Health Benefits of Energy Efficiency and Renewable Energy

Webinar Transcript

May 16, 2019

Contents

This transcript reflects the statements made during a live webinar on May 16, 2019. The transcript has been reviewed for accuracy. Any grammatical errors or otherwise unclear passages are true to the statements of the presenters.

State and Local Energy and Environment Program

I. Introduction

Slide 1. Quantifying Health Benefits of Energy Efficiency and Renewable Energy

Operator: Good day, ladies and gentlemen. My name is Laurie and I will be your conference operator today. At this time, I would like to welcome everyone to the Quantifying Health Benefits of Energy Efficiency and Renewable Energy Conference Call. All lines have been placed on mute to prevent any background noise. If you should need assistance during the call, please press "star," then "0" and an operator will come back online to assist you. Thank you. I would now like to turn the call over to our first presenter for today, Denise Mulholland. You may begin your conference.

Denise Mulholland: Thank you, Laurie. Good afternoon, everyone. And welcome to today's webinar. This is the second in a series of three webinars that the Environmental Protection Agency (EPA) is hosting on Quantifying the Multiple Benefits of Energy Efficiency and Renewable Energy. And this one, as Laurie just mentioned, is focusing on quantifying health benefits. My name is Denise Mulholland and I am with the U.S. Environmental Protection Agency's State and Local Energy and Environment program. Our program works to support state, local and tribal governments as they're designing, analyzing and implementing programs that reduce the environmental impact of their energy use.

So we know that many of you are thinking about how to quantify the health benefits of energy efficiency and renewable energy and we truly hope that today's webinar is going to help inform your efforts going forward. But before we get started, I do want to turn it over to Alexis St. Juliana from Abt Associates who is going to explain to you how you can participate on the call today. Alexis?

Slide 2. How to Participate

Alexis St. Juliana: Hi. Thank you, Denise. And thank you, everyone, for joining today. There are two options to listen to today's webinar. The first is through your computer and, if you're doing so, please make sure that your computer speakers or headphones are unmuted. The second option is to call into the phone line. If you experience audio feedback while called into the phone, please try muting your computer speakers. All participants, whether connected via phone or computer audio, will be muted throughout the duration of the webinar.

Slide 3. How to Participate

Alexis St. Juliana: There are three different ways to participate during today's webinar. First, you can enter questions into the question and answer box on the right side of your screen. Please try to let us know who your question is for and we'll moderate all of those questions at the end. Anything that we don't have time to answer, we will compile and post responses on the EPA web site. And I'd quickly like to note that all of the hyperlinks that you see on your screen today should be active, so you can click on those and explore the content.

Slide 4. How to Participate

Alexis St. Juliana: The second way to participate today is through several poll questions. It should be fairly simple to participate, but users on mobile devices or tablets may need to exit full screen mode and tap on a poll icon which looks like a slip of paper dropping into a ballot box. And then, the third and final way to participate today is through our webinar feedback form. We'll share that at the end of today's webinar and you should also see that link in the question-and-answer box. So, Denise, that's all I have. Back to you.

Slide 5. Today's Agenda

II. Poll I

Slide 6. Poll 1

Denise Mulholland: Great. Thanks, Alexis. Well, hi everybody, again. Now that you know a little bit more about me and you've heard about how you can participate today, I want to kick off the webinar with a poll to just learn a little bit more about you and your experience quantifying the health benefits of energy efficiency or renewable energy.

So on your screen you will see some questions that we have for you or a question that says which best describes your experience with estimated health benefits of energy efficiency or renewable energy. So, first, you're new to this type of analysis. Second, you've estimated health benefits using screening level approaches or, third, you have estimated health benefits using sophisticated approaches. And you can – and this is just a pick one kind of answer, I believe. So just select your answer and we will give it a couple of seconds. OK. Well, it looks like – great.

It looks like the majority of folks are new to this type of analysis, so that's very exciting. Welcome. Hopefully we can increase your knowledge today on quantification methods that you can use in your own day-to-day work. So the way that it's going to work today, we're going to close out the poll.

III. Denise Mulholland, Environmental Protection Agency

Slide 7. Methods for Quantifying the Multiple Benefits of Energy Efficiency and Renewable Energy: A Guide for State and Local Governments

Denise Mulholland: And how we're going to go with the webinar is that I'm going to start the presentations today by giving a high-level overview of a resource that EPA has developed and recently updated. It's called Quantifying the Multiple Benefits of Energy Efficiency and Renewable Energy: A Guide for State and Local Governments.

You can use this how-to guide to learn about the different methods and tools that are available for quantifying these benefits. Then, what we're going to do is transition into having several speakers. We have three speakers lined up to – who are going to talk to about how they themselves have quantified the health benefits of energy efficiency or renewable energy.

And they're going to be presenting on a range of different methods, so from basic, intermediate and sophisticated approaches so that you can get a feel for how others have applied this type of analysis. And then, you can certainly go back to the guide after and learn more about the different methods that they describe. So, without further delay, I'm just going to jump right into the overview.

Slide 8. EPA's State and Local Energy and Environment Program

Denise Mulholland: OK. So this is a little bit about the program that I work on. Our State and Local Energy and Environment Program provides free tools, information and technical expertise to help states, localities and tribes understand, quantify and communicate the multiple benefits of energy efficiency among other things.

What we do is we appreciate that state and local governments have lots of different objectives and lots of things that they care about in terms of benefits and impacts and we work with them to support their decision-making; to save them time and resources by providing tools and information; and at the end of the day, help them benefit the environment, as well as public health.

Slide 9. EPA's Multiple Benefits Guide

Denise Mulholland: The resource that I just mentioned is called Quantifying the Multiple Benefits of Energy Efficiency and Renewable Energy. This is a resource that we – it's really a how-to guide that we - recently updated last summer.

It's split into two different parts. The first part of the guide is – describes what, why and when you would you would quantify the multiple benefits across a range of benefits that I'll talk about. And then, the second half of this guide is devoted to really explaining how to quantify them.

So it presents a lot of figures and tables and information that clearly presents the methods, the tools, the steps that you can apply yourself to quantify the benefits. And our goal is really to make it easier to understand the process and just empower you to be able to understand what your options are and you can compare across all the different methods and pick what works best for you.

Slide 10. Part ONE: What Are the Benefits of Energy Efficiency and Renewable Energy?

Denise Mulholland: So I'm going to walk through parts of the guide right now just to give a little flavor for what you can find when you get there. The first part, as I mentioned, talks about what are the benefits of energy efficiency and renewable energy.

And if you look at the schematic that's on the slide in front of you, going from left to right, you can see we have energy efficiency and renewable energy will essentially reduce total electricity demand and increase the amount of electricity generated from clean resources.

And the impact of that, you know, can result into reduced emissions. And we're talking about greenhouse gas emissions, criteria air pollutant emissions. This can improve air quality, improve public health, reduce premature death. And these are the types of benefits that we're going to talk about today or the benefits quantification methods to do that that we'll talk about today.

But certainly, energy efficiency also gives you benefits to the electricity systems – so it reduces the cost of electricity service and can help you avoid the need to build new big power plants. It can boost the economy. It can save your consumers money. It can create jobs and enhance economic growth.

And collectively, these benefits provide – they generate benefits to society and the resource can help you quantify all of these different types of benefits, but today, we're just going to focus on the emissions and health benefits.

Slide 11. Part TWO: How to Quantify Multiple Benefits?

Denise Mulholland: So, in part two, that's the part of the document where we really dig into the details on how to quantify them. And so, this schematic is just really an analytic framework that we've developed that just walks you through at a very high level where do you begin.

You know, first, you're going to figure out what's the scope and the strategy for the analysis. Is it a – how much time do you have, what kind of resources do you have, what's the need? The second thing you're going to do is determine the electricity impacts from your energy efficiency or renewable energy. That's really the foundation for any subsequent benefits analysis.

So you'll see in step three here we then present – from this electricity impact, you can quantify the benefits that you care about. So it's the electricity system benefits, the emissions and health benefits, or the economic benefits. And then from there, Step 4, you can use that benefits information to support informed decision-making.

Slide 12. Map Out The Benefits to Quantify: Relationships

Denise Mulholland: And so, once you choose – basically, I've laid out a couple of different benefit options that you can quantify. And for your analysis, of course, you're going to choose which benefit you care about and which – and there might be most that you care about.

So this slide here on slide 6, or 12, shows you how the benefits are mapped out within the guide and how they relate to each other. So the first box at the top is Chapter two on direct electricity impacts.

Again, that's the foundation for all future subsequent benefits analysis that you're going to do. And that would be – you could do electricity system benefits which are described – the methods are described in Chapter three, emissions and health benefits are described in Chapter four and economic benefits are described in Chapter five.

And each chapter provides step-by-step instructions on how to do the analysis. It provides a range of basic to sophisticated approaches that you can use, depending upon your need. It includes tips and key considerations, things to think about as you're doing an analysis, as well as lots of case studies and lists of tools, resources and data that you can use for your own analysis.

And one thing to note is that quantifying these benefits, there is a relationship. And so, you know, start – you start at the top of the electricity impact. But if you want to get down to, say, health benefits which are in the bottom of the middle column there, you have to go through the electricity impacts, you have to quantify the emissions impact and the air quality impacts typically to get to human health.

So there's – this sort of shows, you know, you can't just jump necessarily straight to that. There are some other things that you'll have to pull together to do your analysis and I'll talk through those next.

Slide 13. Use Flowcharts and Figures in the Guide to Navigate the Process

Denise Mulholland: So this chart, this figure shows what I was just trying to say a little bit more clearly. And essentially, the first step is to estimate your direct electricity impact and you can find more information about that in Chapter two.

The next step would be quantifying emissions reduction. That is described in part two Chapter four of the guide. And we covered the first – step one and two in our previous webinar that was last month and we'll be posting the materials for – from that. So for those of you who missed it, you can certainly find all the resources there and information.

But here, for example, we just – I just put out under step two some EPA tools that you might use to quantify the emissions impact. So you might use our Emissions & Generation Resource Integrated Database (eGRID) database to conduct just some basic-level analysis. Or for more intermediate-level analysis, you might use EPA's Avoided Emissions and geneRation Tool (AVERT) model and the speakers today are going to be talking about some of these models. So you'll hear a little bit more about them.

We're going to focus on steps three and four in my presentation and, again, those are also from Chapter four. But essentially, once you have your emission reductions, you'll need to get your air quality changes and – in some way - to get your health benefits.

Slide 14. Choose a Method for Quantifying Impacts

Denise Mulholland: And so, with any analysis, you're going to want to understand what the options are. And typically, you'll find – for any of the benefits you'll find basic, intermediate and/or sophisticated methods available. And then, there are some considerations that you have to think about as you're choosing.

So, for example, which benefits do you care about and what methods are available to estimate them? What level of rigor is needed? Is this a screening-level analysis or is it something that's for regulatory purposes and maybe needs to be more sophisticated?

What's the time period? Is it a short-term analysis or a long-term analysis? What are the data requirements? What kind of data do you have? What kind of financial cost does it require and how much do you have? So it's sort of thinking through what's the purpose and what do you have and what do you need and what's available?

Slide 15. Compare Method(s) to Evaluate Air Quality Changes

Denise Mulholland: So we're going to – so moving a little bit farther into the actual step itself, here is a slide that describes information about methods to evaluate the air quality changes or step three from that previous figure that I shared.

And I'm not going to spend a lot of time here except to say that most of the methods for actually doing air quality modeling are pretty sophisticated ones that use complex models that represent dynamic atmospheric chemistry and they can take a lot of time and require a lot of expertise to run.

But there are some basic models and basic approaches that – what we call 'reduced form methods' and those methods are usually based off of more complex analysis that kind of boils it down to a more simplified approach.

And you'll see that those are the methods that are often embedded into other tools that make it easier to do the health benefits quantification. So you don't have to do a full-blown air quality modeling analysis to come up with health benefits. There are these reduced-form approaches that can help you to do this without requiring this extensive complex modeling.

But when you're picking your air quality modeling, you want to be thinking about what kind of pollution – or what kind of pollutants are you interested in. Are you interested in particulate matter or ozone? What is it that you're most concerned about? Which sources do you care about?

What's the geographic scope? Are you looking at a very, very localized impact or is it OK if it's higher level? So these are just some things to think about and the guide provides you a lot more detail about how you might go about thinking about air quality modeling if you need to do that.

Slide 16. EPA Tools For Quantifying Health Impacts

Denise Mulholland: But, as I said, there are some tools that embed air quality modeling in them and you may not necessarily need to do the analysis yourself. So this slide here moves along more to step four, which is the – talks about tools for quantifying the health impact. And so, this specifically talks about EPA's offerings and what we provide for you if you're looking to do this type of analysis.

You'll see that we have basic and sophisticated approaches and tools and resources. So the basic approaches are typically factors, so they're derived from more sophisticated modeling. And they can just give you a sense of the benefits on either a per-ton basis or a per-kilowatt hour basis.

And essentially what you would do with these factors is you just multiply your impact, whether it's your emissions in tons or your kilowatt-hours in savings by the factor and you come up with a – you know, with the dollar value of the health benefit.

The more sophisticated approaches are available like CO-Benefits Risk Assessment (COBRA) and Benefits Mapping and Analysis Program (BenMAP) the models that are listed on the right. And they can provide much more detail about the specific health incidences that are avoided.

So if you look at the blue box on the bottom left, it talks about mortality; different types of bronchitis; heart attacks; different respiratory and cardiovascular hospital admissions; asthma attacks; work loss days. These are impacts that you can quantify using COBRA or BenMAP.

And these are – the difference is though that each model can do things a little bit differently. And so, it's important that you're looking at the different tools to figure out, OK, what is it that I need and what does each offer.

Slide 17. Compare Method(s) to Quantify Health Impacts

Denise Mulholland: And so, on the next slide, I have a table that you can find in the guide that is basically designed to help you pick which method might be appropriate for your purpose based on what the tool offers.

So if you're trying to figure out what's the difference between COBRA and BenMAP, for example, you can look at this table and you can – and also with respect to the – comparing it to the basic approaches, you can stop and think about, well, what type of effect do I want to look at? Do I want to know the actual numbers of health incidences or do I just care about the economic value? Maybe I want both.

What kind of emissions do I care about? Am I worried about particulate matter ($PM_{2.5}$) or ozone or both? And you'll see that, for example, COBRA covers $PM_{2.5}$, BenMAP can cover $PM_{2.5}$ or ozone. What type of data inputs do I have and what does it – what is required of the type of method that I have?

So, for example, a basic approach, you could just use your changes in air pollution and you can use that for COBRA as well as your input. If you've estimated your emissions benefits, then you can just plug those into those approaches. Similarly, for kilowatt hours, if you have those changes, you can apply those to a benefit per kilowatt hour factor approach.

But for a tool like BenMAP, you need to bring air quality modeling to it, so you have to have already done the more sophisticated air quality modeling to run BenMAP. And then, just some other things to think about are what's the level of expertise that's required and how flexible is the model?

So there are tools like – or there are tables like this within the guide across all the different benefits, not just the health benefits that can help you pick and choose and understand which methods and tools are available and appropriate for your purpose. This is just an example.

Slide 18. Explore Case Studies in the Guide

Denise Mulholland: And so, also, you can explore many case studies in the guide. And you can find out how others have applied the different methods and analysis and what they have done.

Slide 19. Learn About Available Tools & Data Resources

And then, you can also learn about different available tools and data that you can use yourself at the back of each chapter. So this is just something from the health chapter.

Slide 20. For More Information About EPA's Program, Tools, and Resources

Denise Mulholland: So, with that, I just encourage you to download the guides. Check it out. You can click on this link or we'll be posting these slides later. But, with that, I will wrap up my talk and move into the next part.

IV. Joy Morgenstern, California Public Utility Commission

Slide 21. Using U.S. EPA's CO-Benefits Risk Assessment model to estimate the value of avoiding criteria pollutant emissions

Denise Mulholland: So what we're going to do now is we're going to switch over to Joy Morgenstern. And the way that the speakers are going to go today, we're going to start with the more basic approach or somebody that maybe - Joy has developed a benefit per ton factor so - something that can be easily used again and again once it's developed.

And then, we'll be increasing levels of sophistication with the analysis going through Cassandra) and David who will speak about the most sophisticated approach today that we'll be talking about. So let's start with Joy.

Joy Morgenstern has worked at the California Public Utility Commission (CPUC) since 2005, focusing on cost effectiveness of demand response, energy efficiency and other customer programs. Joy has always been particularly interested in the social and cultural aspects of energy production and consumption. She has a Doctor of Philosophy (PhD) in energy management and environmental policy from the University of Pennsylvania. She has a Bachelor of Science (BS) in Physics from the City College of New York, a 12-year-old daughter who knows everything, and a cat. With that, I'll turn it over to you, Joy. Thanks.

Slide 22. Using U.S. EPA's CO-Benefits Risk Assessment model to estimate the value of avoiding criteria pollutant emissions

Slide 23. Integrated Distributed Energy Resources Proceeding

Joy Morgenstern: Hi. Let me plunge right in because I've got a lot to cover. What I work on is cost effectiveness of distributed energy resources and the proceeding I'm working on has a goal of making that framework more consistent and more accurate.

So, in line with that, in 2017, we issued a staff proposal to adopt a societal cost test with the three elements that you see on the screen. And I'm only going to talk about one of those three elements, the air quality adder. At the time we issued the staff proposal, it was – the societal cost test was very theoretical. We didn't have any concrete values. We expected the concrete values to come out of modeling that we would do as part of a research project. However, the research funding was delayed and we wanted to move this forward. So we tried to figure out if – could we come up with some sort of rough back-of-the-envelope values for these adders using existing resources? And the existing resources we had were basically me and an intern.

Slide 24. What are DERs?

Joy Morgenstern: Let's see. OK. So just so that you know, distributed – what we call distributed energy resources are – is essentially demand side technology. We're talking about the programs that you see in the bullet points on the bottom and it's just very, very important for us to make sure that these programs are cost effective because California spends somewhere between $1.5 billion and $2 billion a year on these programs.

And that's not including transportation and building electrification at the bottom there which are really in its infancy. And, in fact, those electrification programs didn't really come into this analysis, but they will in the future.

Slide 25. Air Quality Concerns

Joy Morgenstern: So the main thing we were concerned with is what happens when our programs reduce the demand for electricity, in particular, the last item. What is the cost associated with reducing demand?

Slide 26. Air Quality Adder

Joy Morgenstern: So we needed to develop an air quality adder. And, as far as we can tell from the literature, the predominant concern is really the human health-related impacts of air pollution. We needed an air quality adder that could fit into our framework which means that it had to be an avoided cost that would fit into our avoided cost calculator because that's what we use to estimate the benefits of our program.

We recognize that we wanted an adder that differed for different hours and different locations, but we knew that that would be very hard for this preliminary round in particular. Another thing that we would like, but we've yet to figure out how to do is relating decreases in demand with actual lower emissions.

Because our system is so big and so complex and so connected to, you know, the entire West Coast, it's very hard to say if you didn't decrease demand for electricity in one location where the resulting decrease in air pollution is going to occur.

Slide 27. Which criteria pollutants, from where, and from which type of plants?

Joy Morgenstern: OK. So then, here are some decisions we had to make. Which criteria pollutants? We decided nitrogen oxide (NO_x), sulfur dioxide and $PM_{2.5}$ were the ones we were going to consider. In terms of the technologies, obviously, we're most interested in fossil fuel or our system is mostly natural gas, but we do have some coal-based electricity. But we were also interested in better understanding the emissions from biomass and geothermal plants.

And then, there was the question of where – which power plants are we going to include in the analysis because we import about 20 percent of our electricity.

Slide 28. Which databases to use?

Joy Morgenstern: O.K. In terms of data, obviously, we're limited to what data we could get which was mainly eGRID. And the 2016 version wasn't out yet when we did this. So we were working with somewhat old data, but we supplemented that with the California Air Resources database which reports emissions from every power plant in the state and then also from the California Energy Commission's Quarterly issues a report on all the power plants in the state and what their status is. And then, we discovered that the Air Resources Board, the Energy Commission and the federal government each give every power plant a unique ID number except that it's not the same unique ID number. So in order to make sure we were collecting data correctly, we were very happy to find that the Energy Commission had created a cross-reference table, but that added some work to the project.

Slide 29. Which model to use?

Joy Morgenstern: The first model that I looked at was BenMAP. I downloaded it, I read some stuff and I couldn't make heads or tails of it. So I sent out a lot of e-mail. And, fortunately, Denise got back to me and told me if I was going to use BenMAP I needed to input an air quality model. And I wasn't even quite sure what an air quality model was, but I told her what I was trying to do and she suggested using COBRA which is a lot simpler to use.

We did look at those other models, but the other models there let me know – I can tell you a little more about them if you're interested, but they are not tools that estimate cost although they're all models that I think we're going to use in the future.

Slide 30. How to sum the data?

Joy Morgenstern: In terms of adding up the data, this is where our supposedly back of the envelope analysis got really complicated. And just to start from kind of the last question first, the first thing we had to figure out is, when we add up all the generation in the states, should we include every power plant that we get electricity from or only those that are actually what I call emitters.

And we decided we could narrow it down to the emitters, in other words to eliminate wind and solar because our avoided cost calculator has other methods of determining when wind and solar are on the margin.

I should mention that the way we do our cost effective analysis it's all about the marginal unit. So we really only care about that and the avoided cost calculator basically eliminates any hours where renewables are on the march.

And then, we have the question of do we include every power plant or only those that sell to the utilities we regulate? The CPUC regulates about 75 percent of the electricity sold in California. The rest is sold by municipal utilities.

But then, we decided that we really – we really couldn't say for sure which power plant sell to which utilities. We know which ones are selling right now, but our analysis goes out 30 years in the future.

So even a power plant that today is selling all of its electricity under contract to a municipal utility could perhaps, in 10 years, be selling into the California Independent System Operator (CAISO) market or engaged in a contract with another utility.

And then, there was the question of do we include all of these out-of-state power plants because 20 percent of our electricity comes from out of state. And we decided no because – simply because we don't have that data.

Much of our imports are what's called unspecified – come from unspecified sources. We know the total generation we buy, but we just don't know which power plants they come from. So we limited it to in-state emitters.

And then, there was a question of do we adjust it. The eGRID database includes a non-baseload factor for every power plant and it was suggested to us that we should multiply the emissions and generation numbers for each power plant by that factor basically to weight the power plants that are most likely to be on the margin.

Another decision we had to make that was interesting is, once we calculate our emissions per unit of generation, then, in terms of the impact, do – the question arose is do we count the impact within California or out of state as well?

Somebody from California Air Resources Board (CARB) said, "Well, you should decrease the final number by 20 percent because 20 percent of our demand reductions are actually going to affect out-of-state power plants."

And we talked about it and we decided to reject that idea because, if we weren't including the emissions and the generation from those plants, it didn't make sense to exclude the out – the effect as well.

And, at the same time, I felt that even if air pollution is reduced somewhere out of state as a result of our actions, it's still the actions of California rate payers that are creating the pollution and then, hopefully, alleviating the pollution by eliminating the demand.

And we also felt like it's just absolutely impossible to draw a line around the state. If we tried to do that, we would – we'd have to figure out, well, how many tourists are there at Disneyland and are they benefitting from air pollution reductions? It seemed like a bottomless pit of speculation.

Slide 31. Assumptions and Steps

Joy Morgenstern: OK. So the steps we went through to do the analysis – there we go. The very first run we made in COBRA was before we adjusted it and before we limited the total generation. So we got a relatively low number.

But one thing we noticed was that about two-thirds of the impact was coming from the sulfur emissions and about half of those emissions were coming from just four coal-burning power plants. And the problem with that analysis is, of those four plant in California, three of them had actually been decommissioned by the time we did the analysis.

So using the Energy Commission's quarterly data, QFER, we went through the eGRID data and eliminated all the decommissioned plants. And then, eGRID only has NO_x and sulfur emissions data, so we added the $PM_{2.5}$ data from – that we got from CARB. And then, at that point, we decided to use the adjusted emissions and limit it to in-state emitters.

Slide 32. Results

Joy Morgenstern: And here is the final output that we got. This is the output table from COBRA. And so, you can see we did it on a gigawatt-hour basis just because it was too small otherwise. And we got this range of $2.64 to about $6 per megawatt hour.

We decided on using the high end because we weren't considering the out-of-state generation. We weren't considering other pollutants such as volatile organic compounds (VOCs). We felt that it was more likely that the high end was what was accurate. So we recommended – we issued a revised – an addendum to our staff proposal recommending a $6 a megawatt hour air quality adder.

Slide 33. Outcomes and Impacts

Joy Morgenstern: That allowed us to have definite values in our societal cost test. It allowed a proposed decision to come out which the Commission is voting on today, in fact, about having a – using a societal cost test.

Slide 34. Challenges

Joy Morgenstern: OK. Here we go. So some of the challenges I've already talked about. We're not totally convinced that the avoided cost calculator is always doing the best job at accounting for when renewables are on the margin, particularly biomass or geothermal are ever on the margin. It's – that analysis is not going to be quite correct. So that's one of their biggest challenges in addition to determining, as I – as I said before, in addition to determining exactly where the decreases in air pollution are occurring. We also recognize that this $6 a megawatt hour estimate which is a state-wide estimate is really of limited usefulness because air quality does vary so much. We know we really need a much more localized model. So we're considering this to be simply an interim value.

Slide 35. Lessons Learned

Joy Morgenstern: We want to do more in-depth study possibly using BenMAP to develop a model that is much more robust in terms of determining what's on the margin, which technologies where the emissions are occurring, how we can impact local emissions. And, in particular, we're going to need a model that can incorporate the impacts of electrification which are actually increasing the electricity load. And as the grid changes and we add more renewables, the national gas power plants are being dispatched more often. So changes in plant dispatch can have a big impact on criteria pollutant emission and greenhouse gas (GHG) emissions even when the total amount of energy they generate remains the same. So these are all things that we know we need to look into in the future and then hopefully a more robust research project will develop.

Slide 36. For More Information

Joy Morgenstern: OK. Thank you.

Denise Mulholland: Thank you so much, Joy. That was incredibly informative and it's certainly a lot of information I think hopefully folks will find really useful.

V. Poll II

Slide 37. Poll 2

Denise Mulholland: So I think what we're going to do as we transition into – before we transition to our next speaker is to do another poll. And here we just want to get a sense from you all in the audience of what types of information and resources would be most helpful to you related to quantifying health benefits. So, for example – and you can – you can click any and all of these if they would be of use to you or of interest to you.

So, essentially, would it helpful for you to have more resources to help you quantify health benefits and by resources we mean sort of information products, not money – resources to help communicate health benefits, case studies about what other states or local governments have done to quantify health benefits or if you select other, you can – feel free to do that and then just send us a little note in the question and answer (Q&A) box that lets us know what you're thinking would be most helpful in this area.

So I'll just kind of give it a – give it a couple of seconds here. OK. All right. So certainly it sounds like or it looks like we have case studies would be helpful as well as just information on quantifying health benefits would be would be helpful to have as well from the communication resources, so good. OK. Well, thanks so much. This is really helpful and we'll use this to shape the types of projects or resources that we invest in, so great.

VI. Cassandra Kubes, American Council for an Energy Efficient Economy

Slide 38. Saving Energy, Saving Lives: The Health Impacts of Avoiding Power Plant Pollution with Energy Efficiency

Denise Mulholland: OK. Well, with that, I'd like to then shift into our next speaker, our next presentation. And so, I'd like to introduce to you Cassandra Kubes. She is a research manager for the Health and Environment Program at the American Council for Energy-Efficient Economy, so ACEEE.

In this role, Cassandra conducts research, analysis and outreach and opportunities for energy efficiency to reduce air pollution, improve public health and mitigate climate change. She provides technical support and educates decision-makers on strategies to advance energy efficiency, policies and programs. Before joining ACEEE, she worked as a policy associate at Midwest Energy Efficiency Alliance and at SoCore Energy where she analyzed solar energy policy.

Cassandra holds a master of public policy with a focus on environmental policy from George Washington University and a Bachelor of Art (BA) in people, environment, geography from the University of Wisconsin, Madison. Cassandra, take it away.

Cassandra Kubes: OK. Great. Thanks so much, Denise. And thank you for having me on today's webinar.

Slide 39. Saving Energy, Saving Lives: The Health Impacts of Avoiding Power Plant Pollution with Energy Efficiency

Cassandra Kubes: So I'll be going through an analysis that ACEEE did. Let me get this first slide up here – that we did recently back in 2018 looking at the health impacts of avoiding power plant pollution with energy efficiency using a few of EPA's tools that Denise mentioned and one of which that Joy talked about in the previous presentation.

Slide 40. ACEEE

Cassandra Kubes: So, first, a bit of a background on ACEEE for those of you who may be unfamiliar. We are a non-profit organization going on forty years. And we work on energy efficiency policies, programs, technologies, investments and behaviors and our work spans across levels of governments in addition to some international work that we do.

And, as Denise mentioned, I'm a member of our health and environment team and we focus on performing research and outreach on the health and emissions impacts of demand side energy efficiency.

Slide 41. Agenda

Cassandra Kubes: So here's a rundown of what I'm hoping to cover today. I won't spend too much time on this to make up for some time on the backend here. But, basically, I'll go over – I want to get everyone on the same page with what we're talking about when we talk about energy efficiency, if some of you aren't as familiar with energy efficiency.

Slide 42. Energy Efficiency Improves Public Health

Cassandra Kubes: So it's really achieved when outdated practices and technologies are replaced with new and less wasteful approaches. So, you know, for example, in our homes, our offices, some of the ways we can employ efficiency include tightening building envelopes so that condition air doesn't leak out or cold draft don't come through in the winter, replacing incandescent light bulbs with light-emitting diodes (LEDs) or swapping out old appliances with new and more efficient ones.

And there's a really long history of energy efficiency being employed in all levels of government. We, at ACEEE, have annual energy efficiency scorecards where we track progress on a set of energy efficiency policies and programs in states and cities and also at the international level.

And just, for example, to give you an idea of how energy efficiency is happening across the country, more than half of states have a long-term energy savings goal currently in place and every state has some kind of energy efficiency programs that are being operated by electric utilities or third parties.

And aside of those utility programs, there's a wide variety of other programs and policies including things like building energy codes, fuel economy standards, and appliance and equipment standards.

And so, one of the things I really want to focus on today is a set of benefits from energy efficiency, of which there are many, and what we call non-energy benefits of efficiency beyond saving energy and saving money. And those are the environmental and health benefits that result from using less energy and, therefore, burning less fossil fuels and reducing those pollutants that they emit.

Slide 43. Energy efficiency protects the environment

Cassandra Kubes: So, on the next slide here, taking a deeper look at the environmental impact, you can see from this graphic that the environmental benefits of efficiency span really across sectors. Efficiency reduces pollution by reducing the amount of fossil fuels we burn which means harmful pollutants like carbon dioxide (CO_2), nitrogen oxides, sulfur dioxide, particulates are eliminated. And also, neurotoxins like mercury are eliminated.

And as you can see from the graphic here, it helps to mitigate water pollution from electric power and industrial sectors as well. But one of the areas that I'm going to focus on today and one of the areas that the tool is focused on, in particular AVERT, is the power plant reductions and emissions that can occur from energy efficiency.

Slide 44. Health Effects of Fossil Fuel Pollutants

Cassandra Kubes: So all of these reductions in emissions can really have big impacts on improving public health. And, as you can see from this graphic, that we released with the Physicians for Social Responsibility a few years ago, the air pollution caused by burning fossil fuels really damages all the major organ systems in the body.

The fossil fuel combustion pollution contributes to four leading causes of deaths in the U.S., including cancer, chronic lower respiratory diseases, heart disease and stroke. And many of the health harms resulting from power plant emissions tend to be worse near the smoke sacs. So energy efficiency can particularly benefit those populations near emitting facilities.

Slide 45. Plant capacity by power source

Cassandra Kubes: And I wanted to pull out this map to give you an idea of one of the big factors that's involved in – when we're looking at the emissions reduction benefits from energy efficiency. As you can

see here, the fuel sources really vary greatly across the country with more hydropower, for instance, in the Northwest. You can see here coal concentrated across the Midwest for the most part and Natural Gas is really across many regions.

And the fuel source that energy efficiency is reducing generation from is really a key factor in the types of pollutants and the quantity of pollutants that are – that are being reduced. And another big factor is the location of power plants.

You know, the electricity we use is generated by multiple sources, not just the power plant that's down the street from you. So reducing fossil electricity consumption can really affect emissions and electric generating units throughout a grid region even.

And Joy mentioned that dispatch order is also a factor. And other things that are factors in terms of looking at the health impacts as we'll see when we kind of dig in more to COBRA is things like wind patterns and population data. So meaning that the health benefits of energy efficiency would be greater in areas with a larger population, but also in communities closest to those emitting forces.

Slide 46. Saving Energy, Saving Lives

Cassandra Kubes: So that's where our analysis comes in. It's called Saving Energy, Saving Lives. So what we wanted to do is really get a better understanding of how it is that energy efficiency reduces pollution and improves public health across the country.

So we partnered with Physicians for Social Responsibility, or PSR, and we released a report early last year looking at where efficiency can produce the most substantial public health benefits. And we present the results nationally ranking states and the 50 largest U.S. cities as you'll see.

And we described some of the ways – in the – in the report, we described some of the ways that these results might be achieved and how energy efficiency programs and policies can be designed to really maximize public health benefits. So I encourage you to click on that hyperlink if you're interested in more details.

Slide 47. Methodology

Cassandra Kubes: But I'll give an overview here of our methodology and some of the high-level results. So, first, with our methodology, we did a lot of thinking on the front end for how we wanted to apply the energy efficiency. Do we want to base it on a certain policy and apply that across what states are actually achieving? Do we want to do something a little bit more aspirational or something realistic?

So what we ended up doing was selecting a flat percentage reduction in electric use that's – it's really representative of a goal that's readily achievable in various ways really in any U.S. region. So the scenario applies a hypothetical 15 percent reduction in annual electric consumption and it applies it evenly across the country.

And we chose this level of savings because we think it's attainable everywhere in the U.S. and it's already been really widely achieved. I mentioned the scorecards that ACEEE puts out where we kind of document states and city progress toward a set of energy efficiency policies. So we do collect energy savings data as part of that scorecard process.

But also, we do a lot around applying standards. And states across the nation are currently saving between 7 and 18 percent of electricity sales per year due to federal standards that set efficiency performance minimums for appliances and equipment.

And multiple states already have policies in place that reduce annual electric consumption by 20 percent or more through things called energy efficiency resource standards or really energy savings targets that are implemented by utilities.

And so, for this, we really wanted to assume that a state or a city can really achieve that. And the point here I do want to stress is that the results in this analysis are over the course of one year, but energy efficiency produces savings over the course of many years. As you could imagine, installing a light bulb just gets the benefits of that for one year. You did it for the life of that – of that LED. So it's something to keep in mind when we go through the results in a little bit.

But the next step after we chose our amount of energy savings, we entered that into EPA's AVERT tool or Avoided Emissions and geneRation Tool. And that is an emission quantification model if you're not familiar. It identifies the quantity of pollutants that would be reduced and the counties where these emission reductions would be occurring as a result of the energy efficiency that we're entering into the tool.

And what AVERT does is it captures the actual historical behavior of fossil fuel powered electric plants to predict how these units would operate when energy efficiency is then added into the grid taking into account some of those factors that we've looked at earlier of that map of the plants across the country. And we then estimated the displaced emissions from these energy savings. You can choose a baseline year, so we chose the 2017 baseline year and then applied the energy savings across the year.

So then, after that, the third step was that, after getting these county-level reductions and certain pollutants due to the energy efficiency coming online, AVERT actually produces a COBRA-ready file that you then just take and truly save and plug in to the COBRA model, so it's as easy as that.

And – but unfortunately for our analysis, that – the great update to –I've heard in COBRA we're a little too early and that update didn't exist yet. So we ended up entering in the data for all the counties into COBRA.

But either way – the two tools are really easy to use together. And so, we took all of that information, the $PM_{2.5}$, the sulfur dioxide (SO_2), the NO_x reductions across counties due to this energy efficiency coming online from AVERT and we entered them into COBRA to get the avoided health harms due to our energy efficiency scenario. And Denise talked about AVERT earlier and you heard about it from Joy too, so I won't get too much into the particulars of COBRA here. But I will talk about them as they relate to the results.

Slide 48. Save Energy. Protect *Health*.

Cassandra Kubes: So here you can see energy efficiency by reducing annual electricity use by 15 percent can result in some pretty significant benefits, including thousands of lives saved or a reduction of six premature deaths each day, 30,000 fewer asthmatic episodes, and it can save up to $20 billion in avoided health harms.

And that number I do want to parse out for a minute because you'll see in the COBRA tool if you download it and look through the – you know, the background manual, this $20 billion, a lot of it came

from avoided premature adult mortality. And other values roped into that – to that – to that large amount is per incident values of non-fatal heart attacks and hospital admissions.

So there's a lot of other things that COBRA estimates and then monetizes to be roped up into this larger number that are actually parsed out when you look at the results in COBRA. So you can really get down into some more detail and see what data points you'd like to use and what would work best for your analysis.

Slide 49. Top 15 state by avoided annual health harms, low and high range (US$)

Cassandra Kubes: So here are – I mentioned that we ranked the states and cities. So here is a ranking of the top 15 states by avoided annual health harms from low to high in U.S. dollars. So we – so the description here is a little bit strange how to – how to word it because avoided and benefits and things like that.

So it shows where energy efficiency can have some of the greatest health benefits to residents. So, you know, some of the greatest opportunities as you can see here are in the Upper Midwest, Mid-Atlantic and Southeast and we show that Pennsylvania you would see the greatest aggregate health benefits from this reduction in annual electricity use followed by New York and Ohio with North Carolina rounding up the top 10 there.

Slide 50. Top 15 states by avoided health harms per capita, low and high range (US$)

Cassandra Kubes: And then, we also break down the results per capita. So the states that are color coded here and kind of a tan color, those are the ones that are also on the previous list. So you can see where some maintains in the top 15 and others kind of fell out of the ranking.

But when you break the results down per capita, you can see West Virginia would see the greatest benefit per person, $140 or $184, excuse me, on average.

Slide 51. Top 15 cities by avoided annual health harms, low and high range (US$)

Cassandra Kubes: And then, when we look at the results based on the ranking of cities, these are the top 15 cities. It shows that New York City would see the greatest benefit, so it's more than $1 billion in avoided health harms over a one-year period with Cincinnati and Atlanta rounding out the top 10.

Slide 52. Top 15 cities by avoided health harms per capita, low and high range (US$)

Cassandra Kubes: And then, looking again here the same goes for the color coding. And, on average, the dollar value of avoided health harms would be more than $70 per person in these 15 cities across the country with Pittsburgh, as you can see, seeing the greatest per capita benefits with more than $200 per person on average.

Slide 53. Using the Results

Cassandra Kubes: So I want to just quickly highlight some of the challenges and how we've used these results. Just in terms of challenges I did mention that we did this analysis before EPA did their update that streamlined the two tools, AVERT and COBRA. So now it's super easy to do and super quick which is great.

Also, the report is intended to be targeted to health and efficiency professionals, so trying to communicate the results in a way that would be effective for both of these sectors was a bit of a challenge in the messaging. So that's something to consider - your audience with these data points using these tools.

And then, also I'd mentioned earlier but I want - a point worth mentioning here again after you've seen the results is that these are annual results and energy efficiency – the benefits of efficiency – all the benefits really accrue over the) lifetime of the measure being installed. So that's something to really consider when – how you – how you view these results, but also how you communicate them.

And you can see some of the uses for the results that we've had very quickly and may last, well, over time. But I just really want to highlight this is that – what I think is that COBRA is really – some of the benefits of the tool is that it's super effective for understanding the health benefits of efficiency and other technologies by location.

And what's great about it is that it can be used to educate decision-makers and really turn out results quickly to impact policy development relative to other types of models. And, just as an example, we've been able to use COBRA recently even to describe health impacts and energy efficiency policies have had in states that are looking to either adopt stronger efficiency policies or, in one case, vulnerable to rollback of efficiency. So it's something that, in its streamlined use, is really great to have a timely application.

Slide 54. Thank You

Cassandra Kubes: So, with that, I will end things here and turn it back over to Denise.

Denise Mulholland: Thanks so much, Cassandra. I – it's really interesting to see the state-by-state and city-by-city results. And, yes, I still – I've always felt bad that we couldn't get the feature to you before you had to manually submit pollutant changes for three pollutants into 3,000 counties.

So I'm glad that we've streamlined that for you and it's just a matter of saving it and uploading it, two little steps at this point for anybody else. So thanks for going ahead and sticking to it. So thank you very much for the presentation.

VII. David Abel, University of Wisconsin

Slide 55. Quantifying the Air Quality and Health Benefits of Power Sector Transitions

Denise Mulholland:

OK. At this point, I'm going to switch it over to introduce David Abel, who is going to describe a more sophisticated application of health benefits modeling. And David is a post-doctoral research associate at the University of Wisconsin in Madison with appointments at the Nelson Institute Center for Sustainability and the Global Environment and at COWS, which is a high-road policy think and do tank. His research focuses on interdisciplinary modeling to assess the air quality and public health impacts of the electric power sector.

David completed his PhD in environment and resources with an emphasis in energy analysis and policy at the University of Wisconsin where he also received a BS and Master of Science (MS) in mechanical engineering and environment and resources. So, with that, take it away, David. Thanks.

Slide 56. Quantifying the Air Quality and Health Benefits of Power Sector Transitions

David Abel: Thanks, Denise. And so, the great benefit of following Cassandra is that we actually work together on the study that I'm going to talk about the most. But, in general, if you couldn't tell from that background that Denise just gave, this is a topic that's very near and dear to me. It's what I spent the better part of the last six years working on in various ways.

Slide 57. Thank You to All Sources of Support and Collaborators

David Abel: And so, I've got the task today of talking about some of the more sophisticated methods, but don't tune out yet because I promise I'm going to keep it simple and I'm also going to bring it back to the simplest form I think possible to do this type of work. And so, to start, I got a lot of obligatory, but truly heartfelt thank yous to all of our sources of support and collaborators for the work I'm going to talk about. You can see ACEEE there, as well as National Renewable Energy Laboratory (NREL), National Aeronautics and Space Administration (NASA) and the Lake Michigan Air Directors' Consortium and many other sources.

Slide 58. No title

David Abel: And so, I like to always start my presentations with this slide because this is really what I've spent the last six years working on is this space. And, today, we're really focused on those far right two bubbles of air quality and health.

Slide 59. Research Questions & Policy Objectives

David Abel: But I really think they're all tied together and have been motivated by these research questions or policy objectives to really -can we, from an academic and scientific perspective, improve the understanding of interactions across climate and meteorology and electricity and emissions, air quality, health et cetera, et cetera. But then, also, can we use that understanding to identify and quantify cost effective win-win solutions for health, air quality, economy, workforce, on and on.

Slide 60. Slide adapted from Tracey Holloway

David Abel: And so, to start, just to make sure we're all on the same page, I want to define a couple of things, one being emissions. For this work that I'm talking about it's predominantly focused on sulfur dioxide and nitrogen oxide emitted from power plants. And then, of course, those go into the atmosphere. We have chemistry and all sorts of things that happen up there, so we end up with concentrations of fine particulate matter, $PM_{2.5}$ and ozone.

And the benefit – the main benefit which I'll put out there now, I think, of using some of these sophisticated tools is that the ozone chemistry is far too complex to be captured by some of this simple ones. So if you want to consider ozone, these tools are sometimes the only way to do that. And then, of course, we can't forget about this other pollutant, carbon dioxide, which, of course, is the leading contributor to climate change.

Slide 61. Why Care?

David Abel: And then, I also want to make sure to put there why do we care about this at all? Why are there 100 people on this webinar and why is it worth quantifying the benefits of air quality?

And the reason is that it's – you know, they're huge benefits. We spend $50 billion a year roughly to achieve the clean air standards set out under the Clean Air Act. But the reason we do that is because we've historically had 30 to 1 returns in health benefits from there.

And air quality in the U.S. has luckily been a success story. You can see in the satellite imagery here this is concentrations of nitrogen dioxide (NO_2) in 2005 and 2016.

Slide 62. Why Care?

David Abel: We've seen drastic reductions. And a big component of that change has been installing technological controls on power plants.

However, that's not to say this problem is solved. In the U.S. there is still about 100,000 deaths a year that are attributable to air pollution and globally is a problem that is way worse and getting worse in many, many places. I think the best number to describe that is that 91 percent of the population is exposed to levels above what the WHO, or the World Health Organization, deems safe – 91 percent of the world's population.

Slide 63. No title

David Abel: And so, with that preface of why we care about these things, the reason I said it's great to follow Cassandra, not just because she's such a great speaker and can introduce this so well, but also because it saves me the work of talking about this because the first study that I'm going to talk about is really an extension of the work that they did over there at ACEEE, using some more sophisticated tools almost from an academic perspective to see how accurate these simplified tools are.

And to ruin the punchline right away I'll say that we got a lot of the same conclusions that Cassandra just presented which is great news for using those screenings, simplified tools for buried analysis.

Slide 64. What is the impact of 12% Energy efficiency nationwide?

David Abel: So this work was published in Environmental Science and Technology (ES&T). I wanted to make sure that I said, unfortunately, ES&T is a – is not an open-source journal. So if you want this –

access to this paper, please send me an e-mail or you can find it on Research Gate and request it directly through there and I'll get it to you.

But again, here, the research question is what are the impacts of 15 percent energy efficiency? And for this study we actually only focused on the summer months where it ended up being a 12 percent scenario. So what is 12 – what is the impact of 12 percent energy savings nationwide on air pollution and public health?

And to do this we used three tools. I'll skip talking about AVERT because there was a great webinar in this series last month that talked a lot about different emissions quantification methods but also because Cassandra did such a great job explaining it.

And I'll focus on the air quality tool and the health tool, which have both been up on slides that Denise showed at the beginning, one being – the first being CMAQ or the Community Multiscale Air Quality Model.

So this is what will be called a chemical transport model when it calculates air quality on a grid throughout your domain which, for us, was the contiguous U.S., and then BenMAP, the Environmental Benefits Mapping Analysis Program which ties that air quality result to the health outcomes that we care about.

Slide 65. National Summertime Displacement

David Abel: And so, to start with, how did emissions change? Well, you can see here a couple of maps where each bubble represents one power plant. On the top you're looking at NO_x, on the bottom you're looking at CO_2 displaced at each power plant by investing in energy efficiency.

And the colors there represent the types you can see. Coal is dominant and gas appears – gas appears there as well. But overall, we save – if we reduce 12 percent of our energy demand, we save about 12 percent across the board emissions-wise. It's a little bit higher for NO_x and SO_2. And if you want to look at that on an emissions rate, it's about 0.49 kilograms per megawatt hour or 0.61 kilograms per megawatt hour for SO_2 and NO_x, respectively.

And these are in the paper, but also here to reference specifically for this scenario that if you would like to do a more simplified analysis these numbers can then be applied as a national average or an energy efficiency program, for example. As it saves 1 megawatt hour you can count on it probably saving within this range of emissions.

Slide 66. Chemical Transport Modeling

David Abel: And so, I will take a step back to talk about chemical transport modeling itself. And this is a really sophisticated diagram here and I'm not going to talk about it much at all except to say that these models are very sophisticated.

And so, the source here you can go look up CMAQ online. It's an EPA tool. It's free and open source. But it does take a significant amount of expertise to run because there are so much that goes on in here from chemistry to meteorological impacts to emissions all captured in one model.

Slide 67. Chemical Transport Modeling

David Abel: But essentially what the model is doing is it's dividing the domains, so for us in the U.S., into a three-dimensional grid. So you end up with these grids, squares or cubes and for us it's every 12 by 12 kilometers is one square and then there is 27 layers into the atmosphere.

And then, within each one of those boxes, there's really just six things happening and these are all dependent on chemistry and other things like that that make it more complicated. But there's really just six things happening.

One is that chemicals are entering that box through emissions; or they're leaving through deposition, so being deposited back to the surface of the earth; or they're blowing into that square or blowing out of that square because pollution goes around in the atmosphere; or lastly, they're being produced chemically or destroyed chemically.

That's really all that happens. It's just made much more sophisticated by the fact that these things are all super dependent on meteorology and topography and that there are hundreds or thousands of these cubes and dozens of pollutants and 20-some layers in the atmosphere. And multiply all these factors together – and I've done it before – and I think you end up in a trillion sometimes depending on how big your domain is.

The best reference I think for how sophisticated this is – not to scare anybody away – but the modeling that we did for this study that I'm – that I'm talking about took about two months' computational time, a little bit better than what the typical desktop that you would buy, so it's a computer with 16 processors, so two months of computing time.

Slide 68. 45 (6.2%) Non-Attainment Counties Gain Compliance

David Abel: But what you get then that you can't get with any of these other tools is a very sophisticated and local grid of air quality data for all of these different pollutants. And so, to just zoom in and look at ozone, what I'm showing here, we have actually aggregated from that grid to a county level and then counted the number of days that ozone exceeds 70 parts per billion.

So if you're not familiar with the standards, the ozone is regulated such that, if you have four days where the maximum daily eight-hour average ozone in your county is above 70 parts per billion, then you're not achieving that federal standard.

And so, any county here on the top map that is in yellow or darker is at least in danger of not achieving their standard. This is corrected for monitor. Bias model, of course, is not exact, so this will not adhere.

For one of these counties you may be achieving the standard even if this map says you're not. That's because this is calculating my model, not reality. But it's worth making a point that if the model is saying you're not achieving the standards it's at least a danger that needs to be consider. And in the bottom, which is the good news, is the number of exceeding states that can be avoided – excuse me – solely through investing in this 12 percent energy efficiency over the summer.

And it ends up being at about 6 percent of the counties that don't achieve the standard can gain compliance solely through energy efficiency, which I think is a really powerful outcome especially considering the fact that only one state ever has included energy efficiency as part of an air quality management plan and that's Texas. It is actually in the early 2000s.

And they removed it from their plan later because it's just difficult to quantify which to bring us full circle is why and it's great that there are so many people on this call and so many tools that are being developed to do this type of work.

Slide 69. BenMAP

David Abel: So then, the second tool that I want to talk about – and it looks like I missed my header here, unfortunately, sorry – but this is BenMAP. So this is quantifying the health outcomes once we have that map of air quality.

And I like to call BenMAP a glorified data management tool. It's basically using geographic information system (GIS) techniques or geographical information systems techniques to combine a map of pollution, a map of population, a map of baseline incidences of health outcomes, and then effects estimates which comes from epidemiological literature and multiplying those altogether to then quantify the actual health impact from a change in pollution. And then, a subsequent step of BenMAP can be used to monetize those impacts.

And then, this little pyramid in the bottom is showing – it's just an example of some of the types of things that BenMAP can quantify from, you know, cardiac effects and asthma, all the way up to premature death and emergency room (ER) visits.

But all of this, it's not too different from what you would do in COBRA or what you could do with just an epidemiological study outside of BenMAP. What can be difficult with BenMAP is making all of these – formatting all of these data sources so that BenMAP can use them the way it wants to. But I would recommend to anybody who's thinking about using BenMAP to look into it. The difficulty might be calculating the pollutant change but that's aside.

I also wanted to mention there is a picture of a young girl's face here. I believe her name is Ella Kissy-Debrah. She is kind of a sad story, unfortunately. But she died a few years ago in London after having severe asthma attacks her whole life.

And the reason I put her here is because she just recently – you know, I think just a couple of weeks ago, the courts there granted – her mother has been fighting for the last year or so to actually have pollution – air pollution listed on her death certificate rather than acute respiratory failure like it is now because they knew there was such a correlation between her asthma and the unsafe illegal pollution that was going on in London at the time.

Slide 70. $PM_{2.5}$ and O_3 Mortality

David Abel: And so, the result – final results from this study here which are interesting to compare with Joy's results at the beginning, we find that 12 percent energy efficiency can save about 500 deaths, 300 from $PM_{2.5}$ and 173 from ozone every year. You can see the breakdown by state and Cassandra did a great job of breaking it down by city and you saw much of the same – much of the same results that she has already presented.

But another quantification here per kilowatt hour of energy saved is about 3 cents per kilowatt hour from $PM_{2.5}$ and about 2 cents per kilowatt hour from ozone. And if you're familiar with how much electricity costs, that's about 50 percent of what we pay for electricity. And so, the narrative here that I like is really we're paying – if we save a unit of energy, we're saving what we pay, but we're also saving an additional 50 percent on top of that in general public health.

Slide 71. What would be the air quality and health benefits of pursuing 100% renewable operations in Madison, WI?

David Abel: And now, to talk about one last thing bringing this back to super simple, this is something that the city of Madison, Wisconsin came to me after we published some of these results. And they said, "Hey, we are adopting 100 percent renewable standard for our city operations. Can we calculate the air quality benefits of that?"

Slide 72. 100% Renewable Madison will save dollars and lives through reductions in air pollution

David Abel: And I said, "Sure, of course." What we'll use is this sector-based $PM_{2.5}$ benefit-per-ton estimates that Denise and Joy talked about at the beginning. And what we find is that, just by saving – or just by having city operations go 100 percent renewable in a 250,000-person city, we can save $3.5 million to $4.7 million in regional health benefits which comes out to about $14 to $18 per person. And that's a death every two or three years plus 25 to 30 work loss days and 150 to 190 reduced activity days avoided every year.

Slide 73. 100% Renewable Madison will save dollars and lives through reductions in air pollution

David Abel: And coming out of that will be a follow-up study to do a more sophisticated analysis based on a more robust version of the implementation plan using some of the methods that I talked about energy efficiency study.

And I have one more thing here, but I'm just going to stop there since I'm out of time.

Slide 74. 100% Renewable Madison will save dollars and lives through reductions in air pollution

Slide 75. Studies

Slide 76. Research Question:

Slide 2. Slide 77. Emissions Benefits:

Slide 78. 1. Interdisciplinary computer models of varying complexity are useful for analyzing energy, air, climate, and health.

Slide 79. THANK YOU

David Abel: And if you want to know about the same type of thing for the State of Wisconsin, feel free to reach to me. Punchline here, yes, these models are super useful for analyzing energy, air, climate, and health altogether and cost-effective solutions like energy efficiency do exist. Thank you.

Denise Mulholland: Great. Thanks so much, David. That was – that was really interesting and very understandable which I appreciate. It's easy to get nervous when you hear somebody is about to talk about something incredibly complicated and I think you did a nice job of making it accessible certainly from my perspective. So I wanted to just put out a little reminder for folks. We do have some questions that have been coming in, but certainly, if you have questions for the speakers, please feel free to send them in now.

VIII. Poll III

Slide 80. Poll 3

Denise Mulholland: I wanted to – before we switch though to Q&A, we are going to put up one more poll question for the audience and it is coming up. What we're interested in finding out is that, for your own purposes, now that you know how to – or you've learned hopefully more about quantifying health benefits, how would you be most – or how would you be interested in using estimated health benefits?

So you might be – and you can pick as many of these options as apply. So, for example, you might be interested in using health benefits in – for preliminary screening analysis or for cost effectiveness testing like for public utility commissions, for example; maybe to provide information to policymakers or to the general public; or even just to generally explore how energy efficiency and renewables can help you meet your health goals.

And maybe there are some other purposes that – or uses that you have for estimated health benefits that you'd like to share and you could select "Other", and again, just send it to us in the Q&A box so that we have an idea of how folks want to use this information. I'll give it a few seconds here or a minute. And again, select as many as apply.

OK. All right. We seem to have the one with most at this point seems to be providing information to policymakers and then kind of followed closely. I guess there is exploring how it can help meet health goals and similar to cost effectiveness testing, information to general public.

So that's really helpful to know, maybe not necessarily for screening analysis as much, and we'll check out the Q&A for the other box. So thank you very much. This is really helpful.

IX. Question and Answer Session

Slide 81. Question and Answer Session

Denise Mulholland: So, with that, I would like to switch over into the Q&A portion. And what I wanted to do is start with a question that – received a few – a couple of variations of this question, so I'll try and synthesize it. But essentially, I have a question here that I will – I'll initially take a stab at and then see if the rest of the panel has additional input. But essentially, the question is, what about beneficial electrification? So we've talked about energy efficiency, but beneficial electrification includes things like heat pumps and electric vehicles, things that are actually going to increase in greater electricity use or demand for electricity.

So we have been talking about this as energy efficiency is reducing electricity demand, but there are cases, such as with beneficial electrification where the energy demand is likely to go up. So essentially, the question that I have here is can these models account for that and can they be used to reflect that. And I can – I can – I'll just kick it off from my own perspective with respect to the COBRA model, which is a tool that I manage that certainly, when you're doing your emissions analysis, you want to really think through with the tools that you use what are the net effects. Where are there going to be increases or decreases?

And so, certainly, like electric vehicles and heat pumps are a great example of that where you are going to see decreases in one respect from – you know, from one as part of the investment, but then you'll see increased electricity demand. So you might see, for example, electric vehicles you'll see a reduction in emissions in the transportation sector by switching to electric vehicles which are going to be an increase in electricity demand in the power sector. So it's important to represent that net effect, right, so it's not necessarily an environmental benefit unless you account for that.

So speaking just for the COBRA model, you can do that in COBRA. So basically, you would have to come in with your emissions impacts, both the increases and the decreases. And the COBRA model allows you to enter both of those. So you have the option as a user to enter emissions increases and emission reductions across different sectors, so it is not just electricity sector specific. The COBRA model covers transportation, it covers any sector that covered National Emissions Inventory, any sources are covered in the COBRA model. And so, I don't know if anybody else on the phone, any of the other panelists want to respond to that …

David Abel: Yes.

Denise Mulholland:…thinking about beneficial electrification and how you would represent that. David?

David Abel: Denise, I'll jump in to say I'm trying to think of any – I think all of the tools that we talked about today on the air quality and health side could also do residential energy, transport, any of those things, certainly all of the ones I talked about.

The added difficulty is that you're doing multiple quantifications on the emission side. So instead of just running something like AVERT that quantifies the electricity sector impacts, like you just said, you also have to quantify transport impacts, residential impacts, commercial impacts. And that's just another layer of detail that is definitely doable, but hasn't been done in the work that I know.

Cassandra Kubes: And this is Cassandra. So speaking for AVERT and COBRA specifically, we actually did an analysis recently that used AVERT and COBRA and also MOVES, which is another EPA tool, the Motor and Vehicle Emission Simulator.

And we actually were looking at what – we wanted to see what the health and emissions impacts from a 10 percent electric vehicle (EV) adoption scenario would be. We've looked particularly at the Southeast Region, but we really also wanted to do it as a way to see how to use these three tools - MOVES, AVERT and COBRA- together.

And what we found was that it's doable. It's definitely doable. There is – you know, there are a lot of considerations that we – in trying to come up with the assumptions for our analysis. There's always different variables.

But essentially, the – what it boils down to is that using MOVES we got the avoided tail pipe emissions from the scenario which was swapping out gasoline – light duty gasoline vehicles with battery electric vehicles. So we had to get what were the avoided tail pipe emissions. We got that from MOVES.

And then, also from MOVES, we got the energy needs from the electric vehicle charging, so the kilowatt hours that would be then seen as an increase in generation for the grid. So we took that energy needs in kilowatt hours for charging and we plugged that into COBRA to get the increase in power plant emissions.

And then, as a result, we netted out the avoided tail pipe emissions with the increase in EV charging emissions. And then, we added on actually an energy efficiency and building scenario and then plugged all that into COBRA to get the health impacts.

So it's I think a great set of tools to be able to look at. We've looked at electric vehicles, so particularly use that as my plug for using these tools together for beneficial electrification. But, yes, definitely doable and got some really interesting results.

Denise Mulholland: Great. Thanks, David and Cassandra. OK. I have a question here that I think is best directed to Joy although others can certainly feel free to respond. The question is, using eGRID's regional figures for pounds per megawatt hours seems like a sound approach.

How confident can we be in the supposition that improving energy efficiency or adding renewable energy, in particular, area will actually reduce the use of fossil fuel generation and its associated health effects? Actually, I could open that up to anybody, but Joy certainly spoke about eGRID, so if you'd like to take a stab at that, I'll start with you.

Joy Morgenstern: I think we can be pretty confident that reducing generation, particularly fossil fuel generation with energy efficiency or renewables, is going to result in improvements in air pollution levels.

The problem is this is very difficult to say where exactly those impacts are going to occur. And we're going to try and do some more sophisticated modeling, but you really – you know, I think we're – we might wind up doing something like power flow modeling because we really need to better understand what happens when we reduce demand, what happens to the system, and it really depends on the grid where you're located to figure out exactly where these impacts are occurring.

But I feel pretty confident that the impacts are happening. The difficulty is where – the difficulty is also the data. We have the eGRID data, but we also – in California we have data that's collected by the Air Resources Board and the data is not always the same.

You would think that emissions data would be standard, but sometimes we find wide discrepancies in the data. So, while we feel confident in general in these tools and these databases, we feel like there's a lot more work that needs to be done to figure out exactly how are we calculating plant emissions and where improvements are occurring. I'd say those are the two biggest kind of stumbling blocks to getting a real definitive answer that you can feel confident about.

Denise Mulholland: Great. Thanks, Joy. Did anybody else have anything that they wanted to add with respect to sort of confidence about your estimates? OK. All right. What I'm going to do then, I think we've got time for – I've got one more question that I'm going to actually ask to everybody that we've got 3:26, so we've got just a few more minutes. But I will put it out to all three of you.

Basically, what have you found is the most effective way to communicate the results from these tools from your analyses to policy and decision-makers? So if we could start with – let's start with David and we'll go through from the last to the first.

David Abel: Yes. Sorry, I forgot to hit mute. I have found actually that the most effective way to communicate these numbers is not with the dollars or the mortality numbers you end up. And I'm just kind of talking off the cuff here.

But you end up getting into conversations about the statistical value of life and then getting into, you know, topics that weren't the main focus. I've tried to keep things generally focused on win-win. So the study that I didn't talk about was actually looking at the state of Wisconsin adopting a 100 percent in-state energy and this is not just electricity, all energy. And in-state energy in Wisconsin, there is no fossil fuel resources, so essentially it's the same as 100 percent renewable strategy.

But by talking about any health benefits in terms of economic growth and jobs and the health benefits as a bonus on top of that, you know, that's been more effective than any of the other work I've ever done.

Denise Mulholland: Great. Thanks, David. That's really helpful. Joy or Cassandra, did you have anything that you wanted to share on what you found to be the most effective way to communicate results?

Joy Morgenstern: I can jump in. This is Joy. I found actually for our purposes it is – it is really the best to throw the numbers out and I think it's because it's a somewhat different situation in California.

We have state policies that have already committed to huge GHG reductions. We have a plan to completely eliminate fossil fuel use in theory. So I think because, in California, we have been focusing so much on GHG we haven't paid that much attention or as – quite as much attention as we should be on the criteria pollutants particularly here at the Public Utilities Commission.

And so, when I tell people that this actually does have a value, but we have a relatively clean grid in California. So it's only about half a penny a kilowatt hour. But then, I tell them there's other states where that value is sometimes 5 cents or 10 cents a kilowatt hour.

It really impresses on people the importance of the work that we're doing that we've already made the grid pretty clean, but that the values, when we start talking about electrification, are likely to be 10 times as high, you know, is just my guess.

I feel that because I'm primarily concerned with cost effectiveness and I'm dealing with decision-makers who are making decision about the way we should spend millions and billions sometimes of rate – of dollars of rate payer funds that having the numbers there in dollars has a huge impact on their thinking much more so than a theoretical discussion about air pollution and saving lives and all that.

Denise Mulholland: OK. Thanks, Joy. I really appreciate that. It sounds like it kind of depends on people's different perspectives. And, Cassandra, I don't want to prevent you from answering, but we're at the end of our time here for the webinar. So maybe if you have additional thoughts, we can put those with any Q&A – or questions – outstanding questions that we would put out for the audience on our web site.

Slide 82. Upcoming Webinar!

Slide 83. Connect with the State and Local Energy and Environment Program

Denise Mulholland: I do want to close out the webinar, first, by thanking the presenters. Joy, Cassandra and David, I really appreciate the time that you spent preparing and giving your presentations today, thought they were very helpful and informative.

I want to thank the audience for participating, for hanging in there and listening. Hopefully you found this valuable to you. I'd like to ask if you could please fill out the feedback form on your way out of the webinar.

We have just posted today the slides, transcript and recording of the last webinar which was on Quantifying the Emission Benefit – Emissions Benefits of Energy Efficiency and Renewable Energy. So you can find that at epa.gov/statelocalenergy.

And if you – there's a little What's New box on the right and you can click on there and hear the last webinar. We will also be posting the recording, transcripts and slides from this webinar at the same spot in about three weeks from now.

So please feel free to sign up for our webinar newsletter which is right there on the – it was on the screen, right there at the bottom of the screen. Visit our web site and the next webinar that we're going to be hosting is going to be on Quantifying the Economic Benefits of Energy Efficiency and Renewable Energy. We have no date set just yet, but it will be later on this summer, so stay tuned. So thanks, everybody, for your time today. I really appreciate it and hope you have a great rest of the afternoon. Thank you.