Pete Langlois: Good morning, everyone thanks for joining us this long while, with the DVDs advanced manufacturing now is welcoming you.

Pete Langlois: To the second in our series of webinars celebrating energy awareness month, can we move on to the next slide just so that everybody knows that this, in fact, is being recorded.

Pete Langlois: And will be posted So if you do not want to be captured in any way, then please make sure of that.

Pete Langlois: But is also a reminder, it is being recorded, so the weekend have this available for everybody in the future.

Pete Langlois: But those of you who are here with us live well, actually, you know that it is Tuesday October 12 2021 for those watching the recording later on.

Pete Langlois: Welcome, and we hope you enjoy it if you are watching this in the near future there will be.

Pete Langlois: Several more energy awareness webinars that we're having later on this month, thank you for that For those of you.

Pete Langlois: who are familiar with the advanced manufacturing Office here at Department of Energy, we are certainly aware that a robust manufacturing sector is reliance.

Pete Langlois: On the skills of its workforce to remain innovative and competitive we currently have 10 million manufacturing workers United States.

Pete Langlois: And we're expecting about maybe 4 million potential openings over the course of the next decade, and for that to be.

Pete Langlois: useful for industry, we obviously know that skills are important, and with that we're very lucky to have with us.

Pete Langlois: Over the course of this month, in the course of you know all months our energy experts from the better plants Program.

Pete Langlois: With that, I think you see here we're on our second webinar and we've scheduled for the next one on the next slide there we go Thank you so for all of them if you've missed the first one.

Pete Langlois: check well wherever you saw the recording for this particular one For those of you who are watching us live.

Pete Langlois: You can see the schedule and register for everything at the website there in the bottom of the slide yes events COM slash energy awareness.

Pete Langlois: That is yes, events COM slash energy awareness over the course of October 2021 we will be posting the recording as well as the slides.

Pete Langlois: And there are other resources that we will talk to occasionally as it relates to those webinars for this one we're about to have today, please, for your questions go ahead and use our chat.

Pete Langlois: For those of you who have been watching it later on, we will have at the end, the presentation.

Pete Langlois: A slide with our email addresses either for me to talk about the advanced manufacturing office or our presenters today and others who work in the better ones Program.

Pete Langlois: about this topic and better plans and with that let's introduce you to our speaker from today, this is Dr Chris price, thank you, Chris Chris.

Pete Langlois: Is an associate staff member in the manufacturing energy efficiency, research and analysis group at oak Ridge national lab I am proud to welcome a fellow Johns Hopkins blue Jay.

Pete Langlois: And another graduate of Texas a&m to talk to our particular topic today, as well as the better plans program overall and with that I will turn it over to you, Chris.

Christopher Price: Thank you very much.

Christopher Price: So I want to start with just an overview of what the better plans program is what we do and then move into the discussion of the energy intensity and baseline guidance tracking document that we did an update on last year.

Christopher Price: This presentation is going to give the general flavor of what it takes to do a good energy baseline there will be some edge cases that different plants have.

Christopher Price: Everyone slightly different those are going to be addressed in the actual document this presentation is just the the basic steps so if you have any questions and want to dig a little bit deeper.

Christopher Price: Go consult the the document there's even a quick version of it online on the solution Center but also make sure to talk with your your tam your technical account manager, because the stuff is.

Christopher Price: pretty difficult so don't feel like you have to know everything your tam is there as as a resource.

Christopher Price: So the better buildings better plans program a lot of you are already part of the program but for those of you that aren't.

Christopher Price: The goal of better plans is to help manufacturers and our other industrial partners save time, money effort and improve their overall resource efficiency.

Christopher Price: We do this primarily through energy efficiency and improving energy intensity over time, although the program is moving into other areas like water reduction.

Christopher Price: waste reduction we're even starting to move into the carpet space as that's becoming more and more common, so we do this through a combination of several different resources.

Christopher Price: We offer a wide range of no cost software and other tools to help you calculate energy savings figure out what the financial resources, you need to implement projects are.

Christopher Price: There over 60 calculators we have our equipment loan diagnostic program and then a whole suite of guidance documents, one of which we're talking about today, several more over the course of the month, but all of this is available online for free for you to take advantage of.

Christopher Price: The second part of this is the training and education we're obviously doing a webinar we also do a whole suite of implant trainings on different systems steam systems pumping systems.

Christopher Price: The true cost of water all of those things we've done over 120 of those we're moving into the virtual versions of those as well with.

Christopher Price: But it's really that training, education part that really helps our partners, implement some of these projects.

Christopher Price: The third part of it is our recognition opportunities we have 59 goal achievers so far they obviously receive that recognition, but along the way we have our better project and private practice award winners.

Christopher Price: There have been 49 of those we have our social media channels, we have the megaphone of the Department of Energy, we can really help get what you're doing out there.

Christopher Price: Hopefully, bringing some customers, but also just get you some recognition for all the hard work that you're doing trying to save energy and resources.

Christopher Price: The last part of this is i'm currently at oak Ridge national lab the Department of Energy has many other national laboratories that have different focuses.

Christopher Price: So what you have with better plants at the opportunity to work with cutting edge research in manufacturing and energy systems.

Christopher Price: That can really help you improve your energy efficiency by seeing what's coming next, how can we move into the next version of manufacturing.

Christopher Price: So what this looks like so far we have over 250 partners that are spread across the entire United States and the outline territories.

Christopher Price: There are tons of different sectors that are represented in here we have brewing we have automotive manufacturing, we have pharmaceuticals, we have.

Christopher Price: cosmetics, we even have some local governments and wastewater treatment facilities.

Christopher Price: So, with better plants you're not just getting help from your tam and the Department of Energy you also have the opportunity to work with all of these other partners.

Christopher Price: To help identify opportunities that other industries are using that you might be able to take advantage of.

Christopher Price: And then also just get support from other people in your specific sector so that is generally what better plans is and hopefully That gives you an overview of what we're trying to do with the program and also with the webinar today.

Christopher Price: So there are quite a few slides i'm going to be going pretty quickly, so please use the chat function to ask questions.

Christopher Price: I would prefer to answer them as they come up so people step in with those questions as we move on here.

Christopher Price: So, to begin here, the first question with baseline and trying to track your energy usage is really where do we start.

Christopher Price: Everyone really wants to improve their energy efficiency and become more environmentally responsible, but the two main questions and really the two main barriers to this are.

Christopher Price: just getting past the initial hurdle of where do we start, and how are we going to measure how well we're doing.

Christopher Price: When you're just toiling away, and you have no idea how well you're doing that's really a recipe for just getting deflated and not actually making any success, so you have to figure out.

Christopher Price: Where do we start, and how are we going to measure our progress, the two main solutions to these are energy baseline in energy benchmarking and those are the processes i'm going to talk about in this presentation here.

Christopher Price: So baseline in itself is going to be the process of comparing your facilities your processes or a specific piece of equipment to themselves over time.

Christopher Price: And that's going to require setting a starting point for that comparison so essentially what you're doing is you're saying, five years ago, maybe even today we operated this efficiently.

Christopher Price: A few years down the road we then compare to ourselves and say ah we're doing X percent better keep doing what we're doing or we need to make changes.

Christopher Price: Benchmarking is similar except that you're going to take your facilities your processes your equipment and you're going to compare that to.

Christopher Price: Other companies other sectors or even different facilities within your own company so you're taking your equipment and comparing it to someone else.

Christopher Price: Again, you still need to have a baseline to make that comparison you need to know how well, am I doing to compare yourself to someone else so we're going to go over what that entails, and how the guidance document can help you do that.

Christopher Price: So this baseline is part of the better plants pledge so far we've had 59 goal achievers I mentioned that before, but every better plans partner when they join the Program.

Christopher Price: pledges to establish an energy baseline and track their energy intensity over time that energy intensity is a measure of how much energy it takes to make product.

Christopher Price: So, theoretically, you could have overall reduction in energy consumption, but if you're making more product your energy consumption could go up a little bit, but if you're making more product more efficiently that's really what better plants cares about is that per widget number.

Christopher Price: Now the most common goal, here is a 25% reduction in energy intensity within a 10 year framework.

Christopher Price: Some have a little bit more a little bit less some have a shorter goal period, but the standard goal here is 25% within 10 years and what better plans does, in particular, is this is for us based manufacturing facilities.

Christopher Price: The only thing that needs to be included in this pledge is facilities that are directly.

Christopher Price: Manufacturing product, although you can include things like warehouses office buildings corporate headquarters, if you want to and a lot of companies do, but the what better plans is specifically focused on is the manufacturing energy intensity.

Christopher Price: Now, with that pledge comes the perennial question of how do we compare one year to the next year.

Christopher Price: And when conditions are constantly changing, which they are in manufacturing that really can become a difficult proposition.

Christopher Price: Every year there's going to be different weathers weather conditions, it can be really hot outside it can be really, really cold, if your processes affected by things like humidity that can change over time.

Christopher Price: Differences in production, maybe this year or last year with.

Christopher Price: Your production went way down this year could be a real barn burner, you could be making record numbers of product, how do you compare between those two years.

Christopher Price: You may be producing different products than you were last year, from this year So how do you measure that energy intensity and then really the last.

Christopher Price: big challenge with this is companies are really here to be profitable and you do that, either by producing more product or adding onto your facilities buying new facilities.

Christopher Price: Consolidating and closing different facilities, how do you at the corporate level, make sure that you're comparing.

Christopher Price: fairly one year to the next year, when your company looks completely different than it did, five years ago 10 years ago.

Christopher Price: Now the classic example of this is going to be installing a new rooftop air conditioning unit.

Christopher Price: Maybe you convinced your boss to replace that air conditioning unit that's been there for 20 years it doesn't really work everyone's always hot.

Christopher Price: So you buy this brand new air conditioning system that's guaranteed to be more energy efficient at the end of the year, you get your energy bills back and your energy went up.

Christopher Price: What happened well, you could throw your hands up and say I don't know, maybe we should be doing a track at all, or you could say well hold on this year was way hotter than it was last year.

Christopher Price: And with this knowledge, you can then normalize for that weather and you can say.

Christopher Price: Well, if we had the old system, we would have used way more energy than we did this year so Yes, our energy went, but we did actually operate more efficiently.

Christopher Price: And that's what this whole process of bass lining is trying to do is make that comparison between years and answer some of these questions.

Christopher Price: Now there are three primary methods for going about calculating energy intensity improvement, the arrow here basically shows you that from the bottom, to the top it increases the level of confidence that you can have in the results that you get.

Christopher Price: But it does affect the amount of time that it takes to put the results together, and it also affects the amount of data that you need to collect to perform that analysis.

Christopher Price: So at the bottom here is this corporate level energy intensity approach and this is basically saying.

Christopher Price: That instead of calculating things on a facility level you just add all of your energy consumption together at all of your production together divide one by the other and you get a corporate number.

Christopher Price: That is quick and easy but it doesn't really give you any idea about your good performing facilities your bad performing facilities doesn't really take into account the relative size of the different plants, the kinds of products that they make so it's not ideal.

Christopher Price: The next level up here would be to calculate your energy intensity on a facility level so each facility would go through and calculate its energy intensity and its improvement.

Christopher Price: You can roll all of that up into a corporate number so.

Christopher Price: You would have to have a little bit more data, but the quality of the data that you have the information that you get you can identify good performers, you can identify your best practices.

Christopher Price: You can put time and effort on your facilities that are struggling a little bit, so it does give you more information and a little bit more quality in terms of what you get from it.

Christopher Price: However, the the gold standard here that better plans pursues is really this regression approach and this is a statistical analysis method.

Christopher Price: That can take into account multiple variables, so you know that production affects your energy consumption.

Christopher Price: You know that weather affects your energy consumption, you can account for all of those things with a regression approach.

Christopher Price: is going to take more data we use at least monthly data, instead of annualized data takes more time, but the results that you get from it are going to give you a lot more helpful information.

Christopher Price: And really that's the method that we're going to try and get all of our better plan partners to pursue here we'll talk more about each one of these in the coming slides, but this is just a flavor of what what you can do here.

Christopher Price: So for putting together an energy baseline they're going to be around eight basic steps here.

Christopher Price: You are going to work through each one of these steps and, at the end of it, you will have an answer for how well are we doing how well did we do this past year, compared to our baseline.

Christopher Price: Now we'll step through each one of these in the coming slides here, but in general, you can separate these out into a couple of different categories.

Christopher Price: The first four steps are really data collection and decision making.

Christopher Price: This is what energy sources are you going to be tracking winners our baseline year and gathering that data and then making a decision, are we going to use an energy intensity approach, are we going to use a regression approach.

Christopher Price: And then working through all of the data collection issues with that.

Christopher Price: The bottom half here is really the analysis side of things so once you make a decision and start working on the analysis, this is when you would go through and work through the numbers.

Christopher Price: Now all of that you could do by hand by yourself in an excel spreadsheet but.

Christopher Price: Better plants in the Department of Energy have software tools that can do this kind of analysis for you, and in particular.

Christopher Price: it's The energy performance indicator tool talk more about it on a future slide but all of those steps from the bottom half down, you can use the do we software tool to make that whole process generally easier.

Christopher Price: So i'm going to start stepping through the individual blocks on that diagram there, and if you have any questions along the way, please, please stop me, and let me know.

Christopher Price: So the first step is going to be trying to define the boundary of your facilities so for each plant in your better plants pledge what you want to do is draw an imaginary fence around that plant.

Christopher Price: And what you're trying to imagine with that boundary are the energy resources that cross into your facility that you use so that's going to be things like.

Christopher Price: electricity, natural gas, you may use some combination of fuel oils, if you have renewables, that you are purchasing coming in, that would be an energy source.

Christopher Price: Imported resources are going to be things like maybe you purchase compressed air from the plant across the street, maybe you get steam from another facility nearby Those are all energy resources, and that is energy that goes into making your product.

Christopher Price: And, in general, you want to track all of those different sources, but when you start getting down into some of the smaller resources, a can.

Christopher Price: It is more information, but it's not really going to change the end result so better plants lets you make a determination of does this resource.

Christopher Price: account for more than 5% of our energy consumption, if it doesn't, you have the choice of including it or you can exclude it just for simplicity sake.

Christopher Price: one caveat to, that is, you have, if you have a lot of small energy resources in total, they can end up being more than 5% 10% so when you just start excluding different resources, you need to make sure that you're still getting the vast majority of your of your energy consumption.

Christopher Price: Now one part of this is feedstock energy is not going to be included in this calculation so chemical company that uses natural gas.

Christopher Price: In their process, so they may take natural gas do some chemical processes on it and get a different chemical out of it.

Christopher Price: That isn't an energy resource that is a feedstock resource, so you wouldn't include that portion of natural gas in your energy baseline.

Christopher Price: If you use natural gas to heat your product that part would be an energy resource, so that stuff that goes into your product isn't going to be counted here transportation energy, you would have the choice of including, if you want to.

Christopher Price: So if you use gasoline or diesel in your in your vehicles on your plant, you have the choice of including that or not, if it's less than 5% you could exclude it.

Christopher Price: The last bit of this boundary question is, do you have any any energy resources, leaving your facility boundary so let's say you have a large on site solar installation and you're generating a lot of.

Christopher Price: green energy more than you can use if you're selling that back to the grid, that would be energy that is leaving your facility and there are different ways in the baseline guidance document that you would account for.

Christopher Price: producing more energy things like CHP or bio gas energy generation if you're producing more and selling it back or cross that boundary that you defined you would use that as a credit, with some certain multipliers and subtract off of your your energy use.

Christopher Price: Now the next question once you set that boundary is asking the question of when do you want your baseline to start from this is going to be.

Christopher Price: Usually the current year that you join the better plans program and will serve animal serve as your stake in the ground for this is where we started and it's what you're going to use to measure against.

Christopher Price: So it's usually the current year that you joined better plans, but you do have the option of going up to three years prior So if you join the program in 2021 you could use as your baseline, but you have the option of using 2018 2019 or 2020 as your baseline year.

Christopher Price: Now the important bit with this baseline is that it is a typical year of operation at your facility so you wouldn't want to use a year for a lot of companies.

Christopher Price: Should just get thrown right out because production was way too low, it was just an aberration in terms of how their plants operate.

Christopher Price: Some companies could have had an outstanding year if your company had certain essential products, you could have been running 24 seven and had an absolute record year production.

Christopher Price: it's the same sort of thing what you really want is a typical year of production, this also includes if you have any expansions or you install new equipment, you want to make sure that your your year is constant and pretty normal So what does this look like let's just look at a timeline.

Christopher Price: So you join the program and like I said, you have a range of years that you can use to set your baseline it can be the year that you joined or up to three years prior so you have that four year window.

Christopher Price: let's say you select the year before you joined as the baseline here that becomes your year zero.

Christopher Price: Then you can number your better plans pro pledge by every year after that baseline here, so in this case let's say you joined the program in 2021.

Christopher Price: If you set your baseline in 2019 your better plans pledges 10 years from your baseline year, so your goal is a 10% reduction in energy intensity within 10 years if your baseline which should be 2029 you can use this baseline to.

Christopher Price: incorporate energy efficiency projects that you may have implemented in the last couple of years, you can also use it to just make sure that you find that that typical year but you do have some wiggle room in setting that baseline.

Christopher Price: And one one other important caveat here is that if you reach your better plans pledge before that 10 years is up.

Christopher Price: more power to you we're not going to make you wait until the end of that pledge to get recognized for for it, when you hit that.

Christopher Price: 25% reduction that's when you get recognized for it, so in this case, they headed at the end of your eight they got recognized that year, and they were successful better plans.

Christopher Price: So, once you have.

Christopher Price: Set your boundary identified the energy resources that are moving across your fence and set a baseline year The next step is to gather that energy data so for all of the energy resources that you identified in step one and for the years that you.

Christopher Price: selected by.

Christopher Price: putting down your baseline year you're going to find the information on those energy resources and you can get that from a lot of different sources.

Christopher Price: Some some common ones are going to be utility bills, you could have multiple utility meters, you could just read it directly off of your meters on.

Christopher Price: Energy information on specific pieces of equipment if you're trying to baseline a process rather than a whole facility, but there are multiple areas where you can get that.

Christopher Price: Everything for better plans needs to get converted into a comment energy unit so electricity is built on kilowatt hours that's going to get converted into MBT use natural gas.

Christopher Price: can be built directly in MV to use a lot of cases it's built by volume so cubic feet hundreds of cubic feet that also needs to get converted to an energy unit, so that everything gets converted to the same unit, and you can figure out what your total energy usage is.

Christopher Price: One other caveat to this common unit is that.

Christopher Price: Electric, particularly the electricity when you.

Christopher Price: get your bills what's listed on that bill is going to be site energy how much energy you used in your facility.

Christopher Price: But better plants uses what's known as primary energy and what this does is primary energy includes the inherent losses, it took to generate the electricity that you're using and also distributed to your facility.

Christopher Price: So for every kilowatt hour that you use on site.

Christopher Price: More or less it depends on your particular region within the United States, it takes around three kilowatt hours of primary energy to get that one kilowatt energy to your facility so for electricity.

Christopher Price: Every kilowatt hour you save on site means that we didn't have to use three kilowatt hours of primary energy What this means is that.

Christopher Price: Our the way better plants accounting works is it's going to more fully capture the benefits of renewable energy and onsite energy generation.

Christopher Price: So if you are generating a kilowatt hour on site and using it on site, the.

Christopher Price: Losses associated with that are going to be much less than from getting that kilowatt hour from the grid, particularly with renewable energies, because they have no fuel associated with them.

Christopher Price: So, by using this primary energy, you can really capture the full spectrum of the benefits of saving energy at at your plant.

Christopher Price: Now i've talked a little bit about electricity, there are going to be multiple different energy sources that your plants can use, not every plant is different than the standard ones, electricity and natural gas those to cover a lot, the majority of manufacturers across the country but.

Christopher Price: The guidance document itself is going to have more information on all of the different kinds of energy that you may be using at your facility.

Christopher Price: So things like combined heat and power bio gas generation biomass incineration or waste incineration instructions on how to include those in your baseline are going to be in the guidance document itself there's also information on how to account for renewable energy sources.

Christopher Price: Guidelines for power purchase agreements and racks are also in that document, in general, what better plant is seeking to do is to fairly include all of the energy resources that your plant uses and make sure that you get the full credit for using different kinds of energy.

Christopher Price: Now, when you're putting this information together one caveat to it is you need to pay attention to your billing periods, and this is in particular if you're looking at regression and monthly level data.

Christopher Price: Billing periods are always going to depend on when your utility actually reads your meter and sometimes those dates can be.

Christopher Price: Completely random or they can shift around and the process for adjusting your billing periods to a standard unit of time, usually a calendar month is known as calendar ization.

Christopher Price: The general approach to this is, you would take the energy on a bill divided by the number of days on that bill and then allocate energy to different months.

Christopher Price: Now this example kind of shows you why you would want to do this so let's look at a couple of examples December and January have 30 and 33 days, which is pretty reasonable.

Christopher Price: that's around the 3031 day mark that that's pretty good, but when you get into February, which is already a short month you're down to just 24 days on that, though.

Christopher Price: So when you're comparing February to December or January inherently that has nine days it has over a week less.

Christopher Price: Energy consumption on that bill than the other bills, so you need to make sure that your billing periods are somewhat consistent and move things around to make sure that comparison is fair.

Christopher Price: The other part of this is a lot of times utilities bill in the middle of the month, they may read your meter on the 15th but your internal production numbers would go from.

Christopher Price: The beginning of the month, so making sure that your production and your energy are on the same schedule is important here and more information on the calendar ization process is going to be in the guidance document itself.

Christopher Price: Now, once you have done all of this data collection calendar ization stuff you that have a question of what variables what other variables that we want to include in my baseline.

Christopher Price: So normalization can account for a lot of different things, but you're really looking to find the variables that affect your energy consumption, some of the common ones are going to be.

Christopher Price: temperature related heating and cooling load humidity and, of course, production itself, but these are just the common ones, if you have other things that affect your energy usage.

Christopher Price: You can track those and use those in the process as well production is usually going to be measured by the total number of widgets that you make, although you can use something like ours worked if your production.

Christopher Price: portfolio, if you make so many different kinds of products that just having a total number doesn't really make sense, you can use some other variables like ours work to capture how much did our facility run this month.

Christopher Price: One other note here is, you can use revenue as a production metric but that's going to be subject to some some things that make it a little bit more difficult.

Christopher Price: Inflation is going to be one if you use revenue as that variable you need to make sure that you're adjusting for inflation between years, particularly as you get farther away from that baseline year.

Christopher Price: The other bit is that, if your product prices go up that can affect what that revenue number is so if you are selling product at 20% more than you were in the baseline year.

Christopher Price: You could have more revenue, but you may have sold less parts, so you just need to be aware of that, when you're putting that revenue base number together make sure that you're making a fair comparison on the revenue front.

Christopher Price: Now, the next few slides are going to talk about how you actually calculate that energy intensity number and like I said, there are three main ways of doing this.

Christopher Price: And i'm just going to give you kind of overview of what each one of them does.

Christopher Price: So the one that most facilities do already is what we call our classic energy intensity method it's very easy to calculate it only requires annual data.

Christopher Price: And it's something that accounting departments and companies do pretty much already and what it is, is simply your total energy consumption divided by your total production number.

Christopher Price: So theoretically if you're making a similar amount of product per year and your energy consumption goes down your energy intensity would go down as well.

Christopher Price: The main problem with this approach is that it can suffer scaling issues when production varies by a certain amount, and I have a graph here that will show you a little bit about what I mean.

Christopher Price: So if you were to plot your energy consumption versus your production so productions on X and your energy consumption is on the y axis here.

Christopher Price: you'll generally be able to see a pretty clear trend between production and energy consumption and that's going to be that dashed blue why.

Christopher Price: What the classic energy intensity is doing is it's basically assuming that when your production goes to zero your electricity and your energy consumption will also go to zero.

Christopher Price: And you can see that that assumption doesn't really match what the actual way you consume what the way your plant consumes energy it doesn't really matter at all, which isn't a problem if your production doesn't vary all that much between years.

Christopher Price: But if your production goes way up or way down, you can have some scaling issues so let's say your production goes way up.

Christopher Price: Your actual energy consumption trend is that blue dotted line what the classic energy intensity method assumes is that orange line.

Christopher Price: see that orange line is way higher, so the way you consume energy has not changed, but your energy intensity will go down.

Christopher Price: The reverse of this happens when your production goes way down as well, and a lot of you may have seen this with last year's data and the effects of code at 19.

Christopher Price: When your production goes way down the the classic energy intensity is going to assume that your energy intensity.

Christopher Price: Your energy consumption goes to zero so it's going to assume you're down near the orange line when in fact you're more up towards that dotted line.

Christopher Price: So your energy intensity is inherently going to get worse as production decreases just because that relationship doesn't work quite the way your facility actually uses energy.

Christopher Price: So how do you account for this well better plants will push you towards using a regression style approach.

Christopher Price: So what is regression it's a statistical analysis method that you can use to model, the effect of many different variables on your energy consumption.

Christopher Price: I have just a couple of example plots here there's work hours versus electricity, heating load versus natural gas consumption.

Christopher Price: You can see, there are some trends between those two so you can include multiple variables, it gives you more reliable information and it's not going to suffer from that scaling issue that the classic energy intensity does.

Christopher Price: So regression is better because it can account for multiple variables and fluctuations in those variables, it can help you isolate the relative effects of different variables.

Christopher Price: And it's just generally a more rigorous method for calculating your energy intensity.

Christopher Price: Now, at the end of the process, what you end up with is just an equation, you can say my energy consumption is dependent on production.

Christopher Price: multiplied by a number plus our cooling demand multiplied by a number and any other variable.

Christopher Price: That affects your energy consumption to you, so you can say for this level of production and this amount of cooling here's what we would expect our facility to use and you don't have that same sort of scaling issue, as with the classic approach.

Christopher Price: Now, with regression.

Christopher Price: There are three different ways, you can find a model i'm just going to go briefly over this there's more information in the guidance document itself, but when you're using our software tools.

Christopher Price: it's going to ask you what year do you want to model what year do you want to be the model year for your regression.

Christopher Price: there's three different options forecasting your model year is going to be the first year of data that you have.

Christopher Price: You would then use that model to predict what your energy consumption is in the future so we're saying, if our plant from.

Christopher Price: operated like it did in 2020 but in 2024 here's how much energy, it would have us hopefully it's more than what we are currently using because it wasn't as efficient as we are now.

Christopher Price: And that's where the savings are going to be calculated from.

Christopher Price: That casting is the reverse of this your current year is your model year, so you would figure out what your energy consumption would have been in the past.

Christopher Price: If you operate it as efficiently as you do now so savings in that case would be our model of consumption is less than our actual consumption, because we operate more efficiently.

Christopher Price: chaining is a model year in between the baseline year and the current year and it's a combination of forecasting and back casting.

Christopher Price: Depending on what year you're looking at and when you're in the anti tool it's going to say what year do you want to model, and it will have in parentheses forecasting changing and back casting, and this is really what it is asking how do you want me to calculate your savings.

Christopher Price: Now, with regression, you may get multiple valid models for a given energy source and it's important to look at each one of those models.

Christopher Price: to determine if they make actual engineering sense, so the model may be valid, but if it has a whole bunch of variables and the relationships don't make any sense.

Christopher Price: You don't really want to use that that model, and I have an example of what I mean here, so the model may fit well, but it may not make actual physical sense.

Christopher Price: So let's look at two valid models here, one of which you wouldn't use and one you would use so valid model, one is St electricity is equal to heating and production.

Christopher Price: But for this facility, they don't use electricity for heating, they use natural gas, so it wouldn't really make sense to include heating as a variable.

Christopher Price: Now heating could be in this model in an inverse relationship here so as our heating demand goes up or electricity actually goes down.

Christopher Price: But that's not really what you want, in a model, you want to say when this variable goes up our energy consumption goes up, which is why that second model has the cooling.

Christopher Price: Variable in it, because, as the cooling demand goes up the amount of hbc, we need to keep our facility comfortable goes up.

Christopher Price: The other part of this is the sign in front of production, what the valid model, one is saying is that as production goes up our energy consumption goes down.

Christopher Price: Which doesn't make any actual sense for how a manufacturing facility would work, so you would go with valid model number two more than valid number valid model number one, even though both are valid really the second one makes physical engineering sense and you would choose that model.

Christopher Price: Now, if you are unable to find regression models for your facility which can happen.

Christopher Price: A in between method would be to use what we call a modified energy intensity approach, and it is a bridge between a classic energy intensity analysis and a regression analysis.

Christopher Price: And it's better than classic energy intensity, because it does recognize a contribution of baseload energy consumption, so it's not going to assume that your energy is zero when your production and zero.

Christopher Price: But it doesn't need that monthly data you don't need to find the models for it, so you don't need as much data that's going to give you.

Christopher Price: A better number than the classic energy intensity well, but not as much effort as the regression.

Christopher Price: And I have the equation here but there's more information in the guidance document itself, but basically what it's saying is the portion of your energy consumption is baseload and a portion is production.

Christopher Price: The portion that is baseload you're going to look at your improvement in total energy consumption.

Christopher Price: This is not intensity based this is literally just did we save me to us from one year to the next, and you multiply that by the portion that is baseload.

Christopher Price: The other part of this is production related, and that is the improvement in energy intensity and that is literally the classic energy intensity part, so you have a baseline component and a production component.

Christopher Price: These percentages they're going to be estimates, you can do this based off of information about your facility.

Christopher Price: Or the do we has a lot of manufacturing surveys that will have an estimated amount of baseload energy consumption by sector, and you can simply pull that number from those those surveys so as a branch FBI is kind of in between the classic energy intensity and the regression.

Christopher Price: Now the final few steps here are going to be actually calculating your energy intensity improvement.

Christopher Price: Now, as I said, there are different ways of going about this and i'll briefly explain them with with this graphic here so let's say you have three different facilities, you could calculate your energy intensity by summing all of those.

Christopher Price: Plants energy consumption and production data together calculating a corporate level energy intensity.

Christopher Price: And then calculating the improvement in that energy intensity, so what this equation is saying is that the energy intensity from the baseline year.

Christopher Price: minus the current year divided by the baseline here, that is your improvement in energy intensity it's just that you've added everything up before calculating number.

Christopher Price: The other way of doing it the better way of doing it would be why don't we calculate that improvement in energy intensity so you'd use that same formula like above in the green except you would do it on a per plant basis.

Christopher Price: So you would then have that information per plant, you can roll that up to a corporate number.

Christopher Price: by multiplying by the energy consumption of each facility and dividing it by the total energy consumption, essentially it's a weighted average of your facility level.

Christopher Price: energy intensity improvement just weighted by the relative amount of energy consumption that each plant had in the baseline year.

Christopher Price: So this equation is saying our improvement in energy intensity for facility one multiplied by its baseline energy consumption same thing for plant to same thing for plant three.

Christopher Price: divided by our total corporate energy consumption and that's how you would get that facility level approach.

Christopher Price: And you can calculate that improvement and energy intensity with a classic energy intensity method with a modified energy intensity method or a regression based approach this.

Christopher Price: Corporate roll up equation this way to get that corporate number is independent of the method that you use all you need is that energy intensity improvement number to do that roll up.

Christopher Price: Now all of this analysis methods so basically steps five through step eight like I said, you could do it by hand if you want to dig up your stats book and go through and figure out how to do linear regression.

Christopher Price: Rather than doing that do we have a full suite of software tools that can help you either the facility level or the system level.

Christopher Price: In particular, I want to direct you to the NPI tools, the Energy Performance indicator tools.

Christopher Price: There are a couple of versions of this, the empire tool is an excel based tool, the empire light tool is a.

Christopher Price: Online version of the tool that has a lot of the same capabilities, although it's missing a couple of components that the excel based tool does.

Christopher Price: But n pi can do pretty much all of the analysis from steps five to eight here and do this facility level calculation and then the corporate role of information and that's really what you need to.

Christopher Price: track yourself through the better plans pledge period.

Christopher Price: So, like I said empire is an excel based tool it's just a plug in to excel itself and it's really meant to make regression easier, so when you install the N pi add on.

Christopher Price: it's not a separate program you would just open up excel and you would see in the top ribbon that there's now an n pi option.

Christopher Price: And in n pi there's going to be several different options that you can use to analyze your data there's a unit converter.

Christopher Price: You can do a classic energy intensity approach you can use regression, you can also do that corporate role that I talked about.

Christopher Price: If you want more information on n pi and how to use it please talk to your tam or feel free to reach out and we can give you a little bit more of a DEMO on on how it works.

Christopher Price: So, with the last couple of minutes, I just want to go over a quick example of what this process would look like for a example facility.

Christopher Price: So let's say better plants has a corporate corporate partner called fine factories and fine factories has seven total facilities in the United States, mostly concentrated in the Midwest.

Christopher Price: If you look at the map here what you'll notice is that of those seven only for our manufacturing related there's two distribution centers and a corporate headquarters.

Christopher Price: Now ffc decided to only include the manufacturing in their better plans pledge that's all that's required that they could, if they wanted to include those other facilities.

Christopher Price: Each plant is only going to use electricity and natural gas, and once they know that these are the energy sources crossing those facilities boundaries, they decided that, because they joined.

Christopher Price: They could have gone back all the way to the team basically 2016 they chose 2017 as their baseline year so they're better plans pledge, even though they joined in 29 team, because their baseline is 2017 their goal is to reduce their energy intensity by 25% by 2027.

Christopher Price: So if we dig into one of the plants look at the knoxville Tennessee plant.

Christopher Price: There is a little bit of on site wind generation, but once they found how much total energy they use from electricity and grid.

Christopher Price: From grid electricity and natural gas, they found that that onsite wind really is less than 5% of their total energy consumption, so they're just not going to include it in in their baseline.

Christopher Price: They converted their grid electricity from kilowatt hours to MBT you and site energy to source energy using that three point O multiplier that I mentioned before.

Christopher Price: Natural gas was built by volume from hundreds of cubic feet, they converted that to me to use if you want to know more about how to do that from your natural gas bills tune into the natural gas utility billion webinar in a couple of weeks here.

Christopher Price: Now for electricity and natural gas, they were able to find forecast regression models.

Christopher Price: And predict what their total energy consumption would have been in 2018 and 2019 what you see from this plot is that their model energy is slightly more than their actual energy which correlates to an estimated savings from that regression model.

Christopher Price: So, if you look at the facility level results here but you'll notice is that their Columbus plant had a bout of 5% negative energy intensity improvement there other facilities were all positive.

Christopher Price: One note with this is their lexington Kentucky plant was not able to find any valid regression models for for various reasons, but there there weren't any regression models so they decided to use a classic energy intensity method and instead so.

Christopher Price: You have this facility level information you now need to convert this to a corporate level result here, so, as I mentioned in the previous slide the way you do this is with a weighted average of your improvements.

Christopher Price: And essentially what this is is you would multiply negative four or five 4.5% by 28.6% 2% by 9.3% and add all this together, and at the end of it, what you find is that the corporate level.

Christopher Price: They had a two and a half percent improvement, so we know that the knoxville facility itself had a 7% improvement, but when you include all of the other ones at the corporate level it's two and a half percent.

Christopher Price: So more information on how to do this, for your facility is going to be in the full energy intensity baseline and Guy.

Christopher Price: And it's document there's also a summary version of it, that is, about four to five pages it's generally more more digestible but both of those can be a helpful resource.

Christopher Price: So with that hopefully that all made sense and I didn't confuse everyone, but if you have any questions, please let me know.

Pete Langlois: Chris Thank you so much, I have some questions, but before that I want to give you a bit of a break.

Pete Langlois: I know it has a lot to.

Pete Langlois: Present and a lot of time to go on straight like that so gather yourself when we do have about.

Pete Langlois: five or seven minutes left here in the webinar so For those of you who still might have some questions, please go ahead and drop them in the chat.

Pete Langlois: In the interim, what I will do is a shout out to a few people and a few teams in fact that have helped what Chris has presented.

Pete Langlois: Is I mean a lot for you to try and do in your particular facility.

Pete Langlois: We have teams, both at all credential lab which Chris is part of and also Lawrence Berkeley national lab which has spent.

Pete Langlois: years working on the software tools that he alluded to, as well as one other, one that I mentioned here in the chat and then.

Pete Langlois: Chris touched on briefly, which is the 50,001 ready navigator there is so much more information available online about how to do this, so do not be.

Pete Langlois: necessarily feel overwhelmed by it it's easily something that can be done in digestible steps, and especially in this time where things have been potentially.

Pete Langlois: chaotic crazy unusual not baseline effort at all for the last 18 months, where you might have concerns certainly have concerns more about how the workplace might have to function.

Pete Langlois: versus being able to take the time he wants to address energy efficiency, then the We have lots of easy tutorials to help you step through it.

Pete Langlois: At your own pace, and with that I do want to ask a couple things Chris that kind of go at the the idea of what might have happened over the last couple of years.

Pete Langlois: Oh boy um 2020 maybe even.

Pete Langlois: are going to be years, people are throwing out so in terms of having that 25% goal, or whatever goal, it is it's not necessarily something well, would you want to go back a couple years in general to when things were a little more normal and kind of give 20 2021 I want to pass.

Pete Langlois: Do the regression see what my work and what are you hearing from from the companies that you're working with in terms of how they're approaching what is, we hope, a once in a lifetime kind of disruption town, the energy statistics have shown up.

Christopher Price: yeah in terms of setting a baseline it probably would be better to go back a couple of years.

Christopher Price: Like I said it's supposed to be a normal production year you want a good representation of how your plant usually operates and in 2020 if you shut down completely for two and a half months it's really not going to be a.

Christopher Price: Good representation of how your plant operates on a yearly basis, so if you have the option to go back to 2018 or 2019 that probably would be a good idea if you've already established a baseline in 2018 and 2019 and you're looking at results from last year.

Christopher Price: One of the nice things about the regression analysis is that it can be somewhat forgiving there are certain conditions for what constitutes a valid model and, in addition to that, what.

Christopher Price: Things how off can the variables you put into that model be before it's no longer representative.

Christopher Price: And the range that possible is actually quite wide, so I had a couple of plants that did shut down for a month and a half this in 2020.

Christopher Price: But their annual production numbers rebounded enough that they're regression models are still valid in a way that if you were doing a classic energy intensity approach.

Christopher Price: It looked terrible but that regression analysis was able to kind of absorb what happened in a way that the other ones did so if you're trying to establish a baseline you probably should go back if you can.

Christopher Price: And if you already have an established baseline still look at regression for for that year, to see what comes out of it, because it could still be valid and it's probably going to be more reflective of how your plant operated them if you use a different method.

Pete Langlois: Thanks Chris what we were setting up the last slide so that we can see everybody's contact information so.

Pete Langlois: we'll leave that up there for a couple of minutes I do want to ask for, especially for those who are not terribly familiar with this at all performance indicators.

Pete Langlois: we're talking mostly about manufacturing environment but, but not necessarily I mean, depending on what type of facility you're working in that they may vary, but what would be the types of things that.

Pete Langlois: They might want to think about right off the BAT that would be what they want to start measuring against potentially.

Christopher Price: And so.

Christopher Price: I know the common ones for a lot of manufacturing facilities are going to be just straight energy intensity so.

Christopher Price: and energy consumption per amount of unit made some of the other ones, a lot of corporate responsibility programs are going to look at waste waste to landfill water efficiency.

Christopher Price: Now we're starting to look at carbon PR either on an absolute basis or a carbon intensity number Those are just some of the common ones that you might start tracking.

Christopher Price: If you want to look at specific pieces of equipment or specific processes, you can take those things and put it down on the process level if multiple buildings, you could break it down to the the building level rather than like a campus level.

Christopher Price: But those are those are the general ones that most plants are going to use.

Pete Langlois: Thank you we've had known the chat about square footage and talking about footprints, in particular as getting literally down to that, but it also depends since i'm silly.

Pete Langlois: Certainly, for an office building or whatnot occupancy is going to be part of it and that of course is very greatly, and probably will vary greatly going into the future.

Pete Langlois: Thank you so much, Chris We appreciate it again I want to remind everybody that the slides and the other resources that he mentioned will be available in the various.

Pete Langlois: Do we forums, a better building solution Center we don't have the links to that on here, but I do want to note what we do mentioned there and the last line of this slide.

Pete Langlois: If you want to see and register for the upcoming webinars and the rest of our energy awareness month of October 21 you can do that, yes, events COM slash energy awareness and, in fact, there are some of the resource guides there.

Pete Langlois: Our team is put that link back into the chat For those of you who are watching it live we'll leave it up here for next minute or so.

Pete Langlois: If you have additional questions and you probably do for those of us who are in the better plans program you can work with your technical account managers, but Chris Dr price as his.

Pete Langlois: email address there a program manager for better plans is eli levine and he his email address there, I was negligent and mentioning this earlier.

Pete Langlois: i'm working on our education workforce development strategy activities and events manufacturing office.

Pete Langlois: pete long one of them is my email address right up top so you have broader questions about the events manufacturing office or what we're trying to do.

Pete Langlois: Around manufacturing in general and energy awareness and month, in particular, please reach out to me our next webinars coming up just in two days or 49 hours or so from when you're hearing this right now.

Pete Langlois: For those who have caught it our Thursday webinars during this are at 1pm Eastern 10pm 10am Pacific.

Pete Langlois: And our Tuesday ones are typically 11am Eastern and 8am Pacific, and that is covering most of the month of October.

Pete Langlois: We look forward to seeing you at future webinars the next one on Thursday is understanding your electricity bills and especially what Dr price was talking about.

Pete Langlois: there's a lot to unpack about that and will certainly help you in doing the analysis type of work and that he alluded to today, thank you all for joining us, we look forward to seeing you next time.