess, spectrum. So we are looking at the new technologies that are coming through. We are helping utilities find those technologies. We are helping utilities to go and see those technologies first hand and to understand their relevance for their particular applications. We help utilities to try out those technologies and to then implement them at scale within the water sector, and we also work on sharing that knowledge across the water sector. So no matter where you are in the innovation cycle, we have activities to help support you through this process. Next slide.

And so there are two main streams of activity within the foundation. So within the foundation, the Applied Research Program is looking at new technologies, new research that's coming through that has the potential to bring innovation and technology to the sector. And we also have an externally focused program which is the Technology Scans Program and this is evaluating new technologies that are out in the sector, are being developed by others, sometimes small entrepreneurs and innovators, but sometimes also some of our larger water sector participants as well who are bringing technologies to the sector. And what we do is we really look at these technologies from both these sources through the lens of the subscriber needs to try and identify what is the highest potential where innovation can be brought to bear to assist utilities in the water sector and what can we do to accelerate the uptake of that research and innovation. Next slide.

And we have four current topics that we are focusing on for the purpose of pilot projects. They are energy efficiency, nitrogen reduction, PFAS destruction, and water reuse. And we're very pleased to have funded two pilot – have had two pilot projects already funded through the Department of Energy's Energy Efficiency Program. And these are both looking at novel technologies and processes to increase energy efficiency in the water sector. Next slide.

And one of the platforms that we have WRF Tech Link is a place where you can go to actually identify these technologies and see how they can be potentially applied to your utility. This platform is a subscriber-based platform. So any members of the Water Research Foundation can go there and actually view these technologies. There's also a front facing piece as well so that people can scan through and see what technologies are on there. And all of the technologies have been peer reviewed by experts in the water sector. Next slide.

So one of the things that we notice is really beneficial for people who are trying to pioneer these new technologies is to really do a sector-by-sector approach. So we see a lot of horizontal transfer, people developing technologies and testing them out. Often in the industrial space or in the processed water space where private companies are willing to test new technologies and are willing to take on a bit of risk to try new approaches, particularly where they have the promise of being more cost effective.

And so often case studies are done in the industrial sector and then that information is used to actually show how it potentially can be applied to other sectors like the municipal space. So we see this transfer is quite a common approach for new technologies. It also means that these case studies, once generated, provide data that can be shared to actual other people in the sector. So that data transference piece via TechLink means that people can then see those case studies and see how these technologies might apply in their own situation. Next slide.

So we've just taken a bit of a deep dive into the TechLink database platform and had a look at two areas where we see a lot of current innovation being applied. So data driven decision making is one area where there is a lot of action at the moment, a lot of products being developed, particularly for data management and visualization but often also incorporating sensor networks often in combination with machine learning, artificial intelligence to form predictive analytics so that people can predict how their systems are going to perform. This is particularly valuable in asset management but also condition assessments and management of distribution systems.

The second topic that we're going to focus on today is sustainable wastewater treatment. There's a lot of activity in this space regarding carbon/energy neutrality, the movement towards closed-loop resource recovery which some previous speakers have referred to. There's also increasing focus on waster valorization and waste minimization. A strong driver is also to look at reducing the cost of consumables, particularly for treatment. So with that, I'm now going to hand off to Erin who is going to dive into those topics in some more details. Thanks, Erin.

Erin Partlan: Thanks, Christobel. I'll take it over here to give some examples of technologies from our platform that fall into these categories and also highlight a few that exemplify the intersection of municipal and industrial nondevelopment. My first category here is innovative products in data, and we have three subcategories we put together to capture the development in this space. They do overlap, but they also demonstrate some key points of focus.

And so in our first category, we have centralized and actionable data. This refers to technologies that primarily wrangle data and make it easier to view, assess, or report collective data. The second one is asset monitoring and feedback. Those are technologies that are primarily geared towards interfacing with unconnected assets. And then the third and self-explanatory one prediction and optimization are technologies that offer things like computing services to algorithmically offer suggestions of actions and decisions.

And just to highlight a few of the technologies that we pulled out in these categories, so we have the big Z here. It's for Ziptility. It's a smartphone app-based asset management visualization tool. eRIS is a data aggregator and dashboarding software. We have FEND which is a data diode technology for one-way dataflows and enhanced cybersecurity for industrial control. The yellow hydrant here is a technology for hydrant thought AI, and it uses hydrants in water solution networks as access points for data collection. Let's see. So Plutoshift on the right side, it's an AI product for unstructured data to predict the future behavior of a plant. VODA.ai similarly is an AI to clean data and predict risk of failure for pipes. I'm going to dive into two technologies for a deeper dive into how some of these kind of tie back into that industrial/municipal space. Next slide please.

So the first one I'll talk about is Waterhound, and Waterhound is a technology that looking at operational data can feed into their algorithms and offer suggestions for savings in energy and/or consumable resources like water and chemicals. Their algorithm library covers water quality and contaminants relevant to water treatment. Of note, it utilizes digital twin methodology and that's the idea that you can duplicate a plan into the digital space to enable analysis and remote operation. So this is great example. Let's go to the next slide please.

Yeah, so Waterhound is a great example of technology that's been trained in the industrial space. And so I mentioned that they look at water quality and contaminants relevance and they focus on industrial wastewater treatment primarily. But recently they've been awarded a California Energy Commission Grant to test their software on municipal systems so looking for partners in that area right now. Next slide please.

The next technology that I'll look into is one called IRIS by the company Kayuga, K-A-Y-U-G-A. And IRIS is an asset management planning software that has both data collection and analysis components. So a quick walkthrough of this slide. On the top left is a dashboard interface as you might see on many applications showing areas that you can click into. Top right shows a view of asset management history. The bottom left is a prediction actually for future expenditures related to asset maintenance. And the bottom right is an example of an embedded GIS for the software. And so IRIS is a software that seeks to help you just answer questions such as is my asset any cheaper than maintenance and further on to answer the question of how much will it cost me both now and down the road. So behind the scenes there is modeling that looks at the probability of asset failure and the uses of these two proactive asset management. Next slide please.

So a little bit more about behind the scenes. Data-wise the system pulls in from FIDA, LIM, CMMS, GIS, and also financial data. So part of the analysis piece is the ability to dynamically update condition information such as age, maintenance, and usage from the CMMS updates. And they use those to actually calculate an asset conditions like a traffic light, red, green, yellow in terms of whether an asset needs maintenance immediately, in some time, or it's good to go. And IRIS has been used both industrially and municipally so far. It gives a lot of value for the purchase for the high number of assets and load that are rapidly changing. So they have been used such as that docks from a repair times rating. Next slide please.

All right, so our next section is innovative products in wastewater. And again, this is capturing three different subcategories that demonstrate a lot of key points of focus but also have a lot of overlap. So our first category here is energy efficient treatment, and that's technologies that cover those that reduce the energy expenditure of treatment and actually also all of these are actually aeration related technologies. The next category is waste valorization. That's the idea of creating usable products from waste streams and that may include cleaning or upgrading from recoverable materials. The last category is the idea of carbon neutrality, and that's the idea of either reducing or offsetting carbon emissions.

So just to dive into a few of these technologies again. So the first category, again, they're all aeration based. So Moleaer and Perlemax are both bubbling technologies; while Oxymem and Fluence are both membrane aerated bio rapid technologies, those that provide oxygen directly to biofilm so there's no waste of aeration. Doosan is interesting. They have an MBR that is designed to not use any aeration at all to avoid that cost altogether.

In the second category an example is CHAR Technologies. It converts biosolids to usable biochar. 374Water, it treats sludge with supercritical water oxidation to generate CO2 and minerals as the byproducts. And Centrisys is like the whole portfolio of technologies for research recovery. And the last category we have some common names in a few different areas, both biofuels producers. Algae Systems is similar to Genifuel, also using hydrothermal liquefaction to create renewable fuels. And then I will dive into Ephyra and Epic Cleantec for my examples. Next slide please.

So Epic Cleantec is an example from our second category and we're actually taking the idea from resource recovery at a very small scale. So they're focusing on building level installations or blackwater treatment, and the blackwater produces streams of onsite water reuse, biosolids and soil amendments. Most recently they've added on the ability to harness recovered heat energy for onsite use. And so with their system, they're able to actually reduce dependency on city water by 95 percent for a given project. Next slide please.

I want to comment on the, you know, an onsite system is not easy to get underway because of a lot of regulation and permitting issues. And so I wanted to point out the National Blue Ribbon Commission for Onsite Non-potable Water Systems. This is a partnership between the US Water Alliance and the WRF, and we are focused on making it possible for systems like Epic Cleantec to install. They produced a blueprint to help municipalities develop local programs for onsite water systems. And so far, cities like SF, L.A., New York and most recently Austin, Texas have started with approval of onsite systems. It's not specific to the industrial wastewater, but I wanted to highlight the role of policy and enabling tech, especially in the centralized market. Next slide please.

So Ephyra's our last example of today, and Ephyra is interesting as it actually sits in all three categories for our innovation in wastewater treatment. It covers energy efficiency, waste valorization, and carbon neutrality. So what Ephyra does is it takes advantage of a plug flow design optimized anaerobic processes by creating ideal environments for each state of anaerobic breakdown. They also use advance process controls and control each reactor independently. For example, the recirculation flow between the reactors to ensure the correct gauge balance. And the result for this procedure is that you get a better yield per biogas production and also better dewatering of solids. Next slide please.

And just so some high level bits about Ephyra. It's an ideal solution because it fits into existing reactor volume. Optimization results in lower OPEX. And on the point of revenue, it allows for sustainable revenue generation plan through the whole process optimization. And because it uses the combination of a circular economy and also BPM sensors, feedback, and controls. Technology here might be that Ephyra has been proven in the industrial side of wastewater treatment. That is the largest plant in the municipal side. So there's potential for adaptation of that technology to different scales or operation. Next slide please. So thank you for tuning in to this presentation. Feel free to contact myself or Christobel with any questions or you can connect with the Water Research Foundation at any of these outlets.

Melissa Klembara: Great. Thank you, Erin and Christobel, for that presentation. Since we only have five minutes left and there's about five minutes of wrap-up, so I don't think we actually have time for QA unfortunately but so I apologize to our session attendees but there's a lot of meat in these presentations and the session recording and all the presentations will be available and here's additional resources that were provided and this will be available to the session attendees afterwards.

So I have some kind of minor housekeeping things if we want to go to the next slide? So there's a video that they want us to watch on the Better Buildings Solutions Center as previously mentioned. They have over 3000 solutions to help you find proven and cost effective strategies to help you reach your energy, water, and waste reduction goals. So let's check out this video to learn more. Are you guys having any technical difficulties with the video? Let's maybe give it another few seconds.

Okay, it doesn't seem like they're going to be able to tee up that video, but I'm sure you'll see it in other sessions throughout the Better Plans Summit which we'd like to invite you to attend our Better Buildings Summer Webinar Series. That's going to be starting in June. Partners will discuss some of the most pressing topics we're facing, share best practices and innovative new approaches to sustainability in energy performance. To register go to the Better Buildings Solutions Center and click on events and webinars.

And finally with that, I'd like to thank our panelists very much for taking the time to be with us today. We have launched a short feedback survey in Slido and ask that you please take a couple of minutes to gives us feedback on this session. Again, apologies we weren't able to get to QA. Your answers will not be visible to other attendees in this Slido feedback survey. We rely on your feedback to design webinars, future summits, and more. So the poll will be open until tomorrow morning. If you'd like to learn more about resources discussed today, please check out the Better Buildings

Solutions Center or feel free to contact me at the e-mail shown. So thanks again to our panelists and we hope you have a great rest of your session if you're attending more in the Better Plants Better Buildings sessions. Thanks again.

[End of Audio]