Introducer: The broadcast is now starting. All attendees are in listen only mode.

Eli Levine: Hey, everyone, welcome. We're just gonna give4 everyone a few more minutes before we get started. Thanks so much. Just another 30 seconds to let everyone sign on and then we'll get started. Okay, welcome. We'll, we're excited to have everyone here for the eighth installment in our webinar series. This one is focusing on pumping and fan systems. I think it should be really great and have some hopefully useful information for all of you that can join us. Next slide.

In case it's been a while since we've all been in person together, that's still what I look like more or less. I could use a haircut. My name is Eli Levine with the US Department of Energy and we're thrilled to have you joining us here today. So next slide.

As I said, this is our eighth installment in our online learning series. We have been doing quite a few of these in the spring when we first started working remotely during the pandemic and restarted them up here in August. So if you missed last week's version that was focusing on Energy Treasure Hunts. It really was great. So we had our colleagues at the Environmental Protection Agency's Energy Star program join us and then we had Alex Floyd from Tyson Foods who, they were out in front doing a virtual treasure hunt and sharing their experiences.

I know we're all thinking a lot about virtual everything these days and how we can still get our work done in sort of an alternate fashion, and if you are considering doing a treasure hunt, and I encourage you too since I think there's a lot of great information to be learned from holding an energy treasure hunt, I would encourage you to go back. We should be able to have the recording posted in about a couple more days, maybe early next week. So yeah, so here we are for pumps and fans and take a look at the calendar. You could just go ahead and register for all of them on our website and then have it all set up for the future. Next slide.

As you may remember from last time, we're now using Slido to field your questions, so go to www.slido.com on your mobile device or if you've downloaded that app and it's hashtag DOE, and if you have any questions, by all means feel free to enter them as the presentation is going on. And if you just want to see what your colleagues are asking then you can go in and vote, you can go vote on what they're asking in order to, you know, indicate which ones you want to hear the answers to. Next slide.

And so the agenda today is pretty simple. We're gonna have an overview of our pumping and fan systems. As you may recall from the spring, we record these ahead of time just to ensure that you don't hear any kids running around in the background or any other technical difficulties. And then we'll have some question and answer time using Slido. Next slide.

And there is my colleague that I can hand this off to. Tom Wenning from Oak Ridge National Lab, thanks for being with us and take it away.

All right, fantastic. Thank you, Eli. And more importantly, thank you to everyone that has shown up today. This is, you know, our second series for this webinar online learning series. We had some really good stuff a couple months back so hopefully most of you either joined us for those, you know, when we were doing them live or, as Eli mentioned, most of those are posted. And so there's some really good content and material, hopefully you're gonna enjoy today and the next several that we're gonna be doing here.

There is just some really good foundational material that, you know, not only – hopefully you, as participants are picking this stuff up, looking through the attendee list, most of you likely already know almost all of this. But maybe the opportunity here is that you can help indoctrinate others in your organizations, and whether you use the recordings to help train other people or you just take the slides, you know, that's perfectly fine to, you know, steal what we've got and, you know, make it your own and, you know, train more folks in your organization. At the end of the day, we kinda need an energy army of sorts to, you know, do this battle of energy efficiency to save the world, right.

So with that, today we're gonna be talking about pumps and fans, some of my favorite systems, and the reason we're lumping them together is because they are so similar, right. But we've got some really good stuff. So if you have questions, again, as Eli mentioned, please log into Slido, hashtag DOE, and just enter your questions along the way and we'll wrap 'em up on the backside.

Marissa, let's jump into things here. Let's get rolling here. All right. So the DOE has a long history of going into facilities and doing energy assessments. For like the past 20 years, DOE has been doing variations of energy assessments or walkthroughs, treasure hunts, things like that, and so there is a lot of data that's been compiled over the years and here is really kind of a high level snapshot of some of the findings over the years.

And so it's no shock to anyone that our fuel-fired systems really are the biggest consumer within industry and typically consume most of the energy within a facility if you have either one of those systems. But you can see, based on this chart, that it tails off a little bit but there's still really some common major opportunities, you know. So down to our electric motor systems and pumping systems, specifically, and even compressed air is called out, right. So these things are big enough that they're called out in terms of the overall consumption, and then everything else just kinda falls in this other category and, you know, that could be a number of things but this is the common breakdown.

And then I think the more interesting aspect is the numbers below it, this potential energy savings, okay. So these are really based off of some of the observations and the recommendations that have been made through all of the energy assessments performed at either large manufacturers or small and mid-sized manufacturers. And you can see in here there's a fairly decent range of potential energy savings for each one of these systems. You know, anything from 10 to 30 percent on our steam and process heating systems, but commonly with the electric motor systems, the pumping systems, you know, it could be anywhere from 5 to 20 percent, right. So this is real money, these are real opportunities, okay, and so that's why it's important to be looking at this stuff and really to spend some time to understand what's going on and what we might be able to do, okay.

So, pumps and fans, pumps and fans. Most of us probably understand and have seen a couple of pumps and fans. They come in all different shapes and sizes for the most part. You know, everything from your house or if you're watching this on a computer, you know, there's a little fan in your computer that's, you know, working to pump hot air through it to keep it cool. Large scale, I've got a couple pictures here of pumps and fans. These are on the massive side of things really.

So the cooling towers up here in this top left corner, you know, they have everything. They have our, you know, axial fans typically in the top. They have pumps that are circulating water all through there. So there's a whole lot going on. We have a couple pumps here in the middle and over on the right-hand side, you know, some really massive pumps there. And, you know, these things are all around us, and for the most part, they are just a mechanism to move some type of fluid, okay. And I'm using fluid in a vague term because a fluid could be a liquid or it could be a gas.

So ultimately, because these things are moving fluids, there are some really common principles and some common opportunities that have their own slight variation but it's the same general methodology, okay. So I think that's part of why we've lumped these two together today because there are many similarities in terms of just the fundamentals of how to think about these systems, how to approach them, how to work on them, okay. And so let's step into some of this stuff here. All right.

So fluid flow systems. I mentioned that it's the same fundamentals, and I would say largely it's true. Regardless if you're pumping a fluid, you know, say water, you know, a liquid fluid, or you're pumping air, right, so maybe you're just moving air through an HVAC system or, you know, through a process, right. It's the same general concept and really it's the same structure in terms of how we really analyze and evaluate these systems.

And I really like this Sankey diagram specifically because it shows essentially the losses. You know, when you bring electricity into your plant and your facility to power your equipment, you know, one of the things that always crosses my head as an energy assessor, you know, an energy engineer, you know, how much of what we are paying for actually goes to something useful that's gonna make us money, right. Ideally it's a one-to-one ratio.

You know, whatever we have to buy in terms of electricity or material, right, we want that all to translate into valuable product. Well, that's, I guess, the ideal world. In real life there are a lot of losses along the way and energy, you know, you could look at it from that lean six sigma approach. There's a lot of losses that are not adding to value and that's really true in fluid systems pretty commonly, so both pumps and fans.

And this is a fairly good representation. I have another picture, a few slides from now, that's gonna visualize in a different way but what you can see here, there's just a lot of losses. As electricity comes into our facilities and, you know, goes to that motor, you know, there's losses, everything from the distribution system in your facility, that's in the wires, the transformers, there is losses maybe in our drives if we have those connected to our motor. There's losses in our motor itself, right, and all these things can be pretty small.

And then from the motor, you know, we might have that connected to a pump or to a fan, right, through some type of connection. In this case, you know, maybe we're looking at a fan and we have belts that are driving things. There's a couple losses there. And these are all small percentage points. But then we get into some really big ones, the major losses, and that's either in a pump or a fan, you know.

And then the next one, and this is one of the sneaky ones of sorts, the control devices that are out there. So either valves or dampers, and a lot of energy can be dissipated and can be lost across these last two things, okay. And so in this case, you know, we might start off with – you know, let's call this like 100 units of energy on one side. On the backside, you know, this could be much smaller. You know, this could be 30 units of energy that are going through, right. So if you were buying a material, right, and you bought 100 and only gets transformed into something useful, well, can we bump that up, how are we gonna bump that up?

And so that how is what we're gonna work on today and we're gonna spend some time understanding the overarching principles here, okay. And on this bottom, I actually, because I'm an engineer, we have converted things over to a basic equation for you, which really is just a representation of what's up above and we're gonna spend some more time on this. But, you know, the overarching thing in here is, you know, our work, that W there for our electricity, it's really just a function of, you know, the work that we need to put into the fluid, okay, and then that's essentially this useful work up here. You know, what is needed for fluid, whether it's pumping liquid over an elevation or air, you know, through a set of filters or through a process. You know, what is that work that's needed there?

And then all these efficiencies start to add up, okay. And so you know, underneath here is a pretty common – this is just to be a, I guess, a super simplified example. You know, if we need one kilowatt hour of fluid work out in the system to, you know, who knows, push product, right, if you combine these efficiencies, you know, 70 percent efficient pump that's actually really efficient, that's not too bad. A drive that's 92 percent efficient, that's not too terrible. Motor, 90 percent efficient, that's kind of a standard efficient motor, right.

We're looking at needing 1.7 by 1.7 kilowatt hours for delivering that 1 kilowatt hour of work, okay. And in this situation, you know, we haven't even factored in really control, the aspect of how we're controlling things and where we might be losing energy in the system. So let's jump into things more here and go just a step deeper.

So because these fluid flow systems are really similar, because again, we're pushing a fluid, it's the same general fundamentals, and even for our driving equations, in terms of how we look at and evaluate these systems, it's the same structure across both pumping systems as well as fan systems, okay. So our work, in terms of electricity, that we need to purchase, right, ultimately, is gonna be dictated upon essentially our flow rate, that's that V, as well as our pressure drop.

So in comparison to that previous slide, you know, this is that fluid power that's needed in this system, okay. So you know, it's the multiplication of those two things. And then what we do is take into account the efficiency of our pump, efficiency of our drive and the efficiency of our motor, all right. So if we're gonna save some electricity, right, over on this left-hand side, what do we need to focus on? What can we do? What should we do, right?

And so in terms of just thinking about this in a very simplified way, right, we can focus literally on any one of these five items that I've got listed here, okay. So some of these are really straightforward, right. You're thinking, well, if I put in a more efficient motor, boom, that changes things there, or if I put in a more efficient drive, boom, you know, that's something. I could change out my pump, right, that's something. And those are the really standard simple ones.

The ones that get a little bit tougher that we need to do just a little bit work and kind of open our minds and wrap our minds around are the ones on the top, and these are I would say probably the biggest impact or the biggest drivers in terms of what we can do to save energy. So either reducing our fluid volume flow rates, so that's that V, or if we can somehow figure out how to change or modify the pressure differential, so that could be pump head, that could be our pressure drop in the system. And that delta P, that pressure drop can take a number of different things. So, you know, changing our elevations is one. This head loss, that's actually friction, think about it that way, friction in the system. If we can change those things. If we don't need to pump as high of a pressure, right, that's what these things all come to, okay.

So we're gonna step some more into this and it just keeps funneling. It gets a little bit more specific. So with each one of these fluid systems, I told you it's the same overarching framework, the same mindset and approach that is used, okay. So for pumps and fans it's a similar setup, it's just slightly different numbers that we'd plug in, okay. And so you can see, there's a very similar framework here, volume flow rate, okay. And so for pump systems that's in GPM, and then we have that delta P in our pump systems, we call that head or refer to it as head in terms of feet of water column, okay.

With our pumping systems, we have this little factor in here called specific gravity, which is more towards if we're pumping a fluid other than water that really starts to make a bigger difference and we might change this specific gravity. But then there's these constants in the bottom which just help convert all the units. So we have a common unit that gets kicked out on the left-hand side, okay. So for pump systems and using our GPM and feet, 3960, and then for this one, this is just accounting for the efficiency of the pump, okay, and so that's going to give us the horsepower, you know, we call this the brake horsepower, so this is the horsepower that's needed to come out of the motor to the pump, okay. If we wanted to factor in the efficiency losses of the motor or of let's say a variable speed drive, right, we would just tack those efficiencies on down here, okay, and that's how that works. So you can see that, okay.

So that's for pumps. But fans, it's the same structure, it's the same flow of things. We have flow rate and instead of using GPM, gallons per minute, now we're talking CFM, cubic feet per minute, okay. And this, it looks like we screwed up a little bit. We typically don't refer to the pressure drop in fan systems as head, it should just be pressure, okay. But the units are still correct. It's inches of water column, okay. And on the bottom we have a conversion unit, this 6356 to just convert all of our units so they work out and we can get horsepower on the backside.

And then similar to the pump example up above, instead of the pump efficiency we have the fan efficiency, okay. We factor all of those things in and we calculate what's the amount of power needed to go into the fan out of the motor, okay. And similarly, if we wanted to add in the efficiency of the motor or efficiency of the drive, we just add that in and tack it on, okay. So these are the – it's again, the same fundamental theory that we're kinda working on, just slightly different approaches for these two systems, okay.

So another really fundamental aspect of our fluid flow systems is on the system setup, and really what we're looking at here is a pump curve and a system curve, okay, and they're combined together. And really, this could be a pump or a fan curve, okay. So this curve on the top, that's our manufacturer's data that we would get on a pump or a fan. That line represents kind of the physical attributes of that pump or fan, you know, how it would operate at given pressures and volume flow rates, okay. And so for a given speed of that pump or fan it has to operate somewhere on that curve, okay. So you're not gonna operate anywhere else unless you start changing some other things. So that can define or help us to define, you know, one place of, okay, how are we gonna operate with that piece of equipment.

The other data point that we have in here is something we call a system curve, okay. And that system curve, with that exponential curve that we're looking at right now, what that represents is the physical system piping or ducting that we have, okay. So that curve shows us, okay, based on our current setup, right, and that accounts for not only the pipes or the ducts, you know, depending on which system we're talking about, but it accounts for, you know, where those dampers or valves, you know, where they're shut at, right. And so that's the system curve that, again, represents that physical system.

And so where these two intersect, okay, that's where the system's gonna operate at. That's the pressure and flow that we're gonna get out of our pump, okay. And this is powerful because this lets us start to do some of the math of, you know, also understanding, or it's a different way of visualizing and understanding what our fluid power is. Because I have the equation here, if you remember from those previous slides, what it basically boils down to is that volume flow rate times the pressure difference is our fluid work, okay. So it's that area, it's that square underneath the curve here, okay.

And so these pressure, or these pump, fan curves and system curves really help us to better understand, you know, where we're working at in the system and how to move around in the system, okay. Because when we start looking at this, all of the sudden we know, well, we've always got to operate at that intersection, okay. We can't really operate anywhere else. So what that means is we need to physically change something in the system and then we'll start moving around on this curve, okay.

For this system curve, for example, let's say we're operating at this point but, you know, we want to – we don't need as much of our volume flow rate, right. There's too much water being pumped through this system. So what happens? Well, we're gonna maybe throttle down a valve out there. It's gonna increase the friction factor in the system. What happens is we can calculate or we can know exactly how much our resulting energy is gonna be because what we need to stick on that pump curve it will actually ride up, in this case if we're gonna throttle a valve and all of a sudden we're gonna move up here because what's gonna happen is that curve is gonna change because we physically changed something in the system, okay. So hopefully you're able to follow along with that.

And really, one of the big things to keep in mind and is really important within these fluid flow systems is this idea of the affinity laws, of the cubic power of things and so that's what some of these equations that I have down below represent. Where really our power for our system is based on the cube of some of these things if we start messing with the pump or the fan. So if we're changing something on the pump or the fan in terms of either speed or the diameter of our pump or fan, then we really start to look a little bit more at these two equations down here. Because in this previous example up here, you know, we throttled a valve, right. Well, what if we don't need to throttle a valve, what if we have let's say a VSD? Let me see if I can clear some things out here.

So if we had a VSD, a variable speed drive, or let's say we, you know, trim a pump impeller. Trimming a pump impeller means we're just gonna take that little pump impeller out and we're gonna grind it down, just make it a smaller diameter. So instead of closing a valve we're gonna slow down our flow rate, you know, 'cause again that example let's say we have too much flow, so instead of traveling along that pump curve or that fan curve, we want to slow things down or we want to change the diameter. So instead of following a pump curve because we're changing the pump and not the system, we're gonna calm down the system curve.

If you remember, we were roughly right up here instead of up above before, and now we get a play on this cubic laws, okay. Because based on our equation, this work is equal to essentially the volume flow rate times that pressure differential. All of the sudden we're looking at a much smaller box than we were before, okay. And so this is powerful stuff. This is really – I mean for me, it's exciting. I think it's pretty cool. Some of you might be asleep already but I think this is incredible.

And it can get even more complicated from here. What I'm showing is essentially a really basic example of all friction system. If you put in something where you're pumping up against – let's say you're moving water from down low up to high and there is always an elevation change. You know, maybe you're pumping water from the ground and up into a water reservoir or a tank or something. Well, the system curve changes a little bit, it's just a slightly different system where we start off with some pressure, okay, and the system curve is just gonna look a little bit different, okay. And the same theory still applies, though. We follow either the system curve or that pump curve depending on what item we're physically changing, okay.

So I think it's really cool stuff, but let's keep moving, though, otherwise I'll spend all day on it and really geek out on you here. So a couple areas that we start to diverge just a little bit is the system areas or the system opportunities in each of these systems, okay. So it's the same fundamentals, really, it's just in theory or in practice it might look like a slightly different device, okay.

So for this first one, let's start with pumps. We'll go through pumps and then a little bit later on we'll go through fans. So, some high level areas and items to think about in terms of pump system energy, okay. So some things really to look for in terms of energy savings or things to think about if you are using in your facility, one of the most common that we see quite often and very frequently are throttle valves, okay, as a means of controlling the amount of liquid that's going out into our system, okay. So these are really common, almost everywhere. They're not the best control option in terms of energy savings, okay.

Another opportunity that you can look for is a bypass valve, okay. These might be a three-way valve, those are super common, where you might be recirculating part of the fluid back around. If you are in a situation where you have parallel pumps, so pumps that are really aligned side by side and they're, you know, pumping to a common header, right. If they're all running all the time there's probably some opportunities in there for evaluating them a little bit closer to see if there is some opportunities, okay.

Some additional ones are the constant pump operation all the time, or if you're hearing cavitation. Cavitation is something really bad where there is some air bubbles, essentially, being formed or vapor bubbles being formed in the pump, there's just too much suction and it's causing a vacuum and typically it sounds like if you put a bunch of rocks and stones into a blender or – yeah, I think that's the best analogy I can tell ya. It sounds pretty terrible, it's not good for the health of your equipment. So if you really hear something and it's really sounding crunchy and gurgling, there's probably cavitation going on and that's maybe more of a maintenance issue, it's definitely an energy issue but more of a maintenance thing.

But other things to be looking for is if you do have high maintenance costs for your pumps, you know, changing out seals, things like that, there's probably some further investigation warranted. And then this last one, and I really probably should have put it as the first opportunity, you know, there is a really good likelihood or a very high chance that there's some maybe significant energy savings if your system has undergone any change. So if your production levels have changed or if your piping configuration has changed, you know, any of these things are really indications of some good opportunities to find some energy savings, okay.

So previous in the presentation here, I mentioned that DOE has performed, you know, lots of assessments over the years. I'm gonna zone in on a specific time period of 2006 to 2011. We were doing some really great and really targeted energy assessments for large manufacturers, and we were performing thousands of those across all different types but they were really in-depth in each specific system, okay. And so for the fan system assessments, we pulled the dataset from that to just look at, okay, what were the typical recommendations that were found, what were the typical savings potentials as well as cost savings. These are really for kind of larger manufacturers, large to mid-sized manufacturers. But this is really good because in this case I'm showing the pump opportunities from these energy assessments and they are repeating some of the things or showing some of the things that are shown up above.

So this excess valve friction loss all the time, a little bit of a code word for open up your valve, right, or in some cases it might actually a bad valve that's being used in there. Using less than optimal equipment for the application. Typically that meant you were using the wrong type of pump, perhaps. You know, more flow than required to meet the system requirements. You can start to see there's a little bit of a trend, where either a lot of these bigger ones are targeting either the pressure drop or that flow, okay.

And if you go down this list, there's a lot of 'em that are like that. This excessive recirculation that's targeting the flow. We want to reduce the flow where it's not needed. Let's see, downgraded equipment performance, things have broken and worn over time, right. So there's a lot of really interesting savings. And if we look over on the right-hand side, you know, in some cases these savings percentages I'm showing are somewhat small because they are based on a facility, okay, but the cost savings, you know, we're talking fairly good numbers here, you know. Quite a few – tens of thousands of dollars for quite a few of these, with relatively decent paybacks in some of these cases, you know.

I realize some of you might argue, well, some of these are over like two-year payback, understood, understood, but I would argue that a lot of these, because they are in your pumping system, your pumping system's probably gonna be around for a while, right. It's kinda like your house, it's probably not going anywhere any time soon and if you do some of these things smartly you might pay just a little bit more, right, but in the long run you have a more reliable system, you have a more efficient system. And if you do these things really quite right you have a much more flexible system. That way as production does change your system can continuously be optimized and not only for the reliability and the maintenance aspect but for the energy aspect, okay.

So let's get a little bit deeper into some of these pump savings opportunities, and I've got some visuals because that's just how I operate, okay. So here is a really good example of a – what I would call a common pump opportunity, and for most of us, and a lot of facilities around the US, they're inherently built with the idea of using a throttle valve to control the flow, right. So we have our pump, we have our motor and everything hooked in to our pump. Pump's just pumping fluid. It might be going out to the cooling tower, right, or it might be going to our process or our chiller. And a lot of these, instead of coupling things with like a variable speed drive, we just have a throttling valve, right, and you know, we're pumping too much, you just crank down on that puppy.

Well, what that does is it introduces a lot of pressure drop, right, it's a lot of friction that you have to pump across. And so it's just a really poor form of trying to control our flow rates, okay. But in this case you can see there's any number of things in here. You know, so there's everything from the motor to the coupling, the pump, if you remember that equation we were talking about, boom, those are all three things that are in the denominator. But going out into the system, the sneakier unknowns are these throttle valves and even pipe efficiency, that can play a factor.

But in this case, you know, we're paying for 100 units going in, we're only getting 31 that might be going to something useful, you know. So this is the value-add proposition, only 31 of 100, 31 percent efficient, right. Whereas, if we look at the larger parts of how we might be able to change or tweak our system to really maximize them. So on the bottom half, you know, we're not using that throttle valve anymore. You don't see that in there. In addition, we have improved the piping, right. Maybe we eliminated some elbows, maybe increased the diameter of our pipes a little bit.

But we can increase the efficiency in our system and then as we work backwards, you know, instead of a 77 percent efficient pump maybe we're using 88 percent pump, slightly better, right, a slightly more efficient coupling, okay, slightly more efficient motor. And these differences are starting to get much smaller, you see, right. The coupling is just a little bit better, the motor efficiency is a little bit better, and then we have a variable speed drive and that variable speed drive is really what we're using instead of that throttled efficiency. But in this case we have done from a 31 percent efficient system, you know, we were only providing 31 units of power, of useful work for a process, in this case up to almost 72, right. So we have more than doubled the efficiency of the system, what we are getting of value out of what we're paying for, okay. So this is a really visual way of looking maybe at that system but let's keep going.

So one of the end uses, so these are like big opportunities and things just to keep in the back of your head as you are maybe thinking about the pumps in your facility, is asking the question of, you know, why, what are we doing out in the system and starting there. And as far as that equation, you know, it's that flow, you know, the pressure drop through the system, okay. So flow and pressure, those are the two things that we want to really start with.

Here is a good example. We were doing an energy assessment at a chemical facility and they had multiple 900 horsepower pumps on the left-hand side there, this massive room, right, where they were sucking river water to go cool some of their processes, some of their chemical processes. And then after the chemical process, the water would flow through these jackets and then they would dump 'em in this picture on the right-hand side. That's 12-inch diameter pipe that, if I were to take the picture, show you the picture that I have from far away, you know, that's a stream in and of itself, okay, that it has created. So it's taking water from the river, pumping it and then dumping it.

The problem is that most of the year that process wasn't even working. They didn't have it operational. Intentionally, they just – you know, they weren't using that line to create any product, but that whole time, and even while we were there, they had this – I mean they had this really nice stream. You know, they had some frogs and salamanders and things growing in it but it was a really simple fix. That's not a trivial amount of water, that's not a small amount of water that's gushing out of there.

And this is maybe a good example of, okay, they just never asked the question, you know, why are we using all of this water? Well, in some of these cases you didn't need to use that water at all, right. So this was a really good example of reducing unnecessary demand. In this case, you know, all they needed to do was just put in a simple switch with a valve to, you know, shut off that process and shut off the water to it when you weren't doing anything for half the year. Unfortunately, the salamanders and frogs maybe needed to go live in the big river instead of this little stream but they had pretty massive paybacks for this facility.

What I have down here in the bottom left are just averages, not for this specific one 'cause this one had a much bigger payback. But you know, if you find small items out in the space where you don't need to be pumping let's say cooling water over a product because you're not running the line. You know, if you can turn it off you can really quickly start to save a couple percent here and there and it starts to turn into real money, okay.

So another opportunity, and this is simple for some of us to think about, difficult for others, but as it relates to that – the two fundamental items, the flow rate and the pressure, this one is focused on the pressure. And for pumping systems, one of the components of pressure is not only the friction in our pipes but the head or the elevation that we need to pump our fluid over. So if there are opportunities to reduce that elevation change, okay. In some cases there opportunities, not always. Here is an example where you might have something where you can increase the well height to be a little bit less, you know, just let it fill with a little bit more water before you start pumping it out, okay. So that would change that elevation in there that we need to pump to.

Or if you're pumping to a reservoir up above, you know, can you reduce the height of that reservoir, can you – you know, if it's a tank up above do we need to be pushing it all the way to the top of the tank or filling the tank all the way up, different things to be considering. Sometimes these are options, sometimes these are not but this is that elevation component. Do we need to always pump it so high?

So another one is, and this is on that pressure drop, this is on the friction side of things, okay. So that previous slide was on elevation, the other side of this coin here is on friction of our systems. And there's a couple big ways to cut at friction factors, and the two that I am gonna show you, at least on this slide, are really most impactful early on when you're designing the pipe layout and the pipe flow, okay. So these two that I'm showing here are gonna be a little bit more difficult in a retrofit application but for designers these are so important, so valuable in terms of setting our systems up correctly.

So the first one is just using bigger pipes and ducts, okay. Because there's a major function factor here. To really simplify it, the pressure drop is a function of the diameter to the fifth power, okay. So what that means is if we are able to double the size of a pipe, okay, so if we double the size of the pipe, the friction factor, okay, the amount of energy that's lost and wasted trying to pump through that pipe is reduced by 97 percent. That is huge, that is massive, that's a lot of energy, okay, and so that's not something to be discounted.

A more, you know, at home example or way to think about this whole friction factor thing. For any of you that maybe go to the local grocery store or the local convenience store or you stop at the gas station on your way to work to get a coffee, right. They have those little coffee straws, those little red, super tiny ones, right. If you were to take one of those super tiny coffee straws, and then maybe you run over to McDonald's, right, and you get one of their big, fat frosty straws or whatever they have over there or the McFlurry, sorry, sorry Wendy's people. You know, you get one of those big, fat straws. If you try to, you know, push the same amount of air through each one of those, which one is going to take a lot more work? Which one is going to make you really struggle more? Or if you're trying to drink your coffee, which one is going to struggle a lot more? Well, obviously that much thinner one because of that friction factor. So it's the same theory in our industrial applications, okay. So that's one and this is a big one early one.

The second one is the opportunity to use smooth pipes instead of rough pipes. Not quite as big of a savings as say doubling the size of our pipes, right, but still some pretty significant things. So here is a common example of maybe using steel instead of – or using plastic instead of steel, okay. So maybe schedule 40 versus a plastic if you can use that instead. In this case, you know, roughly a 17 percent savings, if you can set the system up correctly upfront, okay. So these are a little bit in the system layout, system design phases but have major long-term impacts and ramifications for kinda the life cycle and overall life or cost of your facility, okay.

So I'm gonna switch gears just a little bit. Those were a couple examples on the pump side. We're gonna step into fans, and fans, again, it's the same fundamental theories that we're gonna go through, okay. So again, the same fundamental aspects of things. So thinking about our equation, right, volume flow rate, that pressure drop and then we have a constant and then an efficiency, essentially, all right. It's the same thing here.

So we have a motor efficiency, we have a fan efficiency that comes down in our fan efficiencies, and then we have a pressure and a flow. These are our top items. And so we're gonna focus on a couple of things here that we can do on each of those fronts, okay. Just to reiterate or hammer it home I guess I put it in here one more time, you know, the fan power, again, it's that flow, it's the pressure, it's the fan efficiency. If we want to add some other things in there in terms of our motor efficiency, drive efficiency, they all just fall underneath in that denominator.

But it's the same fundamentals, right, reducing flow, reducing pressure, those are the big ones. The last one are increasing our efficiencies, so that's for really our equipment, okay, increasing equipment efficiency. So we're gonna step into some of this stuff here in a second.

So similar to the pumps we're gonna show fans. We did a lot of fan assessments in addition to those pump assessments. There is a lot of really good information in our database. What you can see here, it's the same general approach to a lot of these things here. Everything from using variable speed drives to shutting off pieces of equipment or changing the drive types. So already we're seeing just a little bit more maybe on the equipment instead of the fans themselves or the systems themselves, but you can see once we get in here, you know, there's some improve the arrangement of like the air intake. So there is this system effect in there that we're trying to get at. A lot of really good opportunities.

And you can see, I guess in comparison to our pumps, you know, our pumps were in the 30, 40, $50,000.00 range, in some cases the fans, there's much bigger energy savings. And you can see, even in terms of the payback. The paybacks are pretty analogous, you know. Everything – or most of the items here are roughly two to three years and there's a couple of them in here that are much less than that, okay. So some real opportunities in our system that we can be focusing on.

So similar to the pumps, I want to show you a couple of pictures and a couple just overall concepts, and in general, that are the same concepts that we had in the pump system, okay. So one of them that maybe is a little bit more common in our fan systems is in regards to our ducting, okay. So in the pumping systems we talked a little bit about, you know, changing the diameter of pipes, right, or changing the friction factor in pipes. In fan systems those things still apply but another one that is a little bit more immediate or apparent are the couplings, and really the twists and turns and bends and elbows that we see in fan systems.

And to be fair this is still very much true in our pump systems, okay, but ideally, you know, we want to use long and slow sloping bends if possible. And why, you ask, well, it's because of that pressure drop across that turn, okay. And here is an example where maybe on the bottom left-hand side, this is maybe a super common approach, right. It's just a 90-degree elbow in our system. They're everywhere, all the time, of course. But there are slightly better versions that we can use where it doesn't cause as much of a pressure drop, okay.

Because if – and I'm gonna try to draw this and I know it's gonna be a little bit tiny, but if you can imagine, you know, if we're pumping air, if we're pushing air with our fan into this thing, all that air is gonna come screaming in here, and for the most part a lot of that is gonna hit the wall before then being pushed down and around, all right. So some of it does get pushed down and a round but a lot of it just ends up slamming right into that wall and then gets pushed down, okay.

Well, obviously, you know, what do you think is a better way of moving the air around there? Well, you know, if we really need to stick with that 90-degree elbow, you know, we could use some of these little internal veins, that's what these guys are in here, to help direct the air around there. Or even better yet, we can start using some of these gradual elbows, okay. So long, kind of sloping gradual elbows.

And what that means in terms of our pressure drop, in terms of our loss coefficient, that's where maybe we look at this chart up above. So this very top line is that super common example, you know, this 90-degree elbow here, that's this guy. I guess the most amazing thing is that if we were able to use maybe a long, sloping elbow, right, so something like this, right, that's a nice, long, sloping elbow, not – it's not quick and fast, it's an order of magnitude in terms of savings for that pressure drop. So in this case, that 90-degree turn down to let's say this version, where it's just a nice little elbowed version, you know, at almost any one of these points is an order of magnitude of 1.1 for a loss coefficient down to .1, right. That's – these things add up and they add up to be a significant amount within our fan systems, okay.

So the same theory and fundamentals also apply back to that pump system. So if you have 90-degree elbows or if you have T's, those things are pretty terrible. It's kind of the same approach. If we can use long, sloping kind of sweet bends, of sorts, where it's not a hard 90 degree type of a change. Our pipefitters might not like that, you know, that's less for them to be welding and doing, right, but for our savings of our systems, for the optimization of our system, the less we have 90-degree elbows and T's in our system the better off we are. And at least in our fans that I'm showing right here, an order magnitude difference, okay.

So, why does this – you know, why do we see a lot of these things out there? Well, some of it's space constrain, but a lot of it is just kind of lack of maybe planning ahead of time. Here is a couple of really good pictures and examples that have been seen over the years. Hopefully you don't have too many of these examples in your facility. If you do, you might have some opportunities to really think about system changes, system designs, okay. But typically, I guess what you see are what you find in a lot of facilities. Maybe more so for fans than pumps is that you have just a little bit of space so you just shove it in there, you jam it in there and, well, we'll figure out how to get that piece of equipment to fix and don't really consider or think about the effects of all the additional piping and what that is doing to us in terms of our energy savings.

So, you know, everything from – you can see with your example in this top left-hand corner, it's shooting air out but immediately we're turning direction and all of them pumping into this T'd header, right. So there's a big pressure drop right here, we're just, you know, slamming that air right into the pipe all the time. But up here, you know, immediately the fact that we're turning and twisting nonstop that's not good. For our fan here in the middle, I mean that's super obvious, you know, that wall's getting blasted. But in here, you can see this whole thing is just twist and turns and turns and twists, and every one of those it's a pressure drop, okay, and those pressure drops, of you remember back to our equation, fluid flow times pressure drop, that's a big long-term impact, okay.

A couple more examples, things that are just super, unfortunately, common. So on the left-hand side here you can see immediately, you know, we're pumping out of our – we're, you know, moving air through our fan and immediately we're reducing that flow rate. And what makes matters a little bit worse even here is that when fans come out and when they're pumping a lot of air, their pressure profile really looks something a little bit like this, where almost all the air is being shoved out of the top. And in this case, we're cramming, we're bashing, we're smashing and really constricting the ability of that fan to deliver and perform, you know, such as the manufacturer had initially intended and designed it for. So poor configurations, poor design can really hamper or hinder what you're trying to do in a system, okay. So it's not just a set it and forget it type of a deal here with fans.

On the right-hand side, here is a really good example of something where the designers made it easy, they made it simple for the fans to work with the lowest possible flow. And in this case, they maximized the size of that intake, okay. And so at least on this one, unfortunately, this is the same fan here, but on the inlet side really good, on the outlet side not so much, okay. So things to kinda consider, maybe look for in your own facility, okay.

So here is another example and this might be one of the worst that we've seen, but some of you might like to go to the city and go to bars. There is something called dueling pianos bar, right, where two people will get on pianos and they have a little musical battle. Well, this is our dueling fan scenario, not quite as musically enjoyable here and no one's leaving really happy because what's happening here? Well, both of these fans, for whatever reason, are being faced directly at one another. So where are they pushing air to, right. If one's not working and the other one is, it's literally just trying to spin that other fan backwards, okay, because not much of the air is being directed and pushed into the stack or the column, right. They're just constantly battling one another.

So this is just a really poor initial design, right, and you know, this is definitely a case where as a manufacturer or as the end user, you're not getting anywhere near the rated value of what those fans can provide and it's not due to the fan's fault, it's just poor installation, okay. So installation can have a really big effect on some of our systems, especially fans.

A couple other things to note or be cognizant of is that if you get into some larger fans that are maybe specialty built, a lot of large fans are, you know, the manufacturer will really do their best to, you know, give you that fan curve, to tell you exactly how that fan is going to operate. Well, based on some of these examples that I've shown you, you really need to maybe kind of follow up and do some field testing just to confirm the performance of these things, okay. Because here are opportunities for just making sure, one, the system's right, but also making sure you're using the right piece of equipment. In this case, you know, up at the top I'm saying some high efficiency impellers. Certainly with fans there are different types of fans that you could be putting in there and they have a wide range of efficiency depending on what you're trying to do.

You know, if you're trying to move parts or scrap material, right, that will dictate, you know, maybe this design or type of fan that you need, something really robust, maybe not quite as efficient, you know. So some things to be considerate of. But looking or thinking about the efficiency of the actual fan itself, okay. All right.

So another thing, and this is, again, big items but it's part of that flow, okay, is really some of the leakage in our system and trying to make our ducting tight, okay. Most of us – you might have heard about, you know, something like this in your house or your home, right, sealing ducts so you're not losing air. And within your homes it's important because, well, you're paying a lot of that energy to either heat or cool that air, but in addition, you're also paying extra energy in your fan to push air where it's not needed, okay.

And so with ducting, specifically, that can be everything from, you know, holes that were put in to do maybe some measurement that we're gonna talk about in a bit that weren't patched over or plugged up. There is obviously seals and seams that may or may not be sealed correctly, but all of these things have a pretty big impact because, if you remember back to our equation again, work is our flow and the pressure dropping.

So if we're pumping more air than we need then we're using more energy. And if you think back to our flow, our – let's see, our pump curves and our system curves, you know, if we're using more energy, right, it's just pushing us further out, okay, and then our energy consumption goes up, okay. So these are things to really be cognizant of. They seem small but they can have big impacts. All right.

So I'm gonna get into a couple here that I really want to stress these are common opportunities in both pumps and fans. So now we're starting to maybe narrow back in and come back together a little bit in terms of some of the opportunities. So with both of our systems, one of the big things to look at is really how we are controlling the flow, so either controlling the flow of our pumps, of our, you know, water for most of us, or the flow of the air, okay. It's the same, again, general concepts, just a different piece of equipment, we're talking about a valve instead of a damper, okay.

And so these are all the same, though. These are all really common for the most part. So here are some really inefficient flow control methodologies. One that I've seen time and time again in many facilities and really in a lot of injection molding facilities in their cooling systems is that there is a bypass loop. The bypass loop might be all the way out at the very end, okay, and it's just trying to help maintain some pressure drop across these things, the problem is, it's just locked in place and there's always a volume of unneeded or unused liquid that's being pumped around the system.

Another variation of that would be either a discharge damper for fans or in our pump systems this is three-way valve, and it might be, you know, literally coming almost right out of the pump itself where we're diverting some of that and it's gonna be recirculated back into the pump, okay. So really poor control here, okay.

So another one, and these are super common and we've talked about these a couple of times here, are our flow control valves, dampers, okay. So really controlling on the output side of either a fan or a pump, okay. For a fan system, it's just an outlet damper, right. You see 'em all the time. Specific to fans, though, you can also have inlet dampers, so these inlet veins, so it's on the suction side. So you do that in fans, you don't do that in pumps because that's where you get cavitation, maintenance nightmares. But there is some slight savings across all of these, so – you know, and we're just bypassing. We're not changing anything for that flow rate at all, right. So there's no energy savings in that control type. On the outlet side, this is the super poor control, you save a tiny amount but it's not good, it's still pretty terrible. For fans, we have a little bit better option with these inlet veins so you can throttle things on the suction side, okay. But there's better ways for all of these that we can be thinking about or using.

So for pumps and fans there is a couple again common opportunities or common fundamental strategies that you can use. So one of them on this far left-hand side is trimming our impeller or you might have a D-Tip that's what they call it for fans. So you effectively reduce the size of the diameter of the pump or the fan, okay. And when you do that it's a one-time fix, right, but it can change and take you from one operating point to another operating point. And certainly this is a good practice if you have massively oversized or mostly oversized pieces of equipment that you never run up to its full potential, right. If you're just stuck and you know, that outlet valve is always 30 percent closed, right, and it never changes, well, that's an opportunity where you can open up that control valve, you come in, you trim the impeller so essentially you grind it down a little bit.

Another approach, and this is maybe a little bit more common for fans, is within our drives. So for a lot of fans typically they're belt driven, right, and you can just change the size of the pulleys in there and that can have the same effect that the trimming the impeller can have in that you are just doing a one-time speed change of that device, okay.

And so it's a one-time fix. It's good for situations, again, where you're just operating at a constant point, you're not really changing and varying too much.

The more maybe appropriate approach for systems that have a lot of variability or some variability or you might expect to change in the future, right, based on production levels, are VFDs, variable frequency drives, variable speed drives, and then setting them up in our system to only provide what is needed. So in this case, if we go back to this bypass valve example, closing that bypass valve, putting in a pressure differential across our system to make sure that we're always getting enough flow through each of our processes. This is gonna allow us to, you know, go up and down to meet the needs and still be super flexible, right. So we can always essentially be best optimized for our system, okay.

Specific to fans are the system setups, these are the inlet and the outlet system effects that are experienced in fans, most frequently, but you might see something similar even in pumps here. It's kind of a congested little mess. But on the left-hand side are what we're saying, no, this isn't that great, right, it's not the best type of a setup here. And these are, for the most part, hard angles, right, these 90-degree angles and elbows, and you can see the air just kind of comes and slams against the wall and then it has to turn and get pushed around. It's just like a bad mob of sorts or a bad mosh pit, right.

And similarly with fans, because there's this directionality of the fan and where that pressure profile is created, there are poor ways to set this system up versus slightly better ways. So on the left-hand side are the poor ways, on the right-hand side slightly better, okay. So having our elbows, having the inlet veins, the turning veins in there to help direct the air. And then even setting up the box on the inlet side as well as the outlet side to just maximize the airflow through our system, okay.

But I think by and large, and most of us probably know this, variable speed drives are about the best option that you can have for a system retrofit or if you're buying new. These are really important maybe to have on at the very front end of things because certainly for systems that vary the load or vary their requirements that are needed on a pretty regular basis, this can help us be dialed and to always be the most efficient, okay.

With that said, there are some examples or some cases where you might not want a VFD on your system. If you're always running a motor full out and it's, you know, never changing or anything of that nature, right, if you're never throttling back any of the flow, a VFD could hurt you a little bit because there is an efficiency loss on that VFD. But any time you're running below kinda the stated values, the manufacturing points for that piece of equipment VFDs really do provide a pretty tremendous opportunity for saving and optimizing our system not only from an energy but from a maintenance cost reliability standpoint as well. Okay.

So those were a lot of the system fundamentals. We've gone through all of them for the most part. Hopefully you saw that there's common fundamentals, right, but there is a couple differences, right, because, you know, we're dealing maybe with water versus air. But it's the same general fundamentals if you were able to follow along.

So this next section that we're gonna get into is just some of the useful diagnostic tools to, you know, maybe help you quantify some of the opportunities that, you know, as we were going through those opportunities and as you were thinking through, you know, maybe the examples I was giving. You know, if you have one of those in your facility, you know, how do you go to that next step? If we were to change it what's the savings, how do I get to that point? Okay, so I know the best practice but what's that next step to maybe get to a cost savings?

Well, one of the things I want to spend a little bit of time on are our diagnostic tools. So there is different diagnostic tools depending on which system you're looking at, but these things are immensely powerful. I want to really focus on some spot measurement tools and even focus on some of the things that we have available to Better Plants partners through our diagnostic equipment program.

So the DOE, through the Better Plants program, and again, we've been doing a lot of energy assessments over the years, and as part of that we have a large, I'll say collection of diagnostic equipment. And this is just a picture of a couple of those things, but we have a lot more available to you and if you do think of some of these opportunities, you can borrow them for free and I would really implore and recommend that you look into this opportunity to borrow some of this equipment, take the measurement and then just return it without breaking it, and you know, life is all good.

But a couple of the pieces of equipment that you might want to look at depend on which system you're looking at. So we're gonna start with fans real quick and talk about just a few items. So on really low pressure systems, maybe if you have a furnace and you're trying to, you know, watch the furnace draft, you know, how much air is being kinda naturally sucked up through the thing, we're looking at either draft gauges or these inclined manometers.

So these are really low pressure, under one inch of water column and they're pretty simple. It's a basic – really basic principle where you're just watching the height change with that water column in these guys and that's what's going to be translated into that pressure differential, that it goes back to our equation, right. So these things are relatively simple. They're a little bit foolproof for the most part, as long as you get 'em set up and as long as you can get 'em level and everything. But again, they're really low pressure systems, okay.

Another, getting into slightly higher pressure systems, another tool that is super common within fans are our pitot tubes. So on the left-hand side, this is a picture of a pitot tube and the way that this typically works is that you shove this guy into a stack or a duct and maybe I'll try to draw this as best as possible here, but let's say we have a duct right here with an airflow coming this way, right. So these guys over here have just little tubes that are gonna go over to a manometer, okay. And so what is gonna happen is that this pitot tube is gonna sense two different pressures within the tool.

So one pressure is just this total face pressure, it's a total pressure, okay, and so there's a hole right here at the very tip. But in addition, this is like a tube inside of a tube, okay, so in addition to that hole in the very front, there's some holes around the side of it, okay, and that's gonna measure our static pressure, okay, so how much pressure is just pushing out along the duct, okay. And when we take the difference of those two, all right, that's gonna give us a pressure velocity. And so if we want to really use our pitot tubes to do some basic measurements, we use those two pressure measurements and we use our manometer to just measure that and turn that into a signal.

And then we use this equation on the bottom that we can pretty quickly determine what our gas velocity is, so what the velocity is through that duct. And then if we kind of multiply that by an area, all of the sudden we have a volume flow rate, okay. So super useful, these pitot tubes, super foolproof for the most part, really powerful pieces of equipment.

And then another one that we have are our fluid manometers, okay. On the left-hand side, these are something we call slack tube fluid manometers. Essentially it's just a tube that has some water in it, okay, and we would hook, you know, each side of this tube to that pitot tube or to one of these other manometers to essentially find out what that pressure difference is. Because if we hook both of these up and we're taking let's say a static or a total pressure, it's gonna push the water a little bit further in one direction than the other and then we use that pressure difference to – or that height difference to calculate our pressure difference.

So these are pretty convenient, super simple to use, can go to slightly higher inches of water column, in this case, if you buy one of the larger versions, you know, up to 60 inches of water column. So this is a pretty good piece of equipment and again pretty foolproof. You don't have to worry about batteries, so gotta love that.

And then I think as we're getting towards the end of these fan ones, the last one is really our digital manometers, okay, and they can – they have these things in really low pressure, they have 'em in really high pressure scenarios, but it's the same general theory that we're gonna hook in typically two different tubes or hoses to our pitot tube and we'll shove that pitot tube into our duct, right, and one of those measurements will be our total pressure, the other one's gonna be our static pressure, and these digital manometers can help us do that velocity pressure to really then calculate our flow rates.

So really good piece of equipment as well. We have these that are available to rent out. But in addition to that, we have a lot of other pieces of equipment. I don't think we put too much on the fluid systems but we have ultrasonic flow meters that are available. We have pressure transducers for fluid systems. So if we wanted to evaluate our pump, you know, maybe we want a pressure transducer on the front, on the suction side as well as on the outlet side and that can give us a pressure differential across our pumps. And then we combine that maybe with a power reading of our motor itself and we can really start to do a whole heck of a lot, okay.

So as I mentioned before, if you're a Better Plants partner, we have a lot of this equipment. We have data logging equipment to really be able to do some in-depth analysis, okay. And you might be thinking to yourself, okay, this is great, right. I know some of the opportunities now. We have gone through some of the diagnostic equipment that I might want to use. Well, how do I turn some of this data into kinda real-world stuff, right, real-world – you know, how do I still get to that dollars and cents for management and that's where I'm gonna move on to this MEASUR software tool.

So this MEASUR tool is a relatively new software from the Department of Energy where they've combined many of their legacy software tools into one really pretty flexible and open platform, okay. So within this, it's set up such that it can help us evaluate systems, okay, or we can just do some really basic energy calculations. So I'm gonna see if I can do this. I want to pull in the real thing here. So just really fast to give us a high level overview here.

Here is the MEASUR software tool, and what we have in there is the ability to do a system model, okay, where we can model a system, so a pump system or even a fan system that we've been talking about today. In addition, we have a couple of other items that are in here, other modules. But if we don't want to do a full system, right, we can just do some really quick calculations or use the calculators.

So maybe I'll start really quick, I just want to show some of the calculators. We have our motor calculators in here. I think there's 45 plus different calculators, really simple things in here that you can use to either look up system properties or equipment properties, as well as do some really basic energy saving calculations, okay. So we're scrolling down here. We went through the motors, pumps. There are some fans. I keep going, there's process heat and steam, a lot of compressed air in here. We've got some basic lighting calculators, as well as some general calculators, unit converters, right, some – like a cashflow diagram option. There is CO2 savings, if you're into that.

If I come back – maybe I'll jump into one really quick. Let's say our pump calculators, for those of us that are doing some pump stuff, if we need to figure out how to calculate that pump head, you know, there's like a couple basic calculators in here that help us to do that, you know, some diagrams, it tells us, you know, what information we need to enter in here, okay. And it can give us the results of what our pump head – what the value should be that we plug back into that equation, okay.

But we have other calculators in here. A couple really good ones on the motors that can help us on pumps and fans specifically. One of the options I think we looked at was maybe motor drives, so changing the type of drive we're using maybe on our fan system, okay, and what that energy savings might look like, okay. Some really basic calculators.

If I come back to the Home real quick, I do want to show you just real fast, I'll jump into an example of a pump system here, where, you know, maybe following the same approach that we've been talking about. If you do your own energy assessment and you look around and you've found some opportunities, and then you've collected a little bit of data on the system, you can come in and pretty quickly develop a system model using some basic assumptions, and then we can do the what if scenarios. So really fast I'll guide you through, here is a pump example.

This very top row here is our basic navigation, and then the second row is kinda the more in-depth navigation for each one of these steps. So under this first system setup, this is where we're able to develop the as-is system, so develop the system that's physically out in our facility right now, and this tool will help kinda guide us through that so we can set our different assessment settings or our units of measure that we want to use.

We come in here, we can define our pump and our fluids, so really this is the nameplate data that might be off of our pump, okay. Then we come in and we can define our motor data. Again, this is our nameplate data. So this is all super easy to get. This last component here is our field data, okay. So this might require a couple measurements, okay. So this is where we get into that diagnostic equipment and where we might want to plug in a couple of things, okay.

So once we've done that we have just created the as-is system into a system model, okay. The next step with all of these, though, is I guess the fun part, okay. Now that we've created the system model and we had some ideas in mind, maybe we wanted to change the pump type, we wanted a more efficient pump or we want to change the flow rates, right or put in a VFD, how do we do that? What do we need to do?

So this second step, this assessment aspect, there's two approaches that we can use. For most of us, we might want to use this novice view where it's really a checklist of items of these common energy saving opportunities, or alternatively, if you're a little bit more advanced you can use the expert view and just have everything in front of you, okay. Both get to the same end result here.

I'll come to this novice view and you can see, at least in this example, we have evaluated a couple things here. So installing a more efficient pump, okay. In this case we're gonna maybe reduce our system flow rate a little bit. And then maybe reduce our system head, okay. And so these things – these are set up in a way that it just quickly helps us to, you know, zone in on some of the things that we might want to evaluate, okay.

And then what we can do is we can save this stuff or we can view our report, and really quickly just start to evaluate what the opportunities are, okay, so really powerful. And in this case, I glossed over it, but in our assessment I've actually evaluated – or within the example we have evaluated four different options, okay, and so we can really quickly start to evaluate and see, you know, what's the savings potential if we do X, Y or Z, if we change the flow rate, if we change the efficiency of a pump, if we do this or if we do that, right. And quickly pop out, you know, okay, well, what does that mean for the dollars and cents, what does that mean to our bottom line, okay.

So it's a really powerful tool, it has diagrams in there, it has some Sankey stuff. It's connected to these calculators so we can pretty quickly start bouncing around. That was a pump example. Fans are also another option in here, and it's the same setup. You just define the as-is system, you know, what's out in the field right now based on really a lot of the nameplate data, and then we enter in some of our field data, and from there we can go into our assessment.

And you can see, I'm kinda clicking through this here pretty quick, but we have some built-in tutorials to help direct you, you know, where you need to go, what to look at, things like that. So when we're not here you can still move through it pretty fast. But the same concept, same theory, right. So here is a novice view for our fans. We're looking at a more efficient fan and a more efficient motor in this case and what does that mean for us. We can go over to our report and, you know, look what our savings opportunities are, okay. So pretty cool, pretty slick things. And we can save this in here, we can print some reports, some PDFs. Really good stuff. But we also have those equipment property calculators as well.

So I'm gonna come back to our presentation real fast and start to wrap things up. So really, just kind of a little bit of a recap of some of the things that we had talked about today for both of the systems. One slide here, a bit of the top ten savings measures for pumps and then I have I think a top five for fans, okay.

So for our pumps, in no particular order here, some of the big things, shutting down pumps when not needed. And I should say and note that these are very common ones that we've seen through thousands of energy assessments, okay, and so it's not just making things up here, you know, this is based on real-life data. So shutting down pumps when it's not needed. So asking that question of, you know, why are you, you know, pumping water. Do you really need that water, right, do we need the pump.

Operating a minimum number of pumps in a system, okay. So those two are really very much combined. Using VFDs instead of our throttle valves for controlling flow. You know, where are the opportunities in our system to not use a throttle valve, right. If we are over-pumping or if we have oversized equipment, is there an opportunity to trim or change the pump impellers, okay. That's a one-time type of a change. If we're just always throttled down on a valve, you know, is there an opportunity that we can just right-size the pump, okay.

So beyond that we have reducing the pipe and valve pressure losses, okay. So if we recall that could be, you know, upfront, the very first thing. If we're putting in a new system or a new addition, can we design it such that we have, you know, really large, big pipes with no 90-degree bends in there, right. Can we have, you know, healthy sized valves that aren't clamped down, okay.

So beyond that, though, we're getting into a couple of things that may be a little bit more maintenance related, but on our pumps, retuning our pump system to really verify are we optimal, are we at the right point after something has changed. Restoring our internal housing clearances. This is for our pumps, okay. Replacing worn bushings and the rings and really all the internal components of the pump, right, as that stuff starts to degrade and bring it back to its manufacturer's specified operating points.

And then once we get to the final couple here, these are much bigger dollar items, but installing new pumps, so maybe installing the right size or type of pump. And then possibly using more efficient motors, putting in efficient motors instead of standard efficient, okay. So these are costly items but certainly opportunities, okay.

So similarly on the fans, so there's opportunities similar on fans that we can look at similar to the pumps. You know, shutting down fans when not needed, okay. So for providing too much air through the system instead of, you know, throttling everyone down can we shut things off. Similar to pumps, instead of using our throttle valves, or in the case of fan systems, our dampers, are we able to use a VFD instead of dampers?

And maybe within our fan systems can we use inlet dampers. If you already have those in the system can you use those instead of the outlet dampers, right. In terms of our drives, can we use these cogged V-belts instead of a smooth V-belt. You know, these are small efficiency changes but a couple percent here and there can add up to big amounts over time. And the operating as close as possible to the best efficiency point, okay.

And then with fans, but similar to what we have already mentioned with pumps, you know, using the right or changing out the type of fan that you're using, more efficient motors, things like that, okay. All right.

We do have one slide in here, this is more of a reference guide, more than anything, just in case after the fact you really want to look for, you know, just some high level reference numbers. So these I think are pretty good but they're just basic rules of thumb so don't take this to the bank on every single situation but some of these are really good, and some of these conversion units down here for sure I think are really helpful and beneficial if you are looking at these systems and trying to do some of that basic back of the envelope calculations yourself, okay.

All right, so with that I'm gonna get to the end here and say that we do have a lot of resources, there's a lot of tools available for folks. Everything from source books for industry on pumps and fans, so these are really comprehensive guidebooks to give you all the right terminology, the lingo, kind of a basic overview of, you know, the different types of pumps, the different types of fans, the different types of control mechanisms, right. Just really solid, excellent resources.

But then we have our info cards and the cheat sheets through the Energy Treasure Hunts in the Better Plants as well as everything else. So a lot of resources that you're looking at. Certainly the software tools there at the end are all listed. Really good stuff.

All right, folks, all right. So we really do appreciate you hanging with us here. Hopefully that was fairly informative. For most of you a good primer really on pumps and fans. We are at the end of our hour and a half, and so really I don't want to keep people too long. If there are questions, you can feel free to either enter them into the Go To Meeting Q&A or into the Slido Q&A box. But the one that I've seen is are these slides going to be made available and the answer, with all of our stuff, is absolutely. So the recording as well as the slide deck will be available up on the DOE website likely in a week or so.

But you can find the slides for this one as well as all the past webinars up on our DOE website. And so with that, actually I think we're just probably gonna call it a day here. I do appreciate everyone sticking around. Be sure to register for our webinar next week. The one next week is gonna be run by my colleague Sachin Nimbalkar and he's gonna be talking about Process Heating and Waste Heat Recovery. So we've got some really good stuff lined up over the next several weeks, hopefully you will all be able to join us, invite a colleague, you know, get some of the new faces out there trained up in energy efficiency, right.

So with that, I want to thank everyone, take care, be well, make your facilities efficient. Thanks, everyone, bye-bye.

[End of Audio]