

Eli Levine: Hello good afternoon everyone, thank you for joining us today will give you all one more minute to let the room fill up and then we'll get started with today's exciting webinar so thanks so much to stand by.

Eli Levine: just stay in Bible give it another one minute until we get started at one or two.

Eli Levine: All right, well welcome everyone, thank you for joining us today we're very excited for today's topic understanding your utility bills focused on electricity, this is.

Eli Levine: As you know, this is part of our energy awareness month webinar series, where we have a variety of different topics, this will be one of three.

Eli Levine: That we have coming up about understanding all of your bills so we're focused on electricity here and there'll be future ones on natural gas and water.

Eli Levine: As a reminder, and if you've been with us before you've heard this announcement before, but the zoom call is being recorded and we can we intend to post it on our website and share it with all of you who.

Eli Levine: All of those of you who may have signed up that aren't able to make it well with us live, you can go back and watch the recording so just be aware of that and know going in that.

Eli Levine: you're presumed to consent to the recording and use of your voice or or image next slide so, as I said, we are very excited to have you here.

Eli Levine: I guess I should introduce myself, my name is eli levine I lead the better plans program today is a very exciting day for the better plans program as we've released our annual report.

Eli Levine: detailing how our over 250 partners have saved over \$9 billion \$9 billion and cumulative energy savings and 1.9 quadrillion BT, which is the equivalent of all of the.

Eli Levine: Electricity that the state of Wisconsin uses for a full year, so I encourage you to go to the dealer website to the better plans website to read more of the report and to.

Eli Levine: If you're a better plans partner to highlight your participation in the program share the report let's really get the word out about all of our amazing partner accomplishments but.

Eli Levine: Why we're here today energy awareness month and series of webinars, thank you for joining us sign up at that link at the bottom yes events energy awareness if you're liking these webinars and want to keep attending them for the rest of the month next slide.

Eli Levine: This is the schedule We are halfway through by participating today, so we have one on understanding your electricity bills, with three more to come after this.

Eli Levine: Just a quick notice, we all suffer from you know being are many of us suffer from zoom fatigue or being stuck at home.

Eli Levine: Please your feedback as well appreciate it, let us know, if you like, these webinars if you'd like for us to continue to do these webinars if there's different types of webinars you'd like for us to.

Eli Levine: To have or anything else that we can do to better partner with you and support all of us towards our goals of industrial decarbonisation and tackling the.

Eli Levine: climate challenges we face, so, as you know, hopefully, if you've been here, please use the chat for all of your questions.

Eli Levine: We will answer them at the end and as they are pertinent as great as our presenter is talking.

Eli Levine: We may stop it interrupt him to have to answer some of the questions in real time, so we want to see a robust discussion and ample partner participation so ask away, and if you want to learn more.

Eli Levine: Here is our website where you can engage and find all the documents, including the how to understand your utility utility utility bills for electricity on the website next slide.

Eli Levine: So it's with my great honor to introduce our presenter today, Chris price is one of our really stand out technical account managers based at oakridge now national lab for the better plans Program.

Eli Levine: Chris received his bachelor degree from Johns Hopkins University and his PhD from Texas a&m and mechanical engineering, with a focus on advanced control systems.

Eli Levine: Chris does a number of things for oak Ridge national lab including authoring documents, like the one who's presenting about today and presented about.

Eli Levine: Earlier this week on the updating the baseline and energy intensity and tracking guidance document Chris also works with a dozen.

Eli Levine: Better plans partners on everything from helping them set their ambitious goals to understanding their energy used to tracking their performance and.

Eli Levine: And ultimately implementing their sustainability strategy so very excited to have Chris with us here today and also excited honestly to turn it over to him and.

Eli Levine: mute myself and just listen to the presentation so Chris Thank you so much for your work and presenting this document and being with us here today to present everything to the group.

Christopher Price: Right, thank you, we like to.

Christopher Price: see if I can get to the next slide there we go.

Christopher Price: So as eli said this presentation is going to be on your electricity bills how understanding them can help you identify cost saving measures and energy saving measures.

Christopher Price: really just from using your bills to track your energy consumption.

Christopher Price: This pairs pretty well with the webinar that we did on Tuesday on energy based lining and tracking a lot of the information that you would use to make.

Christopher Price: Your energy baseline is going to come directly from your electricity bills or for the upcoming webinars on natural gas.

Christopher Price: You would also use those as well, but before we get into that document, I just want to give you a brief overview of the better buildings better plans Program.

Christopher Price: Many of you are probably already partners so For those of you that aren't just want to show you how this fits in with what we do as as a program.

Christopher Price: So better buildings better plants it's a public private partnership between the Department of Energy and US based manufacturers.

Christopher Price: Our main goal is to help all of our manufacturing partners, be more competitive, to be more profitable and save resources.

Christopher Price: The primary way we've done that in the past is by focusing on energy efficiency measures and tracking energy intensity over time.

Christopher Price: And recently we've been adding in different missions like trying to reduce water usage reduce waste production and we're even starting to move into the carbon accounting space.

Christopher Price: The way that we support manufacturers and reaching these kinds of goals is through various technical support and.

Christopher Price: and knowledge here, so there are four main problems that we provide support in the first is going to be our no cost software tools and guidance documents right now we have over 60 calculators.

Christopher Price: Very cool program called measure that includes a lot of those already, we have our diagnostic equipment loan program our financial navigator to help you implement projects and then a whole series of guidance documents, one of which we're talking about on this webinar today.

Christopher Price: The other component of this is going to be our training programs, we have our implant trainings where we come to your facilities.

Christopher Price: We provide your your staff and your workers, the technical background for how different.

Christopher Price: Processes work and then do energy audits and assess projects in your facilities with COPA we've switched this over to a virtual training model all of those.

Christopher Price: That we've done so far, online, you can go back and watch those trainings whatever you want to their hosted on our dropbox they're a great resource for.

Christopher Price: Identifying projects and learning about your systems, and we also have an ever growing catalog of webinars and other presentation on energy efficiency, including this one, which will get loaded later later this week.

Christopher Price: The third part of it is recognition.

Christopher Price: We know that working on your energy efficiency is a difficult job, and we want to recognize partners for their efforts so so far we've had 59 partners reach their.

Christopher Price: Better plants goals they obviously received recognition from the Department of Energy but along the way, there are opportunities for better project awards better practice awards, we also have our.

Christopher Price: online media social media presence, where we can do some.

Christopher Price: work with you to advertise the projects that you're working on, and we also have our solution Center which has over 350 individual solutions and case studies that you can go back and review and.

Christopher Price: see what other partners are doing the last part of this eli mentioned that I work here at oakridge national laboratory.

Christopher Price: In Tennessee the Department of Energy operates a lot of other national labs across the country, one of the benefits of working with the better plans program is you get access to all of the research and analysis that's being done on advanced manufacturing right now.

Christopher Price: So if you want to see what's coming next for manufacturing we're we're here we're a Department of Energy it's a it's a public use.

Christopher Price: Facility, so you able to come see what we're working on and maybe implement in program the other part of this is our field validation program we are working with partners to identify.

Christopher Price: New technologies and help reduce some of the risk of implementing new energy efficiency technology so those are four main categories for how we support our partners.

Christopher Price: So what this looks like is right now that are plants has over 250 partners across all 50 states and territories in the United States, so we have companies, these are just a selection of a few of them you'll see that we have industries from brewing.

Christopher Price: To pharmaceuticals to cosmetics to automotive manufacturing and even some local governments and wastewater treatment facilities.

Christopher Price: This is really just to show all of the networking opportunities that are available to you through better plants.

Christopher Price: you're not only able to talk to direct competitors and see what they're doing and try and be more competitive, that way but you're able to see what other industries are doing to save energy.

Christopher Price: And maybe implement some of their best practices or there may be a technology that you're they're using that you didn't that you weren't aware of so you're able to leverage, all of this knowledge of having all these different partners to help you save energy.

Christopher Price: So better plants as a whole, hopefully, you can see how this series of guidance documents and webinars fits into what we're trying to do here.

Christopher Price: So the webinar today is just one in a series of guidance documents that were released this month, this first one is on electricity billing.

Christopher Price: Next week is going to be the webinar on the natural gas billing document, and then the week after that would be the one on water billing these are really meant to help you analyze your bills and then save cost and hopefully identify energy saving opportunities.

Christopher Price: The way you would use this guide and the the way that we tried to put this together is really to give you a thorough understanding of.

Christopher Price: How electricity is generated why you are build the way you are, and then to help you identify ways to avoid those costs and save energy, so.

Christopher Price: If your bills were simple wouldn't mean to have a guidance Doc so the reason we put this together is that electricity bills are often very hard to decipher.

Christopher Price: Some bills can be very long and detailed they'll have a separate line item for every charge that appears on your bill.

Christopher Price: I have seen bills were literally only the total is listed.

Christopher Price: And you have to really dig into them to figure out that's what my kilowatt hour consumption was that was what my demand was.

Christopher Price: So, because everyone has a different utility provider everyone's bills are different, it can be somewhat complicated to figure out how to dig into those bills and use them to your advantage.

Christopher Price: In addition to that some charges can appear every single month others don't, so why would a charge show up one month and another.

Christopher Price: And really what we're trying to do with this document is to help you understand all of those reasons, so why utility charges those different fees and then use them to save.

Christopher Price: Energy and cost, so the guide is going to cover and this webinar is going to cover for basic things about the utility bills, which will lead to an understanding of the electricity bills and that's the energy generation component.

Christopher Price: The rate structure components, so your actual contract for your energy usage trends, how you can use your energy trends, to avoid certain costs in your bills and then ways to identify efficiency opportunities.

Christopher Price: So stepping right into it first part of this is going to be the energy generation side that electricity is going to come from many different sources for most.

Christopher Price: States most locations across the country it's going to primarily be a mix of coal power nuclear power and then gas and fuel fuel powered turbines.

Christopher Price: You may depending on where you are like here in Tennessee with the tba there is an abundance of hydro power there have been a lot of investments in wind and solar.

Christopher Price: So your particular mix of energy and electricity sources can be different depending where you are at.

Christopher Price: Now, the cost of generating electricity from each one of these sources changes all the time, it can change over the course of a year and it can change from day to day, depending on the cost of fuel.

Christopher Price: Your utility is going to take this generation mix and it's going to manage which plants are operating and how much energy they're generating to try and balance, how much they're making with how much needs to be used.

Christopher Price: They do this in two primary ways I've divided the sources into baseload plants and then peaker plants so basically plants are.

Christopher Price: generators that normally produce a fairly constant amount of energy they're usually very slow to respond to a signal to produce more energy.

Christopher Price: So they're really good for just a solid amount of electricity that that is being provided the peaker plants are ones that can respond much more quickly, they can turn on an extra generator they can have more turbines more wind turbines operating to produce more energy.

Christopher Price: The costs are also different between the the peaker plants and and the coal powered nuclear power, the baseload plants.

Christopher Price: So the utility is going to look at this mix of energy they're going to say here's what we need for our baseload here's what we need to fill in the gaps.

Christopher Price: here's the relative cost of each one of these, and then they're going to deploy the energy as they need it.

Christopher Price: So, in general, things like wind and solar there'll be the cheapest just because they don't have any fuel input their their renewable energy sources.

Christopher Price: coal, nuclear power gas those tend to be a little bit more expensive, so the utility is going to balance all of that.

Christopher Price: So when that energy is generated, it is distributed to your facilities, through the grid, so the grid it's it's a series of connections, a lot of substations a lot of transformers.

Christopher Price: It gets the energy from where it was produced, all the way to your manufacturing plant.

Christopher Price: And it's important what's important here is because we don't have a lot of storage on the grid right now and that could change in the future.

Christopher Price: When that energy is generated, it needs to be consumed pretty much instantaneously, which is why you have that balancing act with the baseload and the peaker plants.

Christopher Price: So that's just an overview of how you get the electricity. The next question on the generation side is what kind of market are you in.

Christopher Price: There are two main kinds of markets here, there is a regulated electricity market and a deregulated electricity market. In regulated markets, your utility is going to control and operate everything from the generator all the way through to your meter at your physical plant.

Christopher Price: So there is a lot of stability involved in a regulated market; they're usually regulated by state and federal agencies.

Christopher Price: Pricing structures are pretty stable and you can make a lot of plans and a lot of plans for the future based off of that energy price because it's not going to change by that much.

Christopher Price: In contrast, a deregulated electricity market is one where the energy generators and the energy distributors can be completely separate.

Christopher Price: So you could purchase electricity from one generator who delivers it to the grid, then another entity is going to be in charge of getting that power to your plant.

Christopher Price: The main goals of deregulation are really one to lower the cost of energy through competition if you can buy that electricity from multiple sources.

Christopher Price: It should drive down the cost of electricity, the second goal is really to promote green energy, if there are less barriers to.

Christopher Price: Putting green energy on the grid if anyone can get a permit to start generating energy and put it on the grid is the idea that you can adopt renewable energy green energy more quickly.

Christopher Price: The downside of a deregulated market is that it can be a lot more complicated than a regulated market, you have more choices, you have a lot more management that you need to do.

Christopher Price: And so you might have multiple bills, you could get a bill from the generator, you could get a separate bill from the distributor.

Christopher Price: Depending on where you are, you could even have like a last mile distributor to get that energy to your actual plant so you may get instead of one bill, you could have three.

Christopher Price: So you need to be, you generally have to have a lot more management of your energy consumption in a deregulated market.

Christopher Price: So right now there are currently 15 states in the water and Washington DC.

Christopher Price: That are deregulated markets so depending on where your where your manufacturing plants are you may have more options for purchasing electricity than you thought.

Christopher Price: one caveat is, if you are in a city that has a cooperative usually deregulated markets exempt local utilities from the deregulated market, so you could be, for example in Texas, but you may be in the San Antonio.

Christopher Price: or Austin co op district, and you would be outside of the deregulation there so depending on where you are, you may have more options.

Christopher Price: So, with the generation and the market side we're going to start digging into the actual bills.

Christopher Price: And if you look at an example bill here there's going to be seven key components that are important to keep track of.

Christopher Price: The first is going to be the meter number sub meter some some bills will only have one meter on them.

Christopher Price: Some companies, if you have multiple meters will pull it all put it all on the same bill.

Christopher Price: So when you're looking at the at the bill itself it's important to figure out how many meters, do you have and what those meters correspond to is it a particular process is it a particular building so being aware of.

Christopher Price: How many meters, you have and which meter you're looking at on the bill is important, the second thing is going to be the actual meter readings, these are, how much energy, did you consume What was your demand that's what you would track over time.

Christopher Price: The third thing is going to be your power factor we'll talk more about what this is on on another slide but, having a low power factor is going to be something that could penalize you and you may not even know it.

Christopher Price: The fourth thing fixed charges, these are things that appear every month and they're not related to your energy consumption, so something like a customer fee a metering fee, they are on your bill but they're not energy related.

Christopher Price: Consumption charges, these are related to how much energy you use and demand charges is related to the rate at which you use that energy, so you.

Christopher Price: could have different blocks of charges, they could be mixed up, they could be separated out but understanding which charges are consumption based which are demand base is very important.

Christopher Price: Then the last part of this is going to be taxes fees and penalties, the goal would be if you know what the penalties are hopefully you can start avoiding them in the future.

Christopher Price: So digging in here first thing we're going to talk about is consumption so consumption is the total amount of electricity, that your facility uses to make product.

Christopher Price: it's going to be measured in kilowatt hours it's a combination unit compound unit, so it is equivalent to one kilowatt of power, sustained for one hour that compound unit becomes important when we talk about demand.

Christopher Price: It can appear on your bills with various different names, it can be called an energy charge and energy costs are delivered energy charge.

Christopher Price: There, there are many names for this, but it would be related to the kilowatt hour consumption that appears on your bill.

Christopher Price: And you'll you'll figure that out in the bill or your contract by looking for things that are built on \$1 per kilowatt hour basis.

Christopher Price: Now, your utility will come out and read your consumption every single month they'll come to your meter there look at it there's some examples of different meters on here, so you will have.

Christopher Price: That monthly meter data, but if you know where your meters are, and you know how to read that meter you can go out and read your meter.

Christopher Price: Every week every day, every other week you can start to gather more information and with more granularity than what you get just from the bills and you can do it on a regular basis in a way that your utility may or may not do.

Christopher Price: So, moving on to demand charges, we talked about how much energy you use and kilowatt hours industrial facilities and a lot of large commercial facilities are also going to be charged for their electrical demand.

Christopher Price: and demand measures, the rate at which you consume electricity so.

Christopher Price: A facility that uses X amount of power, but it's spread out over the day the utility doesn't have to build as much infrastructure, they don't have to put in, forgive me a bigger electrical pipes.

Christopher Price: For a company that uses X kilowatts but in a very short amount of time, so the way your utility is going to calculate demand.

Christopher Price: Is there'll be a separate meter that is going to calculate your average energy consumption over a given window normally that's 15 minutes, although it can be 20 minutes or 30 Minutes it just depends on what kind of metering your your utility does.

Christopher Price: So, for example, you could watch your consumption meter time it over a 15 minute window if it goes up by 25 kilowatt hours and 15 minutes.

Christopher Price: divide the kilowatt hours by minutes change minutes to hours 25 kilowatt hours and 15 minutes is 100 kilowatts of demand.

Christopher Price: So this is essentially what a demand meter is doing it's sitting there it is constantly resetting and counting every window how much energy you use and then average averaging that.

Christopher Price: So more demand like I said means more infrastructure that the utility has to build and maintain to get you your power when you want it, which is why the utility charges you more if you have more demand.

Christopher Price: Like consumption demand appears on your bill with several different names, it can show up as demand charge demand cost transmission and delivery charge.

Christopher Price: It can have a lot of different names, but it's going to be \$1 per kilowatt type charge.

Christopher Price: Now I told you how you would figure out your instantaneous demand, but which window does the utility use to calculate your demand.

Christopher Price: Now, your demand will naturally vary over the course of the day, and what your utility is specifically looking at is your peak demand so.

Christopher Price: This chart shows you several different days it shows you a baseload demand and average demand both of those are nice to know.

Christopher Price: But what the utility is specifically looking for is over the course of a month, what is the 15 minute window that had the highest kilowatt demand.

Christopher Price: And then that peak is going to set your demand charge for the entire month.

Christopher Price: So really what that points to is that one spike in demand one bad 15 minute window not only sets your charges for the entire month, it can actually set your charges for the next year, so managing when you use your energy is going to be really important to saving costs.

Christopher Price: Now the utility is going to be measuring that 15 minute peak that value over the course of the month, that is your actual demand that's what the utility saw over the billing period.

Christopher Price: What your charges are based off of is actually build demand, which may or may not be equal to that actual demand build demand is it's an adjustment to your actual demand that is established by different clauses in your electricity contract your rate structure.

Christopher Price: An important note here is that built demand it's never going to be less than actual demand it's always going to be greater than or equal to.

Christopher Price: actual demand, so the the game here is that you want to make sure that your build demand is as close to actual demand as possible, so that you avoid those extra charges, so what are a couple of clauses that would increase build demand.

Christopher Price: One is going to be a ratchet clause, these are stipulations in a contract that generally fall into something like 80% of the maximum observed demand over the last 12 months, so, if you look at this example, there is a whole years worth of data.

Christopher Price: If your demand was constant every single month the ratchet wouldn't affect you at all, but let's look at July of 2020 it's that top bar there.

Christopher Price: You can see that the ratchet demand 80% of that peak goes up and then for the next 12 months the minimum demand that the utility will charge you for is 80% of that.

Christopher Price: So when you get your bills your build demand it's not going to be what your actual demand is, it will be at that ratchet demand.

Christopher Price: So the penalty for a ratchet clause is the difference between that ratcheted demand in your actual demand and, as you can see it builds up over the course of the year, and it can cost you extra.

Christopher Price: Something similar to this is going to be a coincident peak clause.

Christopher Price: So your facility has its peak demand, but a coincident peak is going to be, what is your facilities demand when the grid hits its peak so in this example the facility pitted peak around two o'clock in the afternoon the grid hit its peak around 7pm.

Christopher Price: In this case, because the facility was shut down, not a problem where you start to get extra charges is if your facility hits its peak at the same time as the grid that's when you can get those extra charges.

Christopher Price: related also related to this, some companies will charge you for for coincident peak demand what that is is during summer months a utility would call for peak events.

Christopher Price: and your facilities average demand at each one of those peak times is average and then used to set your for CP demand charges for the next calendar year.

Christopher Price: So you could hit a peak theoretically in July of 2020 and then not see the result of that peak until January of 2021 and then pay for it all the way through to 2022 so making sure that you avoid those peaks is pretty important to minimizing your build demand.

Christopher Price: So how do you manage demand.

Christopher Price: The the the game here is going to be managing your facilities load profile, so you would change when you consume energy to avoid hitting that peak.

Christopher Price: There are two main strategies to do this, the first of which is going to be load shedding you simply.

Christopher Price: tell people to unplug their computers your turn off lights you set back each fact units, maybe you turn off a piece of equipment.

Christopher Price: you're really trying to minimize how much energy you're using in a given window to avoid that peak.

Christopher Price: The other strategy is load shifting so you could take a process offline if you have the ability to reschedule and do that production later in the day.

Christopher Price: You can avoid that peak consumption and move it to a time when there is no peak or the electricity is cheaper.

Christopher Price: A lot of utilities will offer demand response programs to incentivize companies to do these kinds of strategies.

Christopher Price: And a lot of times those programs can provide you incentives, they can give you a little bit of extra money at the end of the year, depending on how you respond to those events.

Christopher Price: Better plants is working is going to be releasing a document in the next couple of months on demand response so if you want to know more about that stay tuned we'll have guidance on that pretty soon.

Christopher Price: The next demand related issue is going to be power factor.

Christopher Price: What i'm hoping to do with these slides is give you a general idea of what power factor is and why you're penalized for it don't feel like you have to understand the math behind it i'm just trying to give you the the flavor of why utility would charge you for a world power factor.

Christopher Price: So the way that AC power interacts with the equipment in your facility is going to affect how much power, the facility has to deliver to your plant.

Christopher Price: How much extra power, the facility has to deliver is captured by the power factor.

Christopher Price: Most utilities will penalize you for having a low power factor, because it means they have to provide extra energy to your plant versus if you had a higher power factor.

Christopher Price: Now power factor is going to be inherent to all AC circuits, but it can be managed and with the next couple of slides.

Christopher Price: Hopefully you'll see why here, so, if you look at a single phase AC signal here you have a time varying voltage with a magnitude and a frequency of 60 hertz a time varying current.

Christopher Price: With a magnitude and a frequency, but the current can be out of phase with that voltage and depending on the equipment in your plant that phase difference can be pretty small or it can be bigger.

Christopher Price: What does that phase difference mean well, if you look at instantaneous power if you multiply voltage by current.

Christopher Price: do some of the math you end up with an expression for instantaneous power that has two parts.

Christopher Price: The first is going to be real power measured in kilowatts this is actual energy that does work in your plant it lifts a pallet it turns a motor.

Christopher Price: It heats a building this is energy that is being used for work, the other part of this is reactive power which is measured in kilovolt amp hours reactive.

Christopher Price: This is necessary to operate your equipment, but it does no actual work so, for example in a motor for the motor to operate there needs to be magnetic fields, set up in the motor those magnetic fields don't do work but they allow the motor to spin so you need both of these components.

Christopher Price: The issue is that the utility doesn't just supply either real power or reactive power they actually supply a parent power to your facility and how much apparent power they supply is related to that power factor.

Christopher Price: The relationship is governed by the power factor triangle you've probably seen us before real power is on the bottom reactor power is over, on the right.

Christopher Price: apparent power, the thing that the delivery the utility is delivering to your plant is the high pot news of this triangle.

Christopher Price: The angle of the triangle is related to that phase difference between voltage and current so what you'll notice is that the apparent power is.

Christopher Price: The same as the real power or more so the more phase leg that you have the lower your power factor, essentially, the more apparent power, the utility has to supply your plant.

Christopher Price: So for a given amount of real work, the lower your power factor is the more apparent power, the utility has to supply and that's why you're penalized for a low power factor.

Christopher Price: Now power factor is usually listed on your bills directly, you can see it'll be a number, you can record overtime power factor penalties are very rarely clearly listed on your bills, so it can be difficult to know if you're even penalized for it and, in most cases, you probably are.

Christopher Price: How you're penalized for low power factor depends on how your build for that demand.

Christopher Price: If you are built based on real power so you'll know this, if your demand charges are calculated by kilowatt by kilowatts.

Christopher Price: you're you're telling you will have a minimum required power factor that's usually point nine five some somewhere in that range.

Christopher Price: You can calculate your adjusted demand power factor adjusted demand by multiplying your real demand by the ratio of the required power factor to your actual power factor.

Christopher Price: And the demand penalty for having a low power factor is just your cost of demand multiplied by the difference between the adjusted and real demand.

Christopher Price: Important here is that you are only penalized for a power factor that's less than the required power factor, so if you are correcting it, you would only correct it up to that minimum required you would never try and get it up to one.

Christopher Price: If you're building on apparent power, so how much energy the the utility is having to actually supply your plan.

Christopher Price: You are inherently penalized for any power factor, less than one and that's because from that power factor triangle, if you have any.

Christopher Price: reactive power in that power factor triangle, the apparent power is greater than the real power.

Christopher Price: The palantir here is just the difference between that build demand in cave ETA and your real demand and kilowatts you can just subtract one from the other units work out just fine.

Christopher Price: If you don't know me real demand, you can just take that build demand income level amp years multiply it by one minus your power factor and cost of demand.

Christopher Price: So, depending on how you're built for demand that penalty can show up in a different in a different way.

Christopher Price: So how much does a low power factor costume run through a quick example here consider a facility that has an average power factor of point eight five.

Christopher Price: The demand cost is around \$8 a kilowatt there is no ratchet clause if there was a ratchet clause, the cost would be greater because you're built demand could be adjusted that ratchet demand could be adjusted upward by the power factor adjustment.

Christopher Price: The utility requires a minimum power factor of point nine five and the average build demand is 150 kilowatts.

Christopher Price: In this example they're built on kilowatts figuring out what the real demand is you would use that first formula I showed you exit flip it because we're going to find real demand not the adjusted demand.

Christopher Price: When you work through it, what you'll see here is that every month the bill is adjusted upwards by about 90 kilowatts because the power factor is below the requirement.

Christopher Price: If you multiply that 90 kilowatts by the \$8 a kilowatt over the course of a year you're talking about 80 \$500 or more in penalties, because the power factor is too low, this just gets worse if your power factor is point eight or Point seven five.

Christopher Price: And you may not know that that penalty is there because it's not a separate line item on your bill.

Christopher Price: So how do you fix a low power factor well nearly all facilities have a low power factor, because they have large Motors in their facility.

Christopher Price: motors are just essentially large coils of wire, which is the definition of an inductor and inductor is caused the current to lag voltage so the way you would correct this is by installing capacitor banks on site to offset the the induction the inductive loads in your plan.

Christopher Price: There are two kinds of capacitors there is static capacitance which is cheaper and dynamic capacitance which is more expensive, the static.

Christopher Price: capacitance is going to provide a constant amount of capacitance the dynamic systems have electronics in them the let them vary the amount of capacity that your your plant has to fine tune what that adjustment is.

Christopher Price: So you would fix a baseload amount of phase difference you fix it really a baseload amount of power factor.

Christopher Price: With that static capacitance and then fix the remaining with the dynamic and that way you minimize the cost and typically.

Christopher Price: If you look at the ic the industrial says that Center database paybacks on fixing power factor are usually around a year to a year and a half they're almost entirely under two years.

Christopher Price: Other charges on your bills can show up in addition to those direct consumption and direct demand charges.

Christopher Price: One of the main things that you'll see is a whole bunch of writers and writers, are going to be modifications to your rate structure.

Christopher Price: So your rate structure may say that your consumption costs five cents a kilowatt hour a writer is going to adjust that up or down.

Christopher Price: Depending on certain parts of your contract here some writers, are only going to apply certain months of the year, so a writer may only apply January through March, which is why some charges could appear on your bills.

Christopher Price: at certain times of the year, and not in other times of the year.

Christopher Price: You can usually spot a writer because they'll they'll have a very descriptive name that tells you what the purpose of the writer is so that's going to be something like a renewable energy development fund.

Christopher Price: nuclear decommissioning charge energy efficiency cost recovery factor usually tells you what that that charges going for.

Christopher Price: writers can be built on your kilowatt hour consumption, they can be built on your kilowatt demand it just depends on.

Christopher Price: What the rate structures sense, so if you have a whole bunch of writers, you can go to your contract and you can see them listed out and then correlate that to your actual bills.

Christopher Price: we've covered a lot of the energy based charges, but there's also going to be a few kinds of charges on your bills, that are not related to energy.

Christopher Price: So the first of which are going to be fixed charges, these are built into your rate structure, those are going to be things like customer fees and metering fees they're not really affordable.

Christopher Price: they're just part of the contract, but making sure that you have the right schedule the right contract is important because the charge the metering fee can be different, depending on which plan you're on.

Christopher Price: Other non energy charges that can appear can be completely avoided, with a little bit of planning so things like late payment fees insufficient funds fees.

Christopher Price: If you work with your billing departments to make sure that you understand that your utility requires.

Christopher Price: Having your your your check in hand by the due date or if they just need to see that the bill was postmarked by the due date that can save you a lot of.

Christopher Price: Money over the course of the year, because essentially a late payment fee is just a very high interest loan for for your energy so avoiding those is pretty critical.

Christopher Price: The last one here is going to be tax related local taxes sales taxes those will be a certain percentage of your bill, an important note here is that at the state tax level.

Christopher Price: A lot of States allow manufacturing companies to to claim an exemption from state sales tax if they can show that a certain percentage of the energy on a meter is related to manufacturing.

Christopher Price: purposes, you would apply for that exemption by getting a predominant use study to verify that that percentage of energy for that meter is manufacturing.

Christopher Price: And some states will even let you claim two years of back taxes, you can get a refund for 24 months of state sales tax it just depends on the state that you're in.

Christopher Price: If the exemption exists, and if you can claim a rebate on past sales taxes so working with your utility to figure out if that's an option for you can save you some some costs there.

Christopher Price: we've gone over specific charges, the next few slides are going to talk about why those charges appear on your bills.

Christopher Price: So your utility is going to offer several different rate structures several different contracts in a document that's called a rate schedule.

Christopher Price: So all of the ways that they let people purchase electricity are going to be part of that rate schedule.

Christopher Price: Choosing the right rate structure is critical to minimizing your overall energy costs.

Christopher Price: If you are on a service that's too small, you can have penalties for using too much energy if you're on a service that is too big, you could get charged for not using enough energy.

Christopher Price: So, making sure that you're on the right schedule is very important to avoiding unnecessary energy spending some example.

Christopher Price: schedules that you might be on it you're manufacturing facilities exterior lighting for parking lots and outside walls.

Christopher Price: In general, most facilities will be on some sort of service designated as general service small, medium or large.

Christopher Price: The important thing with these is that there's going to be a criteria for a minimum amount of demand or a minimum amount of consumption to qualify for that.

Christopher Price: The types of charges that they have are all going to be different, some may not charge demand some a charge demand on kilowatts some may charge demand on kilovolt amp years so looking at the full slate of what is available to you can help you pick the right one.

Christopher Price: Now, in each one of those schedules, there could be a different pricing option.

Christopher Price: A very common one, is just a uniform pricing structure, the more energy you use your unit cost does not change, you could have a decreasing block structure, the more energy that you use the cheaper that energy becomes.

Christopher Price: You could have an increasing block rate, where the more energy you use the more expensive that energy becomes.

Christopher Price: utilities around the country are starting to do time of use rates, one of which is an on peak off peak rate structure so depending on the time of day, that you use that energy your energy costs could be more expensive.

Christopher Price: that's where managing your energy consumption, you could shift things to a cheaper energy time becomes important a new option that's starting to come out with smart meters and.

Christopher Price: More computing technology is real time pricing so rather than having us fixed time of day, where the energy costs, a certain amount.

Christopher Price: Real time prices fluctuate with the market.

Christopher Price: So, depending on fuel costs or weather events energy prices could vary all over the place, so knowing which one of these you're under can help you get to a cheaper energy blocks sooner.

Christopher Price: or avoid hitting a higher energy block entirely moving energy around make sure that you're getting the cheapest rate Those are all very important.

Christopher Price: Now, how do you calculate your actual cost of energy when you're starting to evaluate energy efficiency projects, how would you use your bills to estimate how much you could save and there are two main ways of doing this.

Christopher Price: The first is going to be a blended cost of electricity, this is very quick very easy to put together but it's only going to estimate savings from energy consumption reduction projects.

Christopher Price: So a blended cost is just your total cost of electricity over your total kilowatt hour energy consumption.

Christopher Price: That is going to roll into it things like demand charges and fixed fees it's just that if you had a project where your energy consumption does not go down you've just moved demand a blended cost isn't really going to capture that.

Christopher Price: More detailed way of capturing your cost is going to be a marginal cost, and that is.

Christopher Price: going to require that you really know your rate structure inside and out.

Christopher Price: So essentially what you would do with this is, you would look at your rate structure and you'd say here are all of the charges that are rated are related to kilowatt hour consumption and add those all together.

Christopher Price: And that is your dollar per kilowatt hour cost of energy you do the same thing for demand everything that's built on kilowatts you would add together and you would say every kilowatt of demand, I saved.

Christopher Price: here's how much money I would save so you can do it the quick way with the blended cost, you can dig into it with the marginal cost.

Christopher Price: So what does this look like, if you go back to that example bill I showed you earlier.

Christopher Price: There are three consumption related charges, this has blocked energy charges so energy charged one applies to the first 250,000 kilowatts energy charged to applies to every kilowatt hour above that.

Christopher Price: there's also a wider for energy efficiency, there are several demand based charges those apply to the built demand they're all listed there there's also a series of other penalties and fees on that bill.

Christopher Price: So, looking at the cost of energy for that bill the blended cost for that bill is just \$32,000 over 420,000 kilowatt hours, the estimated cost of electricity, the blended cost is about.

Christopher Price: eight cents a kilowatt hour, and that includes demand and all the other charges in there for the marginal cost because it's on a block structure.

Christopher Price: If you know that for months of the year, you never hit the block to rage so four months, out of the year, if you save a kilowatt hour, it would be at the Block one cost.

Christopher Price: Eight months out of the year, it would be at the black to cost.

Christopher Price: You can figure out what your marginal cost of consumption is, and that is about five cents a kilowatt hour, you can do the same calculation for demand, which is about five and a half dollars per kilowatt.

Christopher Price: So if you were evaluating an energy efficiency project, you would know if we say this, many kilowatt hours here's what our savings are, it also saves on demand here's what our demand savings would be.

Christopher Price: Now opportunities that you can identify from analyzing your bills, we talked about a few of them on some of the other slides.

Christopher Price: demand management, this is the load shedding and load shifting can you move your energy around to avoid costs.

Christopher Price: Power factor correction, if you know your power factor and track it over time, you can figure out what the penalty is and then figure out if.

Christopher Price: A power factor correction project is cost effective for you.

Christopher Price: recreating your bills, if you know how you are billed for your energy, you can audit your utility yourself, you are able to spot billing errors if you're on top of your bills you're able to spot issues with metering water meters natural gas meter sometimes they can fail.

Christopher Price: Knowing that ahead of time, you can correct for those metering errors before you even have for you have to pay for.

Christopher Price: State sales tax exemptions just knowing if you're being charged for sales tax on a meter, even though it is production predominant that is important to.

Christopher Price: Saving costs and then avoiding late fees that's just a management issue, making sure that you get the the payment where it needs to be.

Christopher Price: The last two, I want to talk more about on the remaining slides here, and those are going to be tracking your energy consumption spotting trends and anomalies over time and then an analysis notice production and load factor analysis.

Christopher Price: So tracking your energy usage, if you know how to read your bills and you're collecting them, you can start putting together spreadsheets to look at how you use energy over time.

Christopher Price: You could do this on your own, but do we offers several software tools that make that process easier, you can use them to spot trends anomalies and look for opportunities.

Christopher Price: for energy and cost savings, so the first software tool is going to be the energy footprint tool, you can use this to store.

Christopher Price: information from your bills and trend over time, you can even track other variables like production heating demand cooling demand.

Christopher Price: water usage all of that can go in this document gives you a common place to put that information and pass that trending capability built in.

Christopher Price: The other part of it, I touched a bit on the energy performance indicator tool at the webinar on Tuesday, this is more for the regression.

Christopher Price: analysis, the energy intensity analysis, so the footprint tool, you can collect that data, the Energy Performance indicator tool would be used to baseline and then calculate your efficiency improvements over time so together those two pieces of software can really help you spot issues.

Christopher Price: When you're doing that analysis, an important thing to look out for particularly with electricity bills, is the issue of billing periods.

Christopher Price: Those periods depend entirely on when your utility reads your actual meters and that can be consistent every month, or it can vary by several days.

Christopher Price: So the process of normalizing for those varying billing periods is known as calendarization.

Christopher Price: In general, you would take the consumption on a bill divided by the number of days on a bill and then allocate days to the correct month.

Christopher Price: So what does this look like a quick example here what you'll notice is that December January, are both kind of reasonable those.

Christopher Price: Months each have 31 days 30 days and 33 days are only off by around a day or two from the build period, but then you look at February that only has 24 days.

Christopher Price: it's already a short month but it, the way the meters were read it's cut down only to 24 days, so if you were to trend your energy consumption.

Christopher Price: January, February there's nine more days of energy consumption on January's bill than there are in February.

Christopher Price: So when you're looking at trends it's important to make sure that your billing periods are consistent and the number of days doesn't vary all over the place.

Christopher Price: The other part of it is your utility could read your bills, in the middle of the month.

Christopher Price: If you're tracking production and whether those are going to be based on calendar months, so your energy consumption that goes from the middle of the month, the middle of the next month.

Christopher Price: You could have some differences, just because those two periods don't align so being aware of that is important.

Christopher Price: The last slide here is a load factor and electrical factor analysis, this is using that energy data to understand how you use energy.

Christopher Price: So electrical load factor is just a ratio of monthly kilowatt hour consumption to your theoretical maximum amount of energy consumption.

Christopher Price: So if you take your built demand and your billing hours, so the number of hours in the given month.

Christopher Price: That demand is your peak 15 minutes of energy consumption, you multiply it by the number of hours in the month that is an estimate of.

Christopher Price: How often in the month did your facility run at its absolute peak energy consumption, unless your facility uses a constant amount of energy it's going to be fairly low.

Christopher Price: A nother version of this is looking at your production mode factor, so instead of multiplying by the total billing hours you'd multiply by your total production hours.

Christopher Price: And this is a ratio of when you are operating How much are you operating at peak energy consumption, what this looks like you can see your energy and demand on the left there the right is a plot of your electrical load factor in production load factor.

Christopher Price: and electrical load factor of around Point two is usually a single shift production facility.

Christopher Price: There are common ranges for to shift and three shift operations, if you are a one shift operation, but you operate like a to shift operation.

Christopher Price: That can usually signal that you have equipment running outside of operating hours, it can really help you understand what you are operating equipment, when you really shouldn't be.

Christopher Price: A production load factor, ideally, it would be equal to one when you're operating your operating at peak capacity, but in general the value of around point eight is going to be pretty good.

Christopher Price: A pls value that is significantly higher than one is going to indicate that equipment is being left on outside of operating hours.

Christopher Price: And that's just a signal that you need to have better shut down operations better control of your energy management over time.

Christopher Price: So in that way you can use the software tools and this load factor analysis to try and identify energy savings opportunities so with that that is all of the slides that I have and i'm very happy to answer any questions that you might have so thank you.

Eli Levine: Wonderful thanks so much Chris that you can hear me correct.

Eli Levine: Yes, great well, the first question we had was from Anna you know, a friend of the program how is our cost recovery figured by utility.

Christopher Price: cost recovery i'm assuming this is related to the writers in there.

Christopher Price: All of those are going to be set by the public utilities, either at the state or the federal level that's something that larger manufacturers can have a say in So if you want to be part of your.

Christopher Price: Electric liability Councils, you could have an effect on those cost recovery factors, but in general that's going to be listed out in your in your rate structure.

Eli Levine: Great thanks Chris and I know we are approaching the two o'clock hour here on the east coast, so if folks need to drop off that's fine but.

Eli Levine: I know that you're willing to stay on for several minutes more if folks have questions Oh well, we have a number of questions coming in, so just going through, yes, Michelle we will post the copy it will share a recording of the presentation and.

Eli Levine: And all of that, just as soon as we get a transcribed you can put it up on the website, how do Elf and pls relate to the baseline.

Christopher Price: um well.

Christopher Price: baseline in that is comparing your facility to itself over time.

Christopher Price: You can use the Elf, and the pls you could say here's what those values were last year versus this year and use that as a baseline a metric to say, last year we are operating more like a to shift operation now we're operating more like a one shift operation.

Christopher Price: Our pls is closer to one, so we are using our peak electricity more consistently we're doing a better job of managing our energy.

Christopher Price: Over the course of a month or a year, so the Elf Elf, are an extra tool in in that in the baseline and energy analysis thing, and you can use them for baseline but they're not.

Christopher Price: they're not an extra they're not part of what you would use for your better plants baseline hopefully that makes sense.

Eli Levine: Yes, thanks, Chris and I'll comment that I've gotten a couple of notes, as to how.

Eli Levine: helpful this presentation was so I very much appreciate you taking the time today for everyone I've linked to the report that Chris and the oakridge team put together.

Eli Levine: If you want to you know, read the actual law guidance document that supports the presentation today another question, we got we've got a few of them here I'm.

Eli Levine: Sorry, is there any risk associated for FP greater than 100%.

Christopher Price: Power factor greater than one.

Christopher Price: Yes, you can over correct, you can have more capacitance in your facility, then you have indicated that would essentially lower your power factor again.

Christopher Price: it's just in the opposite direction, so you would get penalized for that the issue with that is that having too much capacitance has other implications for the grid.

Christopher Price: That can be worse than just having a low power factor, so, in general, you would never want to correct your power factor, all the way to one.

Christopher Price: You would want to have a little bit of a buffer with that dynamic capacitance you'd usually only corrected to about point nine 5.96 somewhere in that in that range.

Christopher Price: So when when you're talking about that power of fact that you can overcorrect it's very rare that that happens, just because manufacturing has a lot of motors, a lot of inductive loads, but it is a possibility.

Eli Levine: last question we've gotten so far, Chris when using an energy management company one and what analytics should be requested from them to assist you in reducing energy such as peak times or penalties that you spoke up.

Christopher Price: And really the key one is going to be your 15 minute demand profile pretty much every facility sorry pretty much every utility.

Christopher Price: You can request your 15 minute demand data from them that's not going to be on your bill it's something that you can either request or I know that utilities in Texas had a online portal that you could log into.

Christopher Price: and see what your demand profile is so that would be the data that you would need to know here's where we hit our peak demand during the last month, it was at 145 in the afternoon on Tuesday the 12th.

Christopher Price: You would also need to know the information about when the grid hit its peak usually your utility company will publish a public document that has.

Christopher Price: That information in it the grid hit its peak on this date at this time, and you can use that to put together a historical picture of.

Christopher Price: Okay, we know that, generally, for the last five years, the grid hit its peak at four o'clock between four o'clock and six o'clock in the afternoon between July and September.

Christopher Price: that's the kind of information that you, you would need to have access to, if you are hiring an energy management company.

Christopher Price: They would probably be doing that request the request for that information to the utility on your behalf, but if you want to start looking at this yourself that kind of information.

Christopher Price: You can request it from your utility and start looking at it yourself and start doing that demand management demand management.

Christopher Price: calculation and start figuring out well, maybe we can move this process to later in the day and avoid some of those demand charges.

Christopher Price: or like if you have a bill where your demand is particularly high you can go back and look at that demand profile and say.

Christopher Price: What happened, why was our demand 100 kilowatts more than normal when did it happen what was going on in the facility at that time that caused.

Christopher Price: that to happen, maybe you have multiple compressors and all of them kicked on it exactly the same time, because the control was overwritten Those are the kinds of things that you can start doing with that kind of data so hopefully that helps you.

Eli Levine: know very much so, Chris, so I think with that we will give you a chance to get some water, and thank you for all of your presentation.

Eli Levine: for everyone who liked everything that Chris was saying you have his email there directly feel free to reach out to him reach out to me if you're not a part of the better plans program yet.

Eli Levine: Please, please you know join you can have someone like Chris or someone like Chris at your fingertips to work with you on all these challenges.

Eli Levine: The next webinar is actually Tuesday July October 19 at 11am, and that is very similar but it's about understanding your natural gas bills, so, if you like this one, and want to play it forward with natural gas, we will be reconvening.

Eli Levine: At 11am Eastern time on Tuesday so sign up at that, yes, events link below Thank you so much, and we will see you all soon.

Christopher Price: Thank you.