Bruce Lung: Yeah.

Female: Mm-hmm, just to make sure can everyone see it?

Bruce Lung: Yes. Okay, go ahead and we'll wait a couple of seconds.

[Automated message]

Good afternoon. This is Bruce Lung with the US Department of Energy's Better Buildings, Better Plants Programs. I'd like to welcome all of you today to today's edition of our Better Buildings webinar series. In this series we profile the best practices of Better Buildings and Better Plants Challenge and alliance partners and other organizations that are working to improve energy efficiency in their facilities.

Today's webinar is entitled Energy Efficiency and Water Savings are a Combo Deal. Basically in industrial and commercial buildings we looked at everything from the building envelope to the motor-driven and thermal driven systems in the processes to find opportunities to increase energy efficiency. But what about the water used in all these buildings and plants? This webinar will explore how saving energy can save water but also how saving water can yield energy savings.

Today we've got a great line-up of panelists who will discuss water-energy nexus and how to capture water savings from energy efficiency projects as well as some energy savings that can result from improvements that are intended to save water. Lastly we will wrap up with a question and answer session and remind everyone about some upcoming events.

Before we get started with our presentations I want to remind our audience that we will hold questions until near the end of the hour. Please send in questions through the chat box on your webinar screen and throughout the session today we'll try to get to as many of them as we can. I'll also remind you that this session will be archived and posted to the web for your reference. Next slide please.

I would like to introduce all the presenters in due time but today I'm going to introduce the first presenter right now. It's Dr. Prakash Rao. Dr. Rao is a Principle Scientific Engineering Associate with the Energy Technologies Era at the Lawrence Berkeley National Laboratory in Berkeley, California. Dr. Rao conducts research and analysis into the potential for reducing the energy consumption and water use impacts of the US manufacturing sector while maintaining productivity. Dr. Rao received his doctorate in mechanical and aerospace engineer from Rutgers University and a bachelor's in mechanical engineering from Carnegie Melon University. Next slide please. Go ahead Prakash.

Prakash Rao: Thank you Bruce for the introduction and thank you all for joining. So I thought today I could start off by just introducing the energy-water nexus at a high level to help tee off the rest of the webinar. So I wanted to start off by describing what we mean by the energy-water nexus. So throughout our economy water and energy are 2 resources that we end up using as services. What I mean by services is we use these energy and water to accomplish something like heating, cooling throughout our businesses and throughout the US.

And in many cases there is a strong coupling between the energy and the water. So energy is required to extract water from the ground, from the surface, wherever it is, energy is required to treat the water at the plant, energy is required to convey it and distribute it to our homes and businesses, within plants energy is required to pump the water around, heat it up, cool it down, and then energy is required to treat the waste water. And on the flip water is required for us to access energy and turn it into a service so water is required for fossil fuel extraction whether it's petroleum or natural gas or coal and water is required for example at the power plant to generate electricity and for certain types of power plants like coal plants or nuclear plants.

So this dependency on the 2 of energy on water and water for energy is called – that is the water-energy nexus. What I'm showing here is a chart from the US Department of Energy in their 2014 report, "The Water-Energy Nexus Challenges and Opportunities," and what this chart shows is energy and water flow through the US economy. So on the top in the green is energy, on the left-hand side are the sources, petroleum, natural gas, et cetera, and where it is used in our sectors, in transportation, residential, et cetera, and how much is actually used and how much is lost as you go to the right. And on the bottom we have the analog with water, the sources, where it's used and where it's discharged. And as you can see the Department of Energy has mapped over how much energy and how much water is used for each of these sectors and for each of theses purposes.

Now the relationship between the 2 is what we call the water-energy nexus so not every quad here is used for every building gallon and vice versa but there is a relationship and understand this relationship for the water-energy nexus helps us better manage our resources, these 2 resources. Where are there opportunities to reduce both? So if you do an energy saving action is there water savings? Or what are the penalties? If you're doing an energy saving action is your water bill going to go up or vice versa? These are things we need to understand in order to make more comprehensive decisions with resource management and that's what the water-energy nexus can do for us. Next slide please.

So as a real example this water-energy nexus stuff isn't sort of highly academic just to show you in play. In my home state here of California in April 2015 Governor Jerry Brown mandated a 25-percent reduction in water use in response to the severe drought. Well 19 percent of all of California energy consumptions related to water, that's not just – that's treating the water, conveying the water, using it at home or in our businesses, and what the University of California Davis, their Center for Energy – or Water and Energy Efficiency put together is they looked at the data, they looked at how much were the energy savings with the water conservation mandate, and they looked at 1 quarter, July to September of 2015 of the same year of the mandate and the results were – make the point about the water-energy nexus in spades.

So if we looked at all this energy savings from utility programs in this state implemented over that same quarter, that same time period, they equal the energy savings from the water mandate, so about 460-gigawatt hours over that time period. So from that 1 measure of reducing water use by 25 percent throughout the state we saw an equivalent energy savings that equaled all the energy efficiency incentive and rebate programs implemented in that same time period so it's a pretty substantial impact there. Next slide please.

And now what I wanted to do is talk a little bit about the system level, where do we see this energy-water nexus in your businesses, where might you see this? So the first right off the bat is pumping systems so pumps are used to pressurize and distribute water. Using you know first order or using principles of physics what we know is back of the envelope the energy required for a pump to move water is related to the – it goes with the cube of the flow.

So what does this mean? So that equation there in the middle, think energy required on the left, flow on the right. If I double my flow in my facility, if I'm following just the principles of physics that's going to be an 8-fold increase in energy consumption whereas on the other end if I half the flow in the facility it's going to be 1/8 of the energy consumption and that's the cube power. So there's a strong power with these affinity laws but it shows that relationship between energy and water.

Now in reality it's not exactly a cube and you're not always going to see these savings or these increases. It depends on your pump system and design and the pump itself and your distribution network. The advanced manufacturing office at the Department of Energy has some wonderful resources to explain the more technical details that we won't go into today, but at 1 of the last slides at the end of the webinar you'll have a link to learn more about that. Next slide please.

Another example of the water-energy nexus within our businesses and facilities, so cooling towers and in this case very specifically evaporative cooling towers. Here is a great example of water being used as a service. Now water – we drink water but much of the water that we use is actually as a service and in the cooling towers what we're doing is we're taking water and we're using it to cool down our buildings or processes.

So warm water is going to come through the condenser and a pump is used there, it's trickled down in this evaporative cooling tower, and a fan is going to pull air over it. So what's happening is essentially energy is enabling the use of water as a service. The same is allowing for convection over the water, which cools it down, and then it's pumped around. And if you look at a 500-ton chiller operating at minimum efficiencies per ASHRAE about 15 percent of energy consumption of this system is for the cooling tower. So it's – this trade-off is something that one would need to understand. Next slide please.

And the last example on the equipment side that I wanted to walk through it steam. Steam again is water being used as a service. We're taking water, we're heating it up, boiling it, and then using the steam for thermal energy to power something, to dry something, to heat something. Steam is a very significant energy consumer in our manufacturing operations, 31 percent of on-site energy, 11 percent of on-site water at least by 1 estimate. Next slide please.

Thanks. So what I want to do with the steam system is kind of show the idea that energy saving actions will lead to water savings as well, particularly in steam systems so I wanted to highlight it. I put together this mock steam system, it's 100,000 pounds per hour, 150 psi of steam, and just some typical things that we – energy saving opportunities and steam systems, what's the water savings? We don't often think about the water savings.

So if we look at this steam system that's pulling in about 45 million gallons per year of make-up water and we have some parameters here. Let's say 30 percent of the steam traps are broken, common measure is fix your traps, it's returning 70 percent of its condensate, 80 percent of recovery is about best practice, and it's blowing down about 10 percent of its water. So what are the – so there's energy savings associated with remediating these actions but what are the water savings? Next slide please.

Increasing the condensate recovery, so we're at 70 percent, which means 30 percent of the water is not returning back to the boiler to become steam again and the challenge here is that that water is very warm versus the make-up water is very cold so you're losing a lot of thermal energy. So best practice is you increase your condensate recovery, let's say we go from 70 to 80 percent, in this example you'd save quite a bit of energy and the associated energy cost savings, 31,000 MMBtu's, but you're only still going to save 10 million gallons annually of water so substantial water savings by increasing your condensate recovery because you're losing less water. Next slide.

Reducing blowdown from 10 to 5 percent, so blowdown periodically you have to drain the water to maintain quality requirements. Doing this too often can lead to energy losses but it also leads to water losses. So in our example here if we go from 10 to 5 percent, 5 percent is a best practice, you're losing all of that thermal energy when you're blowing down and by reducing it to 5 percent blowdown you're saving energy but you're also saving 5 million gallons of water per year, which might not have been in the calculations. Next slide please.

And then finally fixing traps and leaks, those steams traps or devices along your distribution system, which are going to separate the steam and the condensate as the team condenses traveling around. Traps that are broken up and open can just bleed out steam. In the system that I've put together you have 30 percent broken traps; let's say we drop that to about 10, which is about a reasonable number. You're going to have substantial energy savings, 20,000 MMBTu's, but you're also going to save about 1.6 million gallons annually so again water savings accompanying this energy saving action. Next slide please.

So in all if you look at these 3 measures, returning water condensate from 30 percent to 20 percent, reducing your blowdown by half, fixing a lot of your broken traps, you're going to see a lot of energy savings but you're also going to, in this hypothetical case, we reduced our water use by 40 percent all through these energy-saving actions. So as far as resource management this is something to consider as you know you do the calculate the ROY for example on some of these measures. And I should measure there's also chemical savings and other savings; we're just looking at the energy and water here. Next slide please.

So here is what the system looks like afterwards. In the interest of time we can just go to the next slide. Now that was a hypothetical example but here is a real-world example. So HARBEC is a Better Plants Challenge partner, both in the energy and the water program, a leader in sustainability. They're a plastics manufacturer in the Rochester, New York area.

They have a great story where they were hit with higher fire insurance premiums unless they could increase the water service to their facility. They couldn't increase the water service to the facility so they were going to be hit with a $50,000 fire insurance premium increase. Well the folks at HARBEC said, "Why don't we build a rainwater pond? So they built a 900,000-gallon rainwater retention pond and what that does is it appeased the fire insurance folks and so they save that $50,000 but they're also using it as a heat exchange. They have a heat exchanger in there and they're replacing cooling towers with the pond water. They're sending their warmed processed water to the pond, cools down, goes back to the plant; they don't need the cooling tower as much.

So this was a fire insurance savings project but it's also saving 145,000 gallons per month in water because you don't have to use the cooling tower and it's also an energy saving project. It's saving 17,000 kilowatt hours per month in energy savings because now they add 50 horsepower worth of cooling pumps and fans that's attributable to the tower down to 6 horsepower. So simple financials, you have $50,000 in avoided insurance costs, $3,000 in water costs, we have substantial energy cost savings but we didn't have the firm numbers around those, and then they had a $250,000 implementation cost, but multiple savings, definitely 2 for 1, 3 for 1 when you look at the fire insurance as well with this project right here and more information on this can be found on the Solution Center and there were will be a link to that at the end of the webinar. Next slide please.

So so far I've been kind of talking about the water-energy nexus within your businesses and facilities but I wanted to also discuss the water-energy nexus outside your facility. So energy is involved in bringing water to your facility and taking it away and treating it and we might not always appreciate this so what we've done here is kind of piece together where we could the amount of energy required to bring water to our facilities and to treat the waste water.

Municipally – sorry, nationally for municipal water, let's say it's surface water, it's about 1600 kilowatt hours per million gallons for treating water and then about another 750 to 3000 kilowatt hours to treat the wastewater. So you're looking at about 2500 to 5000 kilowatt hours per million gallons that you use at your facility for treating the water, bringing it to your facility, and then treating the wastewater, so substantial energy requirements outside our facility for the water we use. And I also want to point out geographically you look at southern California, where the national is 1600, in southern California the national average – sorry, the regional average is over 10,000 kilowatt hours per million gallon. So regionally these numbers change and it's important to know and understand that. Next slide please.

So we just saw that there's going to be additional energy savings for every gallon you reduce or every million gallons you reduce or every million gallons you reduce you're going to save on the water supply and on the wastewater treatment. There's also something – that water savings also actually grows so for every gallon you save at your facility on average you're saving about 1.16 gallons at the source because there's about a 14-percent loss in our water supply systems nationally and this can be as high as 40 percent in some areas and as low as single digits in other areas like in Las Vegas and Austin, Texas where they really need to keep close tabs on their water use and not have loss.

But for water you're saving at your facility you're actually going to be saving more water throughout the system and that more water you're saving is less energy required to treat that water, convey that water, distribute it, et cetera. And finally there's also water savings at the power plant. If you're doing electrical projects, electricity saving projects, you might have water savings at your power plant. Next slide please.

And this figure here just quickly illustrates that it's put together by the National Renewable Energy Laboratory so if you look at for example the second bar from the left is the coal using a once-through cooling system. If you save a megawatt hour at your facility you're going to save about 30,000 gallons of water at the power plant if you're getting your electricity from a coal-fired plant with once-through cooling so water savings from your electricity savings.

So that's my overview of the water-energy nexus and all its implications. I guess the 2 points that I want to leave you with that understanding the water-energy nexus can really help you with your resource management strategies and understanding and making more informed decisions about resource management, and also the water-energy nexus will extend beyond your facility. There's water savings at the power plant, there's energy savings in the distribution system, there's energy savings in the wastewater treatment system so it really ensnares all of the United States sort of energy and water use. Next slide please. That's it. Thank you.

Bruce Lung: Thank you Prakash, very illustrative presentation there. Next slide please. Next I'd like to introduce Mark Dhennin, who is the Director of Energy and Environment at Cummins, Inc. Some of you may know the name of Cummins from generator sets and engines and that's exactly the company he's from. Mark leads the Energy, Climate Change, and Eco-efficiency Initiatives for Cummins global facilities and operations. Mark has over 30 years experience at Cummins leading the Energy and Environmental Health and Safety and Materials Engineering programs at site business unit and global levels.

He received his bachelor of science in biology and masters in science in environmental engineering from the University of Minnesota. I should also point out he is joined by Nichole Morris, 1 of his colleagues who will be able to help answer questions on their successful water and energy efficiency programs. Next slide and go ahead Mark.

Mark Dhennin: Well thanks Bruce and hello everyone. So today I'll be talking about how we approach energy and water conservation at Cummins and what I'll be doing is providing some real-world examples of the concepts that Prakash covered very well in his talk. Next slide please.

First a little bit about Cummins, so as Bruce mentioned we're probably best known for making diesel truck engines but we also build diesel and natural gas engines for bus, train, marine, mining, and power generation markets. We also make generators, components like turbochargers and exhaust emission control systems, and we have a global network of distributors and dealers to service these products and we are headquartered in Columbus, Indiana. Next slide.

So to produce the over 1 million engines per year and other components that we make we use quite a bit of energy and water. Our operations are not highly energy-intensive but we still consume quite a bit of energy for machining, engine testing, and assembly operations. We're spending about $150 million a year on electricity, diesel fuel, and gas and by the way, this makes up about 98 percent of our facility carbon emissions are all associated with this energy use. About half of our global energy consumption is taking place in the US. On the water side we're using almost 1 billion gallons of water per year and our top 3 water users are cooling towers, irrigation, and for sanitary purposes. Next slide.

So at Cummins we have always focused on our biggest opportunities to save energy and water and what we've found is that many times we can do both within the same project. So for example any changes we can make to lower our cooling tower loads reduce both energy and water consumption. We've been able to upgrade our process and facility equipment efficiency, very important, and as is optimizing how we operate this equipment and these processes. And finally we also consider the indirect or off-site benefits of saving energy or water at our facilities. So I'll provide examples of each of these opportunities on the next few slides. Next slide.

So many of the conventional energy reduction efforts that we've been doing also have the added benefit of reducing waste heat generation and in turn that reduces the demand on our cooling tower systems. So for example we've been upgrading the efficiency of our lighting systems and our plants for years. In some cases we're on the second or third generation of light efficiency upgrades, but however lighting still remains a big opportunity for us due to the pace of the technical improvements within the technology.

So we've launched a global campaign to implement a common approach to LED lighting by focusing on our biggest opportunities and prioritizing those actions. Along with the energy savings comes significant water reduction, again through the avoidance of that cooling tower demand. And at Cummins we also use a great deal of compressed air in our manufacturing plants; in fact, compressed air makes up about 12 percent of a typical plant's electricity consumption at our company so we've been focused on optimizing compressed air use and compressed air systems on a global basis. So most of our plant compressors are cooled by chilled water and we see significant reduction in cooling tower load when we minimize our compressed air usage as shown on this slide. Next slide.

So we're also implementing some less common technologies that are more focused on some of our unique opportunities as an engine manufacturer. A good example is from 1 of our most energy-intensive operations, which is engine testing. So we burn millions of gallons of diesel fuel each year to develop and produce our engine. So we first focused on eliminating unnecessary testing through more computer analysis and bench testing, but we can't eliminate all of it so we need to make it as efficient as possible.

So when testing engines in a lab setting we need to simulate the loads the engines will see in service and dynamometers or dynos provide that load to the engine. And if you look at the chart below you kind of see how the energy from the fuel is expended in an engine. So about 40 percent of that fuel's energy goes to actually turning the drive shaft. About 30 percent is lost as heat through the exhaust and another 30 percent is removed from the heat – from the engine through the cooling system so only about 40 percent is doing useful work.

So that – so in an engine test the dynos convert the engine power, that mechanical output, into heat, at least with conventional dynos so all of that energy tends to go to waste. However, by using regenerative dynos we convert that power to electricity, which we can then use to power our facilities. So we're able to recover a good portion of the energy from the fuel. So along with that electricity conservation or energy conservation we also reduce the load substantially on the cooling towers so we typically see over a 50 percent cooling tower load reduction with this process. Next slide please.

So another focus that we've had is incorporating energy efficiency into new building construction. So we've now integrated that into our building standards to help ensure efficient performance from day 1. And a good example of that is our new office tower in downtown Indianapolis. In this case the narrow profile of the office building along with its orientation maximizes environment performance and this is through using high-performance glazing with exterior shading, high-efficiency lighting, office daylight controls, demand-controlled ventilation, exhaust energy recovery, and a variety of other technologies.

Along with reducing the heating and cooling loads the shape of the building allows every worker to have direct access to natural light and the façade of the building is a varied grid of glass and metal fins that are calibrated for the particular shading and daylight needs of each face of the building. Not only does that reduce energy and cooling water consumption, we've also incorporated storm water collection at this site so a green roof on the parking garage and the terrace is collected in large 200,000-gallon cistern, which is then used to water the green space trees and plants and it also helps keep over 80 percent of the rainfall on the site and away from the city's storm water system. Next slide please.

We've also achieved major reductions in energy and water consumption by upgrading older, inefficient facility equipment. A good example of that was the replacement of an old cooling tower system at 1 of our big engine plants. The new towers reduced water consumption by 38 percent compared to the previous system by reducing leakage, reducing drift, and through higher efficiency cooling. The tower electricity consumption was reduced 19 percent by improving fan efficiency and reducing pumping loads through a modular approach. And finally the new towers also produce much cooler water, which improves the efficiency of the chiller plant by 25 percent, so win/win all around. Next slide.

Another example is replacing old steam boilers at 1 of our sites with high-efficiency hot water boilers. In this case at this site we had eliminated most of the need for steam in our manufacturing processes so we were able to replace the oversized, inefficient steam boilers with right-sized, high-efficiency condensing hot water boilers. And these units are microprocessor-controlled to provide an infinitely variable supply of hot water that is much more closely matched to the actual demand. Next slide.

So we've also been pursing renewable energy. We've installed now 14 solar arrays at sites around the world totally about 8 megawatts but we're also looking at what we can do offsite. And this summer we signed our first agreement to expand a wind farm in northwest Indiana near Lafayette adding 75 megawatts of capacity, about 30 wind turbines, to the wind farm. This expansion will generate the amount of electricity that we use in Indiana at our various facilities in that state. And the wind farm will be completed about the end of 2018. This is a 15-year agreement, it will reduce – it will produce about 260,000 megawatt hours of clean energy per year, and the utility water savings are huge, 69 million gallons of water per year. Next slide.

So as I mentioned we're also focused on optimizing performance of our existing equipment so we do that by ensuring we've got capable energy and facility managers at each facility and we do this through our Environmental Champions program, in which we deploy training and common tools, share best practices, and really leverage our internal capabilities. Next slide.

And with this approach we've been able to commonize how we manage both energy and water and when you think about it there are many similarities. We use balances to visualize our energy and water consumption, we can do leak elimination practices for each medium, do treasure hunts to find low-cost/no-cost opportunities and have shut-down plans and so on. You can find a lot more detail on our Champion program on the Better Buildings website shown on this slide here.

And finally last slide, we have also implemented a capital project hopper to gather all of the opportunities across our company for energy and water consumption reduction. And by putting these in a common hopper we're able to prioritize based on the best return on investment and the best environmental impacts for given projects. So through that we're able to implement improvements across the company in the most practical and efficient way. And last slide? So thank you for that and I look forward to your questions. Bruce?

Bruce Lung: Thank you Mark. That was very great. At this time I'll go ahead and introduce our third speaker. It's Richard Demerjian, who is the Assistant Vice Chancellor of Environmental Planning and Sustainability at the University of California Irvine. In this role Richard oversees campus-wide sustainability programs, environmental planning programs, and physical and community planning for UC Irvine. Richard has a bachelor's degree in landscape architecture from the School of Environmental Design at California State Polytechnic University, as well as an MBA from the Paul Merage School of Business at UC Irvine. He is also a registered landscape architect in the state of California. Richard, please take it away.

Richard Demerjian: Thank you. I'll be discussing a project under construction at UC Irvine that provides some examples of the water-energy relationship on a university campus. This is a collaborative project between UCI and Irvine Ranch Water District, our local water provider, to convert our central plant cooling towers from potable water use to recycled water use. The project relies on an innovative business model to achieve significant savings in both the embedded energy of UCI's water supply and also the amount of potable water consumed on the campus for energy production. Next slide please.

For a little bit of background we're a public university located in Orange County, part of the 10-campus UC system. It's a large campus, about 1500 acres of land area. We have about 11 million square feet of building space. Being located in the southwest water resource management and drought resilience are key concerns on the campus as well as energy management and greenhouse gas mitigation. We currently consume about 360 million gallons of potable water per year. A significant amount of this is used for energy production on the campus. We use about 140 million gallons of recycled water currently on the campus primarily for campus landscaping so currently about 28 percent of the water that we use on campus that's consumed is potable water that's returned to the campus as recycled water for beneficial use on the campus. Next slide please.

Within the University of California system we have far-reaching sustainability policies. Each campus maintains a water action plan that addresses our water resources management and water conservation goals and projects for the campus. UC-wide each campus has a per capita water conservation goal of reducing water use basically by 36 percent over a 3-year baseline year and our campus has adopted a stretch goal of pushing that to a 50 percent reduction so by 2025 our per capita water use would be 50 percent of our baseline year. So we're currently on track to meet that. We've had a lot of positive water conservation projects on campus but as we continue to grow as far as program and facility growth it'll be difficult to maintain that and then the increment of going from 36 percent to 50 percent will be significant. Next slide please.

We're very fortunate to be served by the Irvine Ranch Water District, which is a good partner to the campus. IRWD has been a pioneer in many areas of water resource management including early development of recycled water systems dating back to 1967. UCI has participated with IRWD in the recycled water program since it's inception in 1967 and continues to be 1 of its largest customers. In 2015 IRWD did a detailed assessment of the water-energy nexus of our water supply both for potable water and recycled water to the campus so it provides the campus and all of the customers in the district with a good understanding of the embedded energy and water that's consumed on the campus. Next slide please.

UCI's _____ are treated at IRWD's Michelson Recycled Water

Treatment Plant, which is about a mile from the campus. It's a state-of-the-art treatment plan that has undergone recent expansion and upgrades and it includes on-site generation of carbon-free electricity now with a biodigestor as part of their biosolids treatment program so that will come online next year so part of the energy in the plant will be generated through renewable sources. What the plant provides is tertiary treated and disinfected waste water under California Title 22, which in California can be used for certain indoor and outdoor non-potable water applications. So the treated and disinfected waste water is then purchased by UCI at a cost savings below the potable water rate and used on campus and currently we use the water for outdoor uses, primarily landscaping and also things such as street sweeping. Next slide please.

We have a history of collaboration with IRWD again dating back to the 1960s. Over the past several years we've done some very good collaborative projects as far as water conservation on the campus, which has resulted in about 78 million gallons per year of water use reduction, which has played a big part in us being able to achieve that 36 percent water reduction and track online as far as our water use goals. Next slide please.

UC is powered by a central plant, which includes a combined heat and power system for the co-generation of electricity and thermal energy. The plant includes a large thermal energy storage tank and 2 sets of evaporative cooling towers. The cooling towers consume about 80 million gallons for year of potable water so energy production of the plant is our single largest potable water consumer on the campus, which accounts for 22 percent of our potable water use so it is the largest user of potable water on the campus. Converting the central plant's recycled water has been a big priority in our water action plan and is a project that the campus has been looking at for several years as far as the potential for implementation. Next slide.

So our project has basically 2 elements. We have a recycled water pipeline, a dedicated 12-inch recycled water pipeline that will serve our central plant. That pipeline is being funded by IRWD. Because of the large volume of water it required a dedicated pipeline rather than connecting into our existing recycled water distribution systems.

The second part consists of improvements to our central plant, which are essentially plumbing improvements to receive and monitor the recycled water as it comes onto the campus. The central plant improvements will be funded by the campus in a method that I'll discuss a little bit later. And the connections at the plant we'll also need to address how we'll treat the recycled water, which has a different water chemistry than the potable water that we currently receive. Next slide please.

So with this project this will be a large project for us so when the project is fully online our potable water savings will be at about 50 percent so we'll be on track to meet our 50 percent water target so it's by far the largest water conservation project on the campus. It will also put us into a position where nearly 80 percent of our potable water consumed on the campus will be recycled and returned to the campus to be used for beneficial use. Next slide please.

I mentioned IRWD is connected a detailed assessment and inventory of the embedded energy in our water supply for both potable and recycled water and it's specific to our location and elevation so we feel pretty confident about these numbers. So potable water delivered to UC has an embedded energy of 4158 kilowatt hours per million gallon, which would be the energy required to pump, create, and distribute the water to UCI and then collect and treat the sewage. A similar calculation of recycled water use shows an embedded energy of 3225 kilowatt hours per million gallon so roughly 933 kilowatt hours of energy is saved per year for every million gallons of water where we convert from recycled use to potable water use. So overall the project will save approximately 81,000 kilowatt hours of embedded energy through the conversion. So the project will result in a significant reduction in the embedded energy consumed in our water supply and also a significant reduction of the potable water used on the campus for energy production. Next slide please.

So as far as the business model it's been our experience that water conservation projects are more difficult to finance than energy projects as they generally have a much longer payback period and rely on significant rebates and a lot of this is due to the cost of water versus the cost of energy. So UCI and IRWD addressed the challenge by funding the central plant improvements by using a on-billed financing approach based on the cost differential between potable water and recycled water where the commodity price of IRWD's recycled water, which is 40 percent less than the potable water rate comes into play. We did receive a grant to offset about 25 percent of the capital costs for the on-campus improvements and the remainder is being financed through this on-bill financing with the cost differential. We're currently estimating that the capital costs will be paid back in about 8 to 9 years and at that point once the capital cost is paid off UCI would then begin to pay the lower recycled water commodity rate, which would result in an annual savings to the water commodity costs. So in the up front years we'll continue to pay the potable rate until the capital cost is paid off and then we would revert to the recycled rate once the capital costs of the improvements are paid off. Next slide.

And just in closing as far as our next steps I mentioned we're currently under construction with the project on schedule right now to start up in February of 2108. Next slide. Thank you.

Bruce Lung: Well thank you very much Richard. That's an impressive presentation. It's really good to see all the things you all are doing over at UCI. Next slide please. Before we take questions and answers I did want to point to some additional resources that our speakers have provided for us today. The first one among those is this document you see, Developing a Corporate Water Management Strategy for Manufacturers. Prakash may have been a little modest earlier but he was actually the lead author and researcher on that document and it really details a lot of good tools and resources particularly for large energy and water users and manufacturers can help them really focus their efforts and look at managing the risk from water consumption.

We also have the HARBEC Showcase Project. HARBEC is a Better Plants Challenge partner and that showcase is up on the Better Buildings Solution Center. We also have a showcase project from Nissan North America, 1 of our Better Plants Challenge partners, that details their water energy saving efforts. We also have some additional resources through the Advanced Manufacturing Office here, AMO at DOE. The Advanced Manufacturing Office within the ERE is where Better Plants lives and so we developed some pumping systems resources, source books, various stack sheets, the pumping system assessment tool, and we also did the same thing for steam systems. We had a long-standing steam program a number of years ago and we developed a steam system modeling tool, a steam system source book, as well as a bunch of case studies and fact sheets that really discussed the interplay between the water use and energy use in steam systems, particularly for the feed water pumping system.

So with that, next slide please, we'll go right to the question and answer session and we did get a few questions in here today. I'm going to give a couple right here to Prakash that came in. The first one was – he's going to answer both of them at once. For electricity generation doesn't water get taken out of a water body but most is put back even at a higher temperature? And then the second question is can you comment on evaporative cooling and the overall effect on water usage? Prakash?

Prakash Rao: Sure thing. Thanks Bruce and thanks to those who asked those questions. They're really great questions and very perceptive. To answer the first question, yeah, electricity generation; it depends. What I described in the presentation was once-through cooling in which case the person asking the question is exactly right. The water is going to come in, cool the condenser, and then go back out to the river or whatever the surface water discharge point is and at a higher temperature.

The caveats though I would say are a couple fold. One is in California for example that's no longer going to be allowed, what's called once-through cooling. You're going to have something called a cooling tower or a recycling closed loop system, which then leads to sort of the second question about evaporative cooling and there what you're doing is where the once-through cooling system just takes in cold water, it gets warmed, and that's how the heat is dissipated, an evaporative cooling system will evaporate the water, which you get a lot more heat transfer when you go from water to water vapor. And that's what a cooling tower does.

And now the difference here is a point that water researchers and folks in the water world are probably familiar with these terms of water use and water consumption; they're different. Use is a general term, you know any time you use water. Consumption is that amount of water that you're using but you're not returning back to the point of source. Evaporative cooling is the consumptive water use. Bottled water is a consumptive water use. And these some would argue in terms of water shed health these consumptive uses are the most important ones to pay attention to because you're depleting the sources in the area that we all share.

So yeah, on evaporative cooling with the electricity generation yes, once-through cooling does do that and returns the water at a higher temperature. The other caveat I wanted to point out in addition to California not allowing it, that river water gain, so about – you want to keep rivers at around 32 degrees Celsius to kind of keep all the fish and everyone else happy. There's a recent study that something like over 50 percent of the United States power plants and thermal generators are at – their peak temperature disposing water to the rivers is higher than 32 degrees Celsius and there's times even when the river temperature is higher than 32 degrees

Celsius just naturally because it's so hot out and it can't use that water.

So the thermal pollution, the higher temperature, is an environmental concern so I hope that answers the questions and if not please ask more in the chat box.

Bruce Lung: Thanks Prakash for answering that and also a reminder for everyone to feel free to send in some questions if you want to right now. The next question is going to be for Mark and Nichole. The questioner asked if there was any downside to converting from steam boilers to hydronic boilers?

Mark Dhennin: And Bruce the answer to that is there were no downsides that we're aware of. But you need to keep in mind that this project was both about replacing quite old, you know 47-year old equipment that was not very reliable but also about matching the heat requirements with processes at the plant that had changed over time so really it was the old equipment that wasn't appropriate for the new usage requirements.

Bruce Lung: Okay.

Mark Dhennin: But the benefits we saw include much lower energy consumption by having instantly variable combustion in your fans, less pumping energy, less auxiliary equipment, low NOx emissions, lower maintenance, accelerated hot water response time, which was a big improvement, and smaller physical footprint. We actually freed up some space at the site.

Bruce Lung: Okay, very good. I'm glad you mentioned that because that's 1 of the things that doesn't always happen when you have new process lines or new configurations in the manufacturing plant. You kind of need to take stock of what you have in terms of the cross-cutting and supportive equipment to see if it's still appropriate or if it's oversized and see if there's any opportunities to either right-size it or change it up a little bit like the way you all did.

The next question we have here is for Richard and the person asking the question said, "Does IRWD have testing procedures where you do not have to shut down the potable water lines to a site?"

Richard Demerjian: Yeah, IRWD, they do have testing procedures at their plant and also we will be testing the water quality at our plant. What we're doing for our project is we're retaining the potable water lines to the project so that we'll have basically dual feeds to the project so that we will receive and use recycled water but if there's ever a concern with water quality or other issues at the recycling plant we have potable water lines that will serve the site. So we're going to have – basically do a water service.

Bruce Lung: And then another question that just came in for you is what is a weighted campus user? Is that like your normalization metric?

Richard Demerjian: It is. It's basically a weighting factor that's used by universities and mainly in sustainability metrics. It was developed by AASHE, which is the Association for Advancement and Sustainability of Higher Education, and it basically weights campus population versus residential versus non-residential population.

Bruce Lung: Okay, interesting. Okay, very good. Still fielding a few more questions in here. One thing I wanted to pose real quick for both Mark and Nichole and Richard, 1 of the things we've noticed both in industrial and commercial buildings end users is that some of them have some pretty aggressive reclamation programs, water reclamation programs and issues going on and I wanted to see if you all are looking into that or if you've already done that as well.

Mark Dhennin: Yeah, so at Cummins Nikki is leading a very interesting project to reclaim waste water for re-use inside our facilities if that's kind of what you're talking about Bruce.

Bruce Lung: Yes, go ahead.

Mark Dhennin: Nikki, if you're on the line could you expand on that a bit?

Nichole Morris: Yes. We have been partnering with a group called Sustainable Water to develop a reclamation program for our industrial and sanitary waste water. Our pilot site is 1 of or largest manufacturing facilities within Cummins and we will – we should have construction completed sometime mid-year next year and it would reclaim around 15 million gallons per year of water that would traditionally be discharged to the local municipalities for disposal. So we would recycle that water and use it in non-potable water areas throughout our facility for coolant systems for machining. It's a high-machining manufacturing facility so we use quite a bit of water for coolant systems and machining processes so we would be able to re-use that water and additional we would be able to re-use it in our cooling tower, which is the largest user at that particular facility.

And we're looking at – that would be our pilot site and then if it goes well there we are looking at doing the same thing at 1 of our Jamestown locations and potentially expanding that and implementing there some of our engineered wetlands for some of our areas overseas.

Bruce Lung: Okay, great. And Richard for you?

Richard Demerjian: Yes, currently we're not doing any on-site reclamation. We've looked at different projects for doing storm water capture and re-use, condensate recovery and re-use, but we haven't any projects moved forward. We're fortunate that we have the Michelson plant a mile from the campus so for us as far as the economies to scale it makes a lot of sense to have the water recycled at the plant by IRWD and then have us basically purchase it back so we're not doing anything on-site.

Bruce Lung: Okay, very good. Let's see. There was 1 other question that came in here. Let me find it here. Somebody had a question about the water in the cooling towers if you can use reclaimed water versus you have to use potable water. Are there any difference? Prakash you want to take a stab at that?

Prakash Rao: Yeah, sure. So I'm somewhat speculating here. I would think that the cycle to concentration is more dependent upon the level of contamination in the water once it's been turned through your system so the incoming water I would assume if it's recycled would have more poor water quality so maybe initially or something like that. But I would think ultimately once it goes through the system it's picking up the same amount of contaminants and I'm not sure about the effective cycles of concentration. That's entirely speculative kind of off-the-cuff thinking but I'd welcome our other panelists to chime in and correct me if I'm wrong.

Richard Demerjian: Yeah, at Irvine the recycled water that's being used is fairly high quality but it is higher in turbidity so it's higher in solids and there is other water chemistry that's different than potable water so the filtration system and the treatment system is a little bit more advanced than what we would use for potable water so that's something that our central plant staff has been working on will be the water testing and treatment for the recycled water, which is a little bit different. There are different chemicals that would be used.

Bruce Lung: Great. Well thank you very much Richard. Mark did you want to jump in?

Mark Dhennin: Yeah, just 1 last thing, so we're recovering condensate in a number of our facilities and that's an excellent feed stock for cooling towers. It tends to be very low in mineral content. You know it's essentially distilled water so you generate much less concentration through that process Prakash described.

Nichole Morris: Yes, exactly. I was going to mention the same thing. At the particular facility that we're doing the pilot reclamation for waste water project they reclaim about 300,000 gallons of condensate from their air compressor mechanical room each year and that goes directly into their cooling tower and it reduces the pollutant load in their tower; it reduces the conductivity so it's a beneficial stream.

Bruce Lung: Excellent. Well thank you very much Nichole. We're almost at the end of the hour and I wanted to give a plug for next month's webinar, which will be how to leverage the DOE National Laboratories. As you can see here Secretary Perry described the National Labs as the "crown jewels of America's R&D efforts." This panel will actually be very interesting because it will be moderated by my colleague and the Program Manager for Better Plants, Mr. Eli Levine, and prior to coming to Better Plants Eli was managing the Clean Energy Manufacturing Initiative and he also worked on the Technologists in Residence program so he knows very well what the National Labs can do and ways that individuals and companies and organizations in society can work with the National Labs. So all of that will be detailed and it should be a really good webinar. We hope you will all come back for that one. Next slide please.

So we want to just give you our contact information. Sorry if we didn't get to all your questions today but please note down our contact information and you can submit questions to us later. We will be archiving this and everyone who signed up will get a notice letting them know when it's available as well as when future webinars will be available. So thank you very much for your attention and for joining us today. We hope it was a good, valuable webinar for you and we hope to see you again in the future.

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