U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY

BUILDING TECHNOLOGIES OFFICE

ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS:
ENERGY CONSERVATION STANDARDS FOR RESIDENTIAL FURNACES

TUTORIAL SPREADSHEET MEETING

CALL # 49279-01-EE-5B

WEDNESDAY, NOVEMBER 7, 2014

The above-referenced working group met in Room 4A-104, 1000 Independence Avenue SW, Washington, D.C., 20585 at 9:00 a.m., John Cymbalsky, presiding.

P R E S E N T

ASHLEY ARMSTRONG,
Office of General Counsel, U.S. Department of Energy

DAN COHEN,
Office of General Counsel, U.S. Department of Energy

JOHN CYMBALSKY,
Office of Energy Efficiency and Renewable Energy, Building Technologies Office, U.S. Department of Energy

ERIC STAS,
Office of the General Counsel, U.S. Department of Energy

A L S O P R E S E N T

ADAM DARLINGTON,
Navigant Consulting

RACHEL FEINSTEIN,
Hearth, Patio and Barbecue Association

VICTOR FRANCO,
Lawrence Berkeley National Laboratory

LAURA PETRILLO-GROH,
Air Conditioning, Heating and Refrigeration Institute

PETER HANSON,
Council on Environmental Quality

MARSHALL HUNT,
Pacific Gas and Electric Company

ROGER HUNT,
Lennox Industries

DIANE JACOBS,
Rheem Manufacturing

CHRIS LAU,
Navigant Consulting

ALEX LEKOV,
Lawrence Berkeley National Laboratory

NEIL LESLIE,
Gas Technology Institute

JACKIE LONG,
Toxicology Council

TOM MASSARO,
New Jersey Natural Gas

WILLIAM MILLER,
McCarter & English;
General Counsel, American Public Gas Association

NICK MISLAK,
Air Conditioning, Heating and Refrigeration Institute

ELIZABETH NOLL,
National Resource Defense Council

HENRI ADROIT (sp),
Goodman Manufacturing

ANDREA PAPAGEORGE,
AGL Resources

GREG ROSENQUIST,
Lawrence Berkeley National Laboratory

DAVE SCHROEDER,
Consultant, Gas Technology Institute

DAVE SCHRYVER,
American Public Gas Association

DON SORINO,
National Association of Home Builders

FRANK STANONIK,
Air Conditioning, Heating and Refrigeration Institute

ALISON WILLIAMS,
Lawrence Berkeley National Laboratory

DAVE WINNINGHAM,
Allied Air Enterprises

C O N T E N T S

P R O C E E D I N G S

MR. CYMBALSKY: Okay. Welcome to the public meeting to demonstrate our spreadsheet analytical tools. My name is John Cymbalsky. I am the program manager for appliance standards here at DOE. I want to first welcome everybody and thank everybody for coming.

Today's workshop will focus on presenting our analytical spreadsheets that we use for all of our rulemakings, and the purpose here is to give interested stakeholders an overview and maybe a little more in-depth knowledge of how to use the spreadsheets, how to find certain key data inputs and whatnot.

What the meeting is not about, and our general counsel will speak more specifically on this, it's not about the furnace proposal that is at OIRA. So questions about, you know, why this or how that are deliberative to the rulemaking and we will answer at the public meeting for the NOPR in due course when that comes out of OIRA.

Also, the meeting today is being

broadcast on the Web via webcast. People on the webcast can ask questions by raising their hand. We will try to patch you in, in audio. If that doesn't work, we will write down your question and read it.

Now, at this time, I'd actually like to go around the room, everyone introduce themselves. A few ground rules, when you do have a question, the microphone has a little button. Push it on. Green light will come on to speak. When you're done, please push it off so we don't get feedback. And again, state your name and association every time you'd like to speak. So we'll start over here to my left with Bud.

MR. MILLER: Thank you, John. My name is William Miller, with McCarter and English, general counsel for the American Public Gas Association.

MR. ADROIT: Henri Adroit, Goodman Manufacturing.

MR. LESLIE: Neal Leslie, Gas Technology Institute.

MR. SCHROEDER: Dave Schroeder, consultant for the Gas Technology Institute.

MS. PETRILLO-GROH: Laura Petrillo-Groh, Air Conditioning, Heating and Refrigeration Institute.

MS. PAPAGEORGE: Good morning. Andrea Papageorge, AGL Resources in Atlanta.

MS. JACOBS: Diane Jacobs, Rheem Manufacturing.

MS. NOLL: Elizabeth Noll, NRDC.

MR. M. HUNT: Marshall Hunt, Pacific Gas and Electric Company.

MR. WINNINGHAM: Dave Winningham, Allied Air Enterprises.

MR. MASSARO: Tom Massaro, New Jersey Natural Gas.

MR. R. HUNT: Roger Hunt, Lennox Industries.

MR. STAS: Eric Stas, DOE general counsel's office.

MR. FRANCO: Victor Franco, Lawrence Berkeley National Laboratory.

MR. ROSENQUIST: Greg Rosenquist, Lawrence Berkeley National Laboratory.

MR. COHEN: Dan Cohen, general counsel's office, DOE.

MR. LAU: Chris Lau, Navigant.

MR. LEKOV: Alex Lekov, Lawrence Berkeley National Laboratory.

MR. DARLINGTON: Adam Darlington, Navigant.

MR. CYMBALSKY: And those in the gallery, if you could just stand and speak loudly and introduce yourself.

MR. HANSON: Peter Hanson, Council on Environmental Quality.

MS. LONG: Jackie Long, Toxicology Council.

MR. SCHRYVER: Dave Schryver, APGA.

MR. MISLAK: Nick Mislak, Air Conditioning, Heating and Refrigeration Institute.

MS. WILLIAMS: Alison Williams, LBL.

MR. SORINO: I'm Don Sorino with the National Association of Home Builders.

MS. FEINSTEIN: Rachel Feinstein, with the Hearth, Patio and Barbecue Association.

MR. STANONIK: Frank Stanonik, Air Conditioning, Heating and Refrigeration Institute.

MR. CYMBALSKY: Okay. So I think we've got everybody introduced. And at this time, I'm going to turn it over to Eric for a quick statement.

MR. STAS: Okay. This is Eric Stas, DOE general counsel's office. I'd like to reiterate John's welcome and thank you all for coming to the meeting today, and I just wanted to say a few words about the overall purpose of the meeting today and the types of questions DOE will and will not be answering.

So as John said, DOE has convened this meeting as a tutorial on the department's analytic tools and spreadsheets used across DOE's appliance rulemakings. So we'll discuss as necessary the models and inputs for conducting the Monte Carlo analysis and other analyses that generate data and results used in those rulemakings.

The goal is to allow interested parties to understand and work with those analytical tools, thereby gaining insight into how DOE generates the data and results for any given rulemaking. So and to illustrate these analytical tools, DOE has made available its preliminary results for the ongoing rulemaking to consider amended energy conservation standards for residential, non-weatherized gas furnaces and mobile home gas furnaces.

But as John said, please note that this data is being offered for illustrative purposes only as part of this tutorial, and DOE will not be answering questions pertaining to any policy decision, model assumptions or other deliberative matters regarding the draft furnaces at this time. The notice of proposed rulemaking, as John said, for the amended furnaces standards has been submitted to OMB for interagency review, and consequently the document's not yet publicly available. It's in draft form, and it's subject to change.

So once the document has been published, however, DOE will convene another public meeting to discuss and receive comments on the proposed rule and at that time, DOE will entertain any questions regarding the proposed standards, policy assumptions, data, policy decisions and there will be another opportunity for public comment and data submission.

So focusing again today, the purpose of today's meeting is to enable stakeholders to understand and utilize DOE's spreadsheets and analytical tools, thereby facilitating stakeholder review of the proposed rule for furnaces and any other DOE rule and to enhance the opportunity for public -- meaningful public comment. So if we can stick to those sort of ground rules, it'll facilitate the meeting.

MR. CYMBALSKY: Okay. Thanks, Eric. I do want to mention that the meeting runs to 1:00. We do have a hard stop at that time. If we feel like we need to reconvene to go into more detail on some of the spreadsheets, obviously DOE will

entertain that request. So at this time, we'll open the floor for opening remarks and/or questions about what Eric just stated.

MR. MILLER: I guess to the extent questions are offensive from the standpoint of what Eric just said, we'll be told at the appropriate time. I mean, APGA -- first of all, I would just say APGA appreciates and AGA appreciates that this meeting is being held.

We requested it several weeks ago because of our inability to understand these very complex spreadsheets. And at Dan Cohen's request, we submitted questions and hope you will proceed to those questions shortly. We have not heard back about those questions. So we're assuming those questions passed muster in terms of the standards you just articulated. But I guess we'll be told that as we go through this exercise.

We would like to proceed through the questions in the order in which they were submitted. Obviously, when we get answers, there will be follow- up questions and answers I'm sure.

And you know, I made that clear in my email to Dan Cohen.

So we appreciate DOE having this meeting. We hope to come out of it with a much better understanding of the spreadsheets and how they operate than we have today. And also, obviously if there's a follow-up meeting after a rule -- proposed rule issues, that will be important as well. And we would have much different questions I'm sure at that meeting than we have today.

But with that, subject to other folks saying whatever they want to say, I would turn it over to Neil Leslie and his colleagues at GTI to march through the questions that we have already submitted to DOE. Thank you.

MR. CYMBALSKY: Anybody else wish to make opening remarks? Okay, Frank?

MR. STANONIK: Frank Stanonik, AHRI. Just I'll say a general prefatory statement. I recognize what Eric has said and what the intent of the meeting is. I'd just ask you to appreciate

that at the moment, our understanding of the spreadsheets is kind of limited to the outputs we see.

So I'm going to -- you know, I probably will pose some questions in terms of outputs that I see that, you know, raise questions. And if certainly we get off-chart here or off the task, yeah, as I think was said, we'll assume you'll pull us back.

But right now, you know, I'm sitting here thinking the only way I can ask you questions is because I see outputs that I don't understand, relative to how you use the tool. And I understand we're not going to talk about the furnace rulemaking directly.

But just kind of, you know, I guess appreciate from our perspective right now, the only way I can relate to that information and the tools is what I'm seeing as outputs.

MR. CYMBALSKY: Right, and we appreciate that. John Cymbalsky, DOE. I think maybe a little example might help and frame up how. So a

question, for example, an important aspect of the furnace rulemaking, for example, is fuel switching. And the spreadsheets, the analytical tools have information about fuel switching in them.

So an appropriate question in my mind is, DOE, can you point us to in the spreadsheet of where we can find out about how you accounted for fuel switching. And Victor will do that. The inappropriate question is obviously the question you probably want to ask but I don't think I need to ask it. But when you do, we'll tell you we can't answer it. Does that help?

MR. STANONIK: Well --

MR. CYMBALSKY: I know, it doesn't -- it doesn't help-help, but --

MR. STANONIK: My intent will not be to ask those question, but you know, without getting a better sense of how we -- I'm sorry. My intent will be not to ask those questions because I understand what's been said here. But until we get a little further along and get a good sense of

it, I mean, your example helps. Thanks.

MR. CYMBALSKY: Okay, anybody else wish to make an opening statement. Okay, so for full disclosure on Bud's -- oh, I'm sorry.

MS. JACOBS: Diane Jacobs from Rheem. So I was here yesterday and you said that the spreadsheet, the same format is used in all the rulemakings or most of them, all of them. So I think that it's good to point out in other contexts, you know, what -- how it's used and it seems like maybe there's parts that come in or come out depending on the rulemaking. So I'm really interested in how it's applied in general. Thank you.

MR. CYMBALSKY: Right, and this is John again from DOE. So that's right. So for example, the life cycle cost spreadsheet, it fundamentally does the same thing in all the rulemakings. Now, for furnaces, there are different aspects that need to be accounted for that you won't see in like a refrigerator spreadsheet.

So I'm assuming questions today, because

this one in my mind's probably a little more complicated than most, will be specific to furnaces. But at the same time, we're asking a question about, you know, how in the analytical tools can we access that and maybe play with some of the parameters, et cetera. So that carries over to all the other products where applicable.

So any other opening remarks? So to address Mr. Miller's comments about questions, so for full disclosure, there were questions that were sent to DOE. The way we want to try to answer the questions that we can answer, because it is a subset -- we'll be honest with you -- as Victor goes through the spreadsheet, he is aware of the issues and he questions that were raised, and we will try to answer them interactively with the spreadsheet demonstration. And if that doesn't suffice, of course you're free to ask your questions as well. So yes, Neil?

MR. LESLIE: This is Neil Leslie, GTI. Just a clarifying thing on when it's appropriate to ask the questions as the spreadsheet is being

described.

MR. CYMBALSKY: Yes, so --

MR. LESLIE: When do you want them? Anytime or just wait until the end or how do you want to do that?

MR. CYMBALSKY: No, no. So John, DOE, so if Victor's on cell AA 135, and that sparks your question about something, you ask the question and we'll answer it. Anybody else? Okay, all right. Let's move on. So at this point, Victor is going to be our point man for bringing you through the analysis in the spreadsheet. So we are going to switch spots and take it from there.

MR. FRANCO: Hi. Good morning. I'm Victor Franco from Lawrence Berkeley National Laboratory and I will be going through the spreadsheets. I will be going through actually two spreadsheets, the life cycle cost analysis spreadsheet and the national impact analysis spreadsheet.

This is kind of -- this flow chart is

going to show you more or less what's the flow and the connection between the two. So we have various inputs. These are just some of the primary inputs. So some of the analysis that goes in, for example, is manufactured cost that comes from the engineering analysis, markups to determine that product price, energy use characterization and then there's a lot of other inputs that we'll go into.

The outputs that come out of that, the results are LCC savings and the payback period. Also, out of that, there's LCC outputs that are some of the primary inputs to the national impact analysis spreadsheet. In addition, there's the shipments analysis that goes into that spreadsheet as well. And from that spreadsheet, we have the national energy savings and net present value.

So as I go through these introductory slides are just to show you more or less to remind you about the analysis, what we're trying to do in the spreadsheet and how -- what worksheets we're going to be going through and how they are set up,

and hopefully that will make it a little bit clearer as I go through the spreadsheets, what part of the analysis I'm going through.

So this is a flow chart that we usually present in the rulemakings just to show the flow of the LCC and payback period analysis. Basically, the yellow presents the final results, payback period and life cycle cost. And the green are the primary inputs -- for example, total installed cost and the annual operating expenses. And then, obviously those have a lot of inputs that each of them actually becomes a worksheet, as we'll see in the next slide -- actually, after this one.

So basically, just to remind you, the life cycle cost is total installed cost plus operating cost and it's the operating cost of the lifetime of the product discounted to the base year. And in the case for furnaces, it's 2021. Obviously it's different for each rulemaking. We're evaluating -- yes?

MS. JACOBS: Diane Jacobs, from Rheem.

So where do you come up with that year, 2021?

MR. FRANCO: So that's the year that the standard is going to take into effect and that just depends on the rulemaking.

MR. CYMBALSKY: So this is John from DOE. So again, that's a furnace-specific number. So depending on the rule, it's the first year of compliance. So that changes.

MS. JACOBS: Okay.

MR. MILLER: Bud Miller. Are these slides available today?

MR. CYMBALSKY: We will make slides available. For the meeting, we want to keep this -- we want to keep everyone's eyes focused on the screen because we're going to be doing spreadsheet stuff and having a stack of paper in front of you I don't think is the best way to do that. We will make the printed slides available though.

MR. MASSARO: It's Tom Massaro with New Jersey Natural Gas. Victor, a question on the installed cost. It looked like the installation cost wasn't a variable.

MR. FRANCO: This is Victor Franco. Let me go back to the previous slide. So the installation cost is the one that's right before the consumer price. That would be the --

MR. MASSARO: Right, right below the consumer?

MR. FRANCO: Yes.

MR. MASSARO: That's not an input?

MR. FRANCO: That is an input.

MR. MASSARO: Oh, okay. It wasn't green. All right. I think anything in green was a --

MR. FRANCO: Those are kind of like the -- except for consumer price because it has a lot of other inputs. But installation cost is obviously a major input to the total installed cost. Those were the two.

MR. MASSARO: Right.

MR. CYMBALSKY: So this is John at DOE. So we will get into the spreadsheets and you will see those numbers and where they are.

MR. FRANCO: So again, this is we're

looking at the -- we're evaluating the economics through the consumer perspective in the LCC analysis. And to do this in the spreadsheet form, we use the analysis and the variability using a Monte Carlo approach. What that means essentially is for certain inputs we have a distribution and we'll go through that as we look at the spreadsheet.

Now, in terms of the tools, and we'll go through this with more time, it's basically to view the tool, you need Excel spreadsheet. Now, to actually understand a little bit more look at the distributions, you'll actually need a program add-in which is called Crystal Ball, and we'll go into more details about that. You don't necessarily need Crystal Ball to look at the spreadsheet.

But if you want to run the spreadsheet, want to look more carefully at some of the inputs, you will need that add-in. And we'll go through that.

MR. SCHROEDER: Dave Schroeder. So some

variables are coming in through Crystal Ball and some are not. That's correct?

MR. FRANCO: Yes. This is Victor Franco. We'll look at that more carefully as we go through the spreadsheet and you'll have an understanding. Most of the variables that are kind of -- that are coming in from Crystal Ball are the ones that are generated by a distribution. We also use Crystal Ball to kind of summarize the results, as we'll go in more detail.

MR. SCHROEDER: So is that -- is that the same for every one of these rulemakings, which variables are and aren't controlled by distributions. How is that decided and what -- which variables go in which bucket?

MR. FRANCO: Victor Franco. This really depends on the rule. But in generally, a lot of them are distributions, especially if we have data that we know that this should be represented as a distribution.

So for example, and we'll go through examples of course as we go through the

spreadsheet. But for example, lifetime is usually a distribution. There's other variables as we go through. And it's very similar to rulemakings. But obviously there's some rulemakings you don't have a lot of data and that might not -- you don't know what the distribution might be.

So let's go. So this is the structure of the spreadsheet. Obviously you'll have this later to kind of look at this. We might go back just to see the flow of the structure if needed when we're presenting the spreadsheet. But I want to go through this a little bit for you to understand and obviously once we get into the spreadsheet, we'll review it again.

So the main kind of calculations for the LCC and payback is in a worksheet that we'll spend a little bit of time called LCC and payback calculations worksheet, and that's where essentially the LCC and payback calculations are being conducted. Everything else is an input to that spreadsheet. From that, once you run the spreadsheet, basically you need a -- we've done a

macro to generate results at the end -- you produce something else called forecast cells. And we'll go what that means.

Basically those are generated with Crystal Ball in a macro. Those forecast cells are the results of conducting the Monte Carlo analysis, and usually for all these rulemakings we set it up to 10,000. You have options to do more or less. But this is what we've come up with as a good value of generating the results. From those forecast cells, we generate the final results. So for example, we have the summary worksheet, which we'll go into, some statistics and LCC outputs that go to the NIA.

Now, as you've seen from before, we have all these key parameters which are the same. So for example, we have equipment price, installation cost, energy use, energy price, energy price trends, lifetime discount rates and then there's data worksheets that are also for each of these and so you can see what goes with what. We'll go through each one of them carefully and the ones

that are related. For example, equipment price, we'll talk about markups and equipment price trends.

An additional one is the building sample, and I will take more time to discuss that one as well. So obviously I didn't want you guys to read it. This is mainly once you have the printout. This explains each of the worksheets before and a description. And this is primary for you to take after the meeting and be able to look at and compare and say, oh, he was talking about the statistics, oh this is what this is, non-itemized switching, this is what this is.

I don't want to go through the descriptions obviously. Just want to point out something that's very critical. We've listed here there's an asterisk. Hopefully you can see it, for some of these. There we go. That's right here for some of these and there's a note at the bottom.

So the results that are displayed in that worksheet are only for the household that's

being calculated. So it's just one household that's being calculated at that time. Once you run the macro, you actually run it through 10,000 times and you get the final results. So it's very important because sometimes it's confusing what's actually the final result of the 10,000, what's actually just one household result.

There's a lot of worksheets, so this is again the second. So just to present a little bit of how the worksheets are set up, so this is obviously when you open up the presentation, this is something that you -- I mean, the spreadsheet you want to look at. You want to look at the final results and this also gives you a way to generate new results if you wanted to. So basically this is the summary worksheet. On the right, there'll be results.

Now, it depends on the product that you're dealing with, what kind of results you'll be getting. For the furnaces rulemaking, we've disaggregated some of the results by region and market, say like new construction, and

replacements to give people that are looking at it more of a sense of what's going on in these submarkets. That's not very usual.

Usually results is just presented national. So this is one difference, furnaces with -- but it depends. There's other rules that you find something like this. Another difference is, for example, you have standby results that are different from the actual standard, AFUE standard. So there's a lot of results represented. Another thing that we usually have in these spreadsheets is some kind of instruction to kind of lead you to how to use the spreadsheet in case you wanted to actually run it, change some of the variables.

And the user options are right here on top, and those are the ones that we've set up so that they can change. And this has been evolving. It depends on the product. One, for example, that's very different is we have this switching. And you can actually turn off and on the switching and see what the results are. Something that's usually available in all these rulemakings is, for

example, the energy price trends or changing the start year.

Something else that's useful is we could sometimes -- these spreadsheets are large and it might take quite a bit of processing time to actually generate the final results. We have this option of trial numbers. So in case we wanted to run this spreadsheet today, we would change this to a lower number and generate results, and you can change that as a user. This is also important just to kind of give you a sense of what we're going to be talking about today in all these input worksheets, kind of the setup.

So we've tried to make it as useful or as easy for the user to kind of navigate through the spreadsheets. But we understand that these are pretty difficult to understand, especially if you don't know the product. But we've tried to make it as user- friendly as possible. So a lot of these worksheets are set up in the following manner. You'll have a data throughout. For example, this is the markups. And so, for example,

on markups, we have markups -- sorry about that -- markups that are divided by region. And you can see the regional numbers and that's the data.

Then you have some other inputs that are coming from other parts of the spreadsheet. For example, in this case we are a region. For example, a specific household, you probably can't really see it but I'll say it verbally, 21, region 21, which represents Texas. So this specific household is in Texas. For that household, it's actually replacement and so it'll use a certain input from these markups. And here on this side are the calculation. Calculations sometimes vary between spreadsheet and spreadsheet.

In this, we thought that this was easier to visualize in this manner. But it depends on the worksheet and we'll go through that. The final piece is actually the export value and this goes to another worksheet or might actually go to that LCC and payback calcs worksheet.

MS. JACOBS: This is Diane Jacobs from Rheem. So just kind of to go back, so we're in

the LCC and PB worksheet, right, or spreadsheet.

MR. FRANCO: Right now we're in the specific worksheet that's generating the markups.

MS. JACOBS: But that's part of --

MR. CYMBALSKY: Inside the life cycle cost worksheet.

MS. JACOBS: It's a life cycle cost spreadsheet.

MR. FRANCO: That's correct.

MS. JACOBS: And I think you just said that the results when you run that are for a single household. But now, you're saying the data is for all these cities and regions.

MR. FRANCO: No, no. So yeah, let's go over it.

MS. JACOBS: Okay.

MR. FRANCO: This is Victor Franco again. Let's go -- this is very important to start with. And we'll go through this every worksheet. We'll review it. But you open up the spreadsheet. You go to this worksheet which is called markups, and you'll see that this -- the results that are

being calculated here are for that specific household, just one household.

MS. JACOBS: Okay, to respond, so it's like a look-up table.

MR. FRANCO: Yes.

MS. JACOBS: So depending on what your input is, it's looking in there and picking one number for one house.

MR. FRANCO: Correct. So for example, just an example here and we'll go through this more carefully, is this household is in Texas. So it will pick up the values that are appropriate for that region in Texas. So that's -- yes.

MR. CYMBALSKY: So we have a question from Julie Hatfield, asking why we have -- using 2003. She feels that's outdated. I believe she's referring to the CBECS 2003 survey, and so, that's kind of unfortunately the last CBECS that was published in its entirety. So DOE would appreciate some more recent data. So Julie, if you have that, please forward it on to DOE. Thank you for the question.

MR. FRANCO: Thank you. Victor Franco. So this is -- it kind of ends the introduction to the LCC spreadsheet. Let me move on to the NIA. Once we finish with that introduction, then we'll go into the spreadsheet. So only a few more slides and we'll actually go to the spreadsheets.

So this is a lot of information obviously. Let's just focus on some of these inputs and outputs. This is kind of the analysis flow chart and then we'll go into the spreadsheet flow chart. So the things we want to focus on first is, as before, we're saying primary input to the NIA is shipments and LCC outputs. Some of those are the actual outputs that are necessary -- for example, consumer price, installation cost, energy prices, energy consumption.

And then, there's others because the NIA is doing this very long period of time. So there's trends that are also built in. And at the end, from all this we get the two primary results, the net present value and the energy -- national energy savings.

MS. JACOBS: Diane Jacobs, from Rheem. So you said that trends over a long period of time. Is it always 30 years you're trying to forecast?

MR. CYMBALSKY: So this is John Cymbalsky, DOE. The 30 years represents the analysis period for the number of shipments that are going to be analyzed. So the analysis period takes 30 years of shipments and then extends it until the last years' worth of shipments have been retired from the stock. So depending on the product, transformers for example has a 30-year life. So 30 plus 30, it would be a 60-year analysis, so to speak.

MS. JACOBS: Okay. So I think furnaces was 26. So it's be 56.

MR. CYMBALSKY: Fifty-six, correct.

MS. JACOBS: Okay, thank you.

MR. FRANCO: So let me move on to -- obviously you'll have this so hopefully this is useful for you to -- once you go back to understand this spreadsheet. Let's move on a

little bit, just where we're talking about the 30-year pay period, analysis period. So we're looking at, for furnaces, just specific for furnaces, the shipments between 2021 and 2050.

After that, then we're just looking to make sure everything is retired and we're analyzing those retirements. Basically the energy savings -- the national energy savings are the primary energy savings and the NPV is the difference between the present value of the savings of the annual operating cost and the present value of the increased annual total installed cost between the base case, which is without the standards, and these standard cases.

Now, how the spreadsheet works is there's a macro that we've built in to generate the final results. Again, this is using a spreadsheet. So you can open it up and take a look at it. It has a macro, so you don't need any additional add-ins or anything. You can actually just use it right away.

And there's one thing to understand

that's critical is that the individual worksheets, when you look at the intermediate results, are not the final results but they represent either the results for a certain region, in this case we've divided it between north and the rest of the country, and a market-type representation, commercial. When we get to the NIA, we'll look at it more carefully of how that's represented. But also I'll show that in the next slide to just go over it a little bit.

MR. CYMBALSKY: Victor? Victor?

MR. FRANCO: Sure.

MR. MILLER: So is the macro -- the result you get using the macro, is that a Crystal Ball result? So it has the -- it is this 10,000 iterations?

MR. FRANCO: No, sorry. Let me make that very clear. No. So the LCC outputs obviously is the result of the 10,000. Once you get to the NIA, you already have that result. And in the NIA, you use the macro to kind of go through the different iterations. You calculate

the results for the north. You copy and paste -- the macro copies and pastes that and it generates the results for the rest of the country.

And obviously actually it goes north, residential, north commercial, rest of the county residential, rest of the country commercial and it generates the final results. And we can actually see that once we get to the spreadsheet. It'll probably be easier to visualize.

MR. CYMBALSKY: So this is John from DOE. So Victor, is it safe to say that the Crystal Ball add-on is only needed for the LCC?

MR. FRANCO: That's correct, yes. The LCC, yeah, is the only one that uses the Crystal Ball add- in. So this again gives you a sense of how the spreadsheet works. And the individual worksheets. So let's start from the outputs.

So essentially when you open up the spreadsheet, what you want to see is the results and this is available in the NIA summary. Those results are being generated from a couple worksheets that are kind of the accounting

spreadsheets and they have different calculations that are going on. I'll go through those.

Basically for this product, we're using -- we have two product classes. So they're calculated differently. We have non-weatherized gas furnaces and mobile home gas furnaces. Now we're going to be mostly talking about non-weatherized gas furnaces. But in case you have questions, let me know.

And those specific worksheets actually calculate three things kind of at the same time. They're accounting for three things. And I just wanted to empathize that. Both they take in the economic and energy use inputs and they process those. And they also take historical shipments and those to actually calculate the shipments. And for non-weathered gas furnaces, they actually calculate the impacts of product switching.

So obviously we'll spend a lot of time on that, on those worksheets because everything is going on there all at once. And there's some other inputs. And so, we'll spend a little bit --

probably less time on the inputs, data worksheets as they're called. But those are important as well. They have the data, some of the data that's being used. Once again, worksheet description. This is for you to have and to take a look at to kind of compare what each worksheet does.

So again, this is the summary worksheet. It's very similar to the LCC, how it's set up. You have a results area. You have instructions here at the bottom. And there are two things going on here. First, there's some analysis parameters just to see what those are. And these are -- you can't really change these in the spreadsheet but at least it will show you what they are.

So for example, for this rulemaking, it's the standard takes in effect 2021. The analysis period is 30 years, so the end of the analysis period is 2050. There are two discount rates that are being used, 3 percent and 7 percent and the present value is 2014. Now, there's another part where you can actually change some of

the assumptions and this is in this which is labeled scenarios.

So for example, similar to LCC, you can change the energy price economic variables, which we call economic growth. And this is -- we use some data from AEO and you can change either reference in two scenarios, the trend and the fuel switch. Those are the primary. So fuel switching again is very specific to furnaces. It's not in all products.

I just wanted to point out that in here then you have this button which actually generates a final result. So in case you wanted to change some of this and you wanted to generate the results you click here and it will change the results at the end, a couple minutes usually it'll take to run through it. So they will spend a lot of time on this worksheet, which is the non-weatherized gas furnace worksheet and it has a lot of different spaces. It's calculating shipments. It's calculating a lot of these inputs and processing and also for non-weatherized gas

furnaces, doing the fuel switching.

So obviously, this doesn't have the whole thing. But just to give you a little bit of background. So basically this part over here is getting data from other worksheets and has -- so the data input. And this side, on the right side, we're actually calculating, doing all those calculations, doing the base case calculations, the standard case calculation and the product switching. And we'll spend a lot of time on that.

The thing that I wanted to just remind you again is that when you're looking at this spreadsheet, which might be confusing when you open it up, is that the results that you're looking at there are for a specific region and it's very, very small here. And we should look at it more closely when we open up the spreadsheet. This one is actually for the northern region and a specific sector. For example, in this case, residential. If you wanted to see the results, then you would have to change the inputs to see just the south, maybe you want to just look at

commercial or something like that.

So that's important. When you generate the final results, obviously it goes through all these and it generates the final results.

MS. JACOBS: This is Diane Jacobs from Rheem. So in the first spreadsheet, you're doing the 10,000 households and all that. And so, you're just segregating the data that you've input into this second spreadsheet.

MR. FRANCO: Correct, yes.

MS. JACOBS: Okay, so it's input. Okay.

MR. FRANCO: Correct, correct. Yes, and we'll go through that a little bit more carefully, how that's set up.

MR. CYMBALSKY: This is John from DOE. Just to clarify the difference in the spreadsheets and maybe frame it up a little differently. The life cycle cost spreadsheet is what would this standard do to an individual customer, right? So that's the sample of one. Then we know that that's not representative. So we throw it through the Crystal Ball. It does the 10,000 Monte Carlo

simulation. So now we have all of that.

So then in the second spreadsheet, what we're trying to do is say, okay, what does it mean to the whole nation. And so, I think if you think of it that way, maybe it'll help logically delineate where certain things are happening, so if that's helpful.

MS. JACOBS: Yeah, I think sometimes, like what's the input, what's the output, you know, can be confusing about -- yeah, just those two things because you can see things. And I know I've been in the NIA and trying to change the input. But it really came out of this other spreadsheet. So to someone who's used to working with it, that must be completely illogical. But it's not always clear. But from the labels, you're kind of guessing what the things are. So okay, thanks.

MR. FRANCO: Victor Franco. So again, as we go through these spreadsheets, please, yeah, stop me if you have additional questions in that area. We'll try to make it as clear as possible,

the inputs, how the inputs kind of work so you can kind of get a sense if you wanted to kind of visualize how that maybe would change or maybe what happens. But we'll go through it individual.

MS. JACOBS: So just -- this is Diane Jacobs from Rheem. So just in my experience, you know, we're going through the technical support data document and maybe we disagree with some of the assumptions. But I don't want to complain about every single thing. So I was trying to use the spreadsheets to see if it would make any difference. Was it worth bringing up, you know? So it seemed like it would be easy to do but it didn't end up being that easy.

But so I guess that's the way I would use it. I don't necessarily only want to see how you did it or the results of yours but to be able to change some of the assumptions and understand whether it's worth making an argument or not. You know, there are a lot of assumptions. Some of them, you know, I may or may not have ever thought about. And it's not really clear which battle go

to after, you know? So okay.

MR. FRANCO: Great, thank you. Victor Franco. So yeah, we'll try to make that clear as we go through.

MS. JACOBS: Thank you.

MR. FRANCO: Yes?

MR. MASSARO: Victor, this is Tom from New Jersey Natural.

MR. FRANCO: Sure.

MR. MASSARO: Kind of along those same lines, it could still be helpful to see -- go back to like an incremental cost of the different appliances versus what we see with our contractor base versus what's in the model. If changing that does have like a demonstrable difference, on the output, is that something that we would get into today that we'd be able to get in there and say, well, if you change the installed cost of this specific appliance to x, this is what the output ends up looking like?

Is that -- is that something we would be able to get into today?

MR. FRANCO: Victor Franco. So we'll obviously open up that worksheet once we get into that worksheet, we can take a look and we'll see if, yeah, if that's appropriate.

MR. CYMBALSKY: Yeah, well the purpose here is to show you how to do that, right, and we'll point you to that spot. We are not going to sit here and run simulations for everybody, just to be clear. Okay. We're teaching you how to fish, not frying it for you. It is a Friday fish day for some of us I guess, so.

MR. FRANCO: So this is the very last slide and this is just -- this is to show you what the topics I'm going to be going through. So LCC spreadsheet, there's a lot more to talk about. And we'll be first talking about the summary worksheet, LCC calculation engine, the building sample, the total installed cost, so customer prices -- consumer prices, installation cost model. Then we'll go into operating costs and maintenance repair costs, energy use, energy prices and trends. Then we'll go into other

components such base case efficiency distribution discount rates, lifetime and product switching. So product switching again is very specific. Almost everything else is very general and all products will have that.

In terms of the NIA spreadsheet, basically we'll be calculating -- we'll be looking at -- focused on summary worksheet, which we kind of already talked about and then the calculation engine, which will have three main components: inputs, the shipments and the product switching.

So I'll begin to talk about the LCC spreadsheet. And as we go through, please stop me if you have any questions. So we'll go through here and let me close -- oh, I'll keep it open in case we want to see something. One more thing, obviously the spreadsheet view, in case you can't see something I'm talking about, please let me know so I can enlarge it.

When you open up the spreadsheet, one of the first things obviously is you want to look at the summary, what are the results. And this is

the sheet that we've been talking about, the summary worksheet. So again, once again, we're looking at the user inputs which are these. There's a button right here which if you press it and you have Crystal Ball, everything's set up properly. You can actually run the spreadsheet and generate new results. And then there's some instructions how to do that.

And then, here on the side are the results that we usually have when we're generating the final results. They're usually like install price, lifetime operating cost, first-year operating cost, LCC, LCC savings and net impact, no impact. These fractions over here --

MS. JACOBS: Victor?

MR. FRANCO: And paybacks.

MS. JACOBS: So it says average life cycle. Do you do like the 10,000 samples and average or is it some kind of weighted average or --

MR. FRANCO: Yes, this is what we're going to be talking about, the specifics. Victor

Franco.

MS. JACOBS: Okay.

MR. FRANCO: So we'll be talking about that, where these numbers are being pulled out and all that and that's very important.

MR. ADROIT: Victor, just a question. Henri Adroit with Goodman. So you can only run the spreadsheet, this particular one if you have the Crystal Ball, right? Otherwise it gives you an error?

MR. FRANCO: That's correct, yes.

MR. ADROIT: Okay.

UNIDENTIFIED FEMALE: Is it expensive?

MR. CYMBALSKY: How much was your flight here? We'll do a quick payback analysis on your flight --

UNIDENTIFIED FEMALE: It cost $400 actually to stay today.

MR. CYMBALSKY: You are getting a great deal. You don't know how much he bills that.

MR. FRANCO: So again, these are the results. Just very briefly, these are the

national results and we try to label it so it's easy to navigate. Then these are the results just for the northern region. Down here, we have the results for the south. Then we have some stand-by results for this product. Now, on the side -- and this is -- this is very, again, very specific to furnaces. We have provided disaggregated results.

So for example, we have the results just for replacements, for residential market and then below that, the north replacement residential, south replacement residential and then so on. New construction, and then even commercial. So --

MR. CYMBALSKY: So this is the results summary, right? So this is not where you would start changing those costs, just to be clear. We'll show you where to do that. This is where you would actually run the scenario and see the results.

MR. FRANCO: Right.

MR. CYMBALSKY: Diane?

MS. JACOBS: So Diane Jacobs from Rheem. Again, is it the average or is it a weighted

average based on population? It's just flat average?

MR. FRANCO: We'll go -- we'll go into that detail right --

MS. JACOBS: Could you give me a hint?

MR. FRANCO: It's the average of the 10,000 -- the 10,000 runs. So for example, you calculate one household and then that gets saved in the process and then you can calculate the next household, the next household and we'll go into what the weighting --

MS. JACOBS: So is the sample somehow related to population?

MR. FRANCO: Of course, yes, and that's very important.

MS. JACOBS: Okay.

MR. FRANCO: And we'll get that when we're talking about the building sample.

MS. JACOBS: Okay.

MS. ARMSTRONG: Okay, so can I answer? My translation is it is a simple average but the weighting comes in because your distribution that

you pick up in that 10,000 is dispersed depending on the weighting of the actual residences that you're trying to pick up. So the results are a weighted average even though it's a simple average of the 10,000 runs. Does that make sense?

MR. FRANCO: Thank you for --

MR. STANONIK: Frank Stanonik. Actually, let me try and flip -- let me try and flip that around to make sure I just understood that. So for the 10,000 runs on the national average, you'd have a certain distribution of I'll say simulations, data sets, right? For the 10,000 runs of either the north or south, it would be a different group of -- yes, because now -- because now, this 10,000 runs is 10,000 runs in a north installation. So it does -- okay.

MR. FRANCO: Thank you for that. So basically, let's go -- let's go to -- let me see. One thing to point out, obviously something that's a little bit different from other products is we have commercial and we have a residential market. And for this product we have a little bit of a

commercial market and that's why we have those results.

MR. CYMBALSKY: But they are residential -- they meet the statutory definition of a residential furnace, so just to be clear.

MR. FRANCO: Another part of the spreadsheet that's kind of like the general results are the statistics and the LCC outputs. So I'll go through those two worksheets. But first of all, if I click on one of these, and hopefully you can kind of see that for example I'm clicking on K7. You'll notice that that's linked to a worksheet that's called forecast cells and that's a specific cell.

Let's go to the forecast cells. So the forecast cells are kind of the output that comes out of the spreadsheet. And for this case, let's go to one that is interesting --

MS. JACOBS: (Off mic.)

MR. FRANCO: Of the spreadsheet, of the runs. So once you decided that you want to do a run, you click run. The spreadsheet runs and then

goes through and generates these statistics. The statistics, which is really hard here because it's not really formatted nicely, this is kind of like the raw output -- is the number of trials that this represents, the results they are being, and the mean, median, min/maximum, 5 percent out or 25 percent out, so on.

And these actually -- all these are nicely formatted in the statistics worksheet, which we'll go to.

MS. JACOBS: So what does it mean if everything is a one?

MR. CYMBALSKY: Can you use --

MS. JACOBS: Sorry, Diane Jacobs. Everything is a one. Is that just because you haven't run it?

MR. FRANCO: No. It depends on what statistic we're trying to look at. But let's focus --

MS. JACOBS: Oh, it's a flag.

MR. FRANCO: yeah, sometimes it's just a flag, a one and a zero and sometimes it's just one

household. So it depends on what you're looking at.

MS. JACOBS: Oh, okay.

MR. FRANCO: So for example, you're looking at specific discount rate and then there's an actual value that you're getting. And so, for example, here you're getting 4.7 is the average of all the discount rates that you're doing but you also have different statistics. So some households have really small discount rates, some have -- and so like you can kind of visualize a distribution of that and we'll go into it.

So everything that's in that summary worksheet, everything that's going to be in the statistics and everything that goes into the LCC outputs comes from here. So it's very important. So that's from the 10,000 run. So let's go back to the statistics so that'll be a nicer format.

So for example, if you wanted to look at the LCC savings, what would be the maximum, what percentiles, how the distribution, you would go here. You could also look at the annual fuel use

and the maximum, minimum and percentiles. And you can kind of see the distribution. This helps you out to visualize a little bit of what's going on in the spreadsheet. And we've provided what we think is the primary inputs and information that would be useful.

We even go to kind of some economic variables, installation location and some energy variables that are important like operating hours, calculated fuel use and some inputs. And so, you can kind of play around and see what everything. But this is again coming from that 10,000 run, all the households that are looked at.

MR. MASSARO: Victor, quick question on that. You were mentioning that this is where you can -- is this -- oh, Tom Massaro, New Jersey Natural Gas. Is this where you would go in and change that?

MR. FRANCO: No.

MR. MASSARO: No, I didn't think so because I still saw the equal sign. All right.

MR. FRANCO: Everything we're looking at

is the final result, still coming up and then we'll go into where you can actually change it.

MR. SCHROEDER: Is there a way you can get - - oh, sorry. Dave Schroeder. Is there a way you can get the complete output? So if you wanted to see like the complete distribution of a particular cost or a particular energy consumption, is there a way you can get that complete distribution for the entire 10,000?

MR. FRANCO: Yes, yes, there is. It's not built into the macro, as you -- I'll probably describe it in just a couple steps.

MR. SCHROEDER: Okay, that's fine.

MR. FRANCO: But that's a good question. I wasn't sure if we wanted to go into that. But I'll actually go into that detail to show you more or less how you would do that using Crystal Ball. So if you don't have Crystal Ball, obviously you wouldn't be able to do it. So just briefly --

MR. M. HUNT: Excuse me, this is Marshall Hunt with PG&E. The Crystal Ball I found on the Web was $1,000. Such a deal.

MR. CYMBALSKY: Less than a life cycle cost of a furnace in the north.

UNIDENTIFIED MALE: You can buy a magic eight ball for $8.99.

MS. JACOBS: It'll only cost $50,000 to learn how to use it.

MR. FRANCO: So just one additional worksheet that I wanted to show you and it's in this realm of final results that is important and we need to talk about it because this is a major input to the NIA is the LCC outputs. This will talk about more detail. This goes into the NIA spreadsheet. And again, this is the results of the 10,000 running the spreadsheet 10,000 times.

So now, we'll be more focused on looking at the worksheets and the individual household calculations when we're going to households.

MR. CYMBALSKY: So I think now we'll turn to the inputs and I think let's just start with the cost of furnaces and go from there. Does that sound -- it sounds like I'm picking up a vibe that that's where people want to start.

MR. FRANCO: There's just one worksheet just before that and then we'll go right into it.

MR. CYMBALSKY: Okay, great.

MR. MILLER: Victor, just quickly, just go back one. The percentiles --

MR. FRANCO: Yes.

MR. MILLER: Okay, so what are you telling - - what is that telling us? So the 5 percentile of all population would have a negative life cycle? I'm trying to figure out. It can't be cumulative, right? Explain to me what I'm seeing there.

MR. FRANCO: Yes, yes, and that's very important. And you kind of think about it. I don't know if you have kids sometimes, they take the standardized tests and they're saying, oh, your kid is in the 95th percentile, or if he might not be a good student, he's in the 5th percentile or something like that.

So in that kind of -- if you're thinking about that, if your child was in the 5th percentile, he would be exactly at this 750.7

negative dollars. So obviously there's -- below 5 percent there's people that are actually worse than that and that gets into this minimum. This would be the minimum. Then you have some people that just don't have anything and then you go into the other range and 95th percentile then goes into the other direction. And so, that at exactly, 95th, 1,900, but then there's people that actually save more and then you get to this 25,000.

MS. JACOBS: And then Diane Jacobs from Rheem, and because it's life cycle cost savings, a negative means it's costing 5 percent -- percentile more, though they're paying more.

MR. FRANCO: Correct.

MR. CYMBALSKY: So 5 percent is just the -- that's the percentage of the

MS. JACOBS: No, that small segment of the population --

MR. CYMBALSKY: Yeah.

MS. JACOBS: Has to pay more.

MR. CYMBALSKY: Right, 11,000 or more. So the first 5 percent losers let's call them,

they save -- they lose as much as 11,000 I thought I saw, yeah, 11,732. So that's the guy who lost the most.

MS. ARMSTRONG: That's the min.

MS. JACOBS: Oh, wow.

MR. CYMBALSKY: So he never used -- he bought a furnace and never used it.

MS. JACOBS: Oh, okay.

MR. CYMBALSKY: That's actually -- that's what that means.

MS. JACOBS: There are those people. Okay, thank you.

MR. FRANCO: And obviously what we're -- what we're looking at the summary, we're looking at the average, which is this value here and this matches the summary. But if you want to look at it in more detail, this is why we provide this so you can kind of like get a sense of the distribution.

So let me briefly go to the main calculation spreadsheet. The main calculation spreadsheet is where all the calculations are

going to end up. All the inputs from anything that's being done in the spreadsheet comes here. And so, for example, we'll talk about retail prices. So for example, the cell R6, we'll go into the retail price worksheet and we'll look at how those are inputted in there. But this is the output from there that goes in here. Installation cost, that's where this is being calculated.

UNIDENTIFIED MALE: The calculations.

MR. FRANCO: The calculations, yes. At the far right of all this are the actual calculations of the annualized calculations that are going on. So first, you would calculate the total installed cost. So that would be your first cost and then every year you're calculating basically your operating costs. But that might be some maintenance, other costs that are associated. So you can actually see here year by year what's going into that household. And it varies. Obviously the energy price varies. And that's why this is varying and then you have maintenance costs that are being generated there.

Everything else are inputs to that. The final thing to look at here are the results. So when you look at and you're comparing for example, well, what's going on here at LCC savings or even LCC. So for this individual household, you're just looking at that LCC savings for that household. And depending on the economics of the household, that's the result that you're getting, just one household.

The final thing to -- what I wanted to talk about this spreadsheet, this worksheet is there's two things to note related to Crystal Ball. When you see a green cell like this, that'll mean that it's a distribution. And we'll open it up and see what that means. When you see a blue, that means that it's a forecast cell. So let's cite that into the idea of forecast cell worksheet. So what happens is if we set this up as to be a forecast cell, then every time that a household is being calculated, this value is being recorded. And then as it's processed, the final result is an average. Going back to the question

-- what was your --

MR. SCHROEDER: Dave Schroeder.

MR. FRANCO: Dave Schroeder had, we would -- once we run the spreadsheet, so this is again -- this is more of a detail obviously. If you have Crystal Ball and you run the spreadsheet, what you're able to do is extract all that data. So what you want to do is you run the spreadsheet. Then you go to the Crystal Ball. If you have Crystal Ball, you actually have this tab called Crystal Ball. And what you can do is once you run it, you actually -- there' a button that -- because we haven't run the spreadsheet.

It's not live. But once you run it, it's active, which is called and hopefully you can see it, which is called extra extract data. Once you click on that, actually gives you what you want to extract. So you might want to just extract one variable or, sorry, one forecast cell. And that'll be it and that'll be the whole 10,000 and actually you can do statistics also. You can actually just the raw data or the statistics or

you can do all the variables. Now, there's so many variables that depending on sometimes it doesn't fit in one worksheet. So sometimes you want to minimize and it also takes more time to extract obviously. So that's that and hopefully that clarifies that and that's more of a detail.

Let me just go in here. For example, here we have a green. If you have Crystal Ball, you can see what the distribution of this is in Crystal Ball. So here, you wouldn't be able to tell what's going on there. It's just a green cell. There's no formula. There's nothing. So you would actually -- I click on here which says define assumption. And you click on it and it'll actually give you what that assumption is. All right, it might take a while because it's looking at it. Hopefully it'll open up.

MR. CYMBALSKY: So while this does it's thing, Richard Murphy had a question. Are there a different set of assumptions, variables for replacement and new and the answer is yes. I think Victor has been detailing that breakout in

the spreadsheets and we'll see more of that as we go through. Another question from David Nestor. What size house is being used as the input and what is the average age of the house. I think this comes from the RECS database.

So each one of those houses has different characteristics. Age is one of them. Size is another one. And that goes to sampling and then goes into the Crystal Ball and gets a distribution, et cetera.

MR. FRANCO: And Victor Franco again. We'll go into that once we get into building sample. So this is how the distribution actually looks for this particular variable. And this is the probability that that will be the distribution. Obviously this will get more of a probability that this will be selected versus these other two.

So this is kind of the weighting, the probability of that. And actually this is another detail. In Crystal Ball you can actually see statistics and percentiles and other things that

are in terms of distribution. Once we get to distribution, it's a little bit more interesting. We'll actually open that up and we'll see how that functions. So hopefully that clears up the flow.

So this is what we can call the calculation engine and we might need to go back to this. So now let's go to the actual input worksheets. And let's start as we were saying we're going to be starting with the equipment prices, the one that calculates the consumer prices. Okay. So basically the consumer prices are the manufactured costs times markups which will also include sales taxes. Now obviously there's a lot of other inputs that go into it.

For this, it depends also for example on the furnace fan type and if it's for example in California that it's being shipped, then we consider that it's a fraction of time it'll be a low NOX unit. So there's very specific variables. And so, there's where you get into the details of what product you're dealing with. But in general, the methodology is you have a manufacturer cost

and you multiply that times markup and sales taxes. Also, you have a shipment cost as well associated with that.

So let's briefly go over the worksheet. Again, almost all these worksheets will have the same setup. We have input parameters. We have data down here. So this is the engineering data that gives us the manufactured production cost and then we actually go into the calculations.

Another thing that I just want to -- I forgot to mention is the first part of the presentation, I want to focus just on the general results that are without the product switching. As we discuss the product switching, then we will have to go back to some of these worksheets, which there are certain components that are related to product switching and you might have questions on. So we'll go into those. But just to have the flow.

MR. MILLER: Victor, could you just slide back to the -- my left, yeah. Learning rate, is that what that says?

MR. FRANCO: Yes.

MR. MILLER: What is the learning rate factor?

MR. FRANCO: So this is the equipment price but we'll talk about that and it's essentially over time equipment prices change, and so this is supposed to take that into account.

MS. JACOBS: Diane Jacobs from Rheem. So you have references to X13 and ECM. Is that for the standby? It was going to the side?

MR. FRANCO: These would be, yeah.

MS. JACOBS: Okay.

MR. FRANCO: These would be down here. This is for the actual furnace motor that's being used for the furnaces.

MS. JACOBS: Yeah, but that's part of a furnace fan, so --

MR. FRANCO: Yes, that's correct. But we have to -- since there is a furnace fan rule, that's going to be before 2021, then we take that into account. So for example, if we were just analyzing today, we would have certain fans for

furnaces which have PSC motors and some fraction that have ECM or X13. By 2021, the assumption is that everything will be X13 and ECM because of the furnace fan standard. So that's why we were considering.

MS. JACOBS: But for furnace -- the furnace rule, you're talking about AFUE, aren't you?

MR. FRANCO: That's correct, yes. But those --

MS. JACOBS: So that's only gas consumption.

MR. FRANCO: That's correct.

MS. JACOBS: So why are you --

MR. CYMBALSKY: Well, what do you do when you buy a furnace, brand new?

MS. JACOBS: What do I do? I don't buy them. I get them. (Laughter.)

MR. CYMBALSKY: You know, and in the government, we don't get free money because we print it.

MS. JACOBS: So --

MR. CYMBALSKY: Sign me up. I'm in. It's the cost of a furnace, right?

MS. JACOBS: Oh, the cost is related to the fan. Okay.

MR. FRANCO: Yes, yes.

MS. JACOBS: The first-time cost.

MR. CYMBALSKY: Right.

MS. JACOBS: Okay.

MR. CYMBALSKY: So you can buy up on the fan.

MS. JACOBS: Okay, okay.

MR. CYMBALSKY: Yeah.

MS. JACOBS: Thank you.

MR. FRANCO: So, correct. Yes, of course.

MR. ADROIT: Henri Adroit, Goodman. More of a suggestion than a question. Would it be possible I guess when you release this again in the NOPR stage to highlight input cells that stakeholders have an option to play around with, assuming that they have Crystal Ball, but just similar to how you did the green and blue shading,

just to be able to highlight the input cells as well that we would have control over?

MR. FRANCO: That's really good -- Victor Franco. That's a good suggestion. Definitely we'll take that into account. Thank you.

MR. CYMBALSKY: Yeah, normally we lock the cells that you shouldn't change. That's how we do it.

MR. FRANCO: So that's sometimes a little bit difficult. You want to know everything that goes into that assumption and then to be able to change the variables and usually the documentation will have that kind of detail to kind of walk you through what kind of the assumptions and then how to generate those assumptions. But that's a really good suggestion. Thank you for that.

MR. LESLIE: Neil Leslie -- excuse me. Neil Leslie, GTI. You said that you lock cells that you don't want people to change.

MR. CYMBALSKY: Right.

MR. LESLIE: Could you elaborate just a little bit on --

MR. CYMBALSKY: So for example, if there's a calculation that takes the number of days of the year into it, we won't let you make it anything but 365. So, an example. You can change that number. You will break the model. Just so that you know my background, for 20 years I wrote the EIA NEMS residential model and it's the same thing there. You protect certain input variables from outside users who purchase and use the model from breaking it. The only way we can do that is by locking cells.

So can they be unlocked? They can, but it's not of any value to do so. You'll just have users break the model and then have more questions that shouldn't arise.

MR. MILLER: John, Bud Miller. It's on. Can we get a list of the locked cells? In other words, what it is that's being locked? You gave an example and that's nice. But can we get a list of those?

MR. FRANCO: Victor Franco. So in this spreadsheet, actually there isn't any specific that's being locked. But what happens is that you have these if statements and there is some logic in that that if you kind of break it -- like John is suggesting, like if you don't have a maximum of 365, then it kind of doesn't make -- the result doesn't make sense. And that's a good suggestion to actually put that as a list of what those variables are and what those -- yeah. Thank you.

MR. CYMBALSKY: My experience, you know, from my previous employment is that I'd say 99 percent of the users who wanted to use a model broke it, not intentionally but unless you protect from going out of the bounds of what the model can and can't do, you have to protect it somehow. And I'm sure Excel and other spreadsheets and programs have that as well. Please come up to the mic. I think you'll have to switch the button on.

MR. SORINO: Don Sorino, National Association of Home Builders. The cells that are locked, you know, I had heard the question can we

know which ones they are. Could we also know what their parameters are?

MR. FRANCO: Yeah, so just to emphasize, in this current spreadsheet, there is actually no cells that are locked and you can't like change. But to emphasize, if you do some -- make some changes and maybe you don't understand what things are doing, you will break the model. It will produce results that might not make sense, but --

MR. SORINO: Understood.

MR. FRANCO: Yeah.

MR. SORINO: But if there are locked cells in any of the sheets, understood we shouldn't unlock them. You had them locked for a reason.

MR. FRANCO: Correct.

MR. SORINO: But to know what those cells are and to know what they're locked at would be helpful information.

MR. FRANCO: Great. Thank you so much. I appreciate that.

MR. SORINO: Thank you.

MR. CYMBALSKY: It's in the documentation.

MS. ARMSTRONG: Yeah, so I mean, typically - - this is Ashley from DOE. So while Victor's saying that there's no specific locked cells in the LCC spreadsheet, the furnace one that he's using for an example, there are sometimes locked cells in other spreadsheets. And I know for example in one of them, questions have some up recently.

There is documentation in there about what cells are locked and why. And specifically, it says like this cell is locked. It's an implementation equation and it shows the equation written out on a worksheet in the spreadsheet itself. So I would encourage you to look at it first and see if you can - - because you can see the equation being implemented but it's just locked. It can't be changed.

But you can actually see the equation. And then on a separate tab, it has the equation written out as well as in the TSD. So you can

follow it all. It's just that if you change that equation, it's then -- it's not an implementation of our test procedure. It's not an implementation of an accurate model. It's not the DOE model and it will not give you any type of meaningful result. So it's not helpful. Okay?

MR. FRANCO: Thank you for that. So just to highlight some of the -- and if as a user, this is part of the complexity -- some of these have a lot of if statements and a lot of uses of Excel that are maybe not usual. They're a little bit more complicated, so using, for example, match function or index to generate these. So if you are an advanced user of Excel, you will more or less be able to navigate these. But we understand that these are hard to do.

So just to highlight the questions about where you would so some of the changes, so for example, let's say for example you wanted to change the manufacturer production cost. So for example, this column right here is picking up the appropriate manufacturer production costs that are

related for that household. For furnaces, it actually picks up other components as we talked about. It picks up what the furnace fan that household will have and, for example, if it's in a region, California, it will have a low NOX add. So that's part of that specific cell. So if you wanted to change that, then you could be able to change it there to change specific.

MR. CYMBALSKY: But to be clear, if you don't care about all that other stuff, let's just say, Neil, for example doesn't believe it's 381, it's 500, we can just change it right here and it will flow through.

MR. FRANCO: Yeah.

MR. CYMBALSKY: So this is an appropriate spot to overwrite the number. Now it's going to ignore all that other stuff. So you want to simplify this? You could just say, I think it's 500, I think that one's 600, et cetera, et cetera.

MR. FRANCO: Exactly. And so, this is the basic -- the first place that you could do that because that's the manufacturer cost. Then

you actually multiply it times markups. So there's an additional place that you might be able to do that. Now, going backwards, if you didn't want to go that far but you wanted to change kind of like the primary manufacturing cost, the inputs are here.

Say, for example, these are fixed values. This is data coming from the engineering analysis. You say, well, what if increase this incremental 10 percent. So here you can actually go, oh, I'll just increase this by 10 percent, 10 percent or 15 percent. And then you can actually change it there. These are fixed values. You generate your results based on that and you have to have an understanding of what you're trying to do. Obviously this is manufacturing cost at 10 percent there, means something else in the final consumer price. It's not going to be 10 percent.

Now, in the final result that comes from this is the retail price and that's related to the markups, which will go to a different worksheet. The retail price is another place that you could

actually have some type of a percentage. So say you wanted to have a fixed 10 percent increase for one of these levels. You thought this is 10 percent more. Then here you can actually just 10 percent, put in that cell.

MR. CYMBALSKY: And so, to get to Frank Stanonik's question about the learning, so you can see it comes in here. If you go back to the learning where it said 0.94, if you just changed it to one, you would zero out the learning. I know that's another thing that people want to know. So the 0.94 I think represents there's a 6 percent decline in the price of furnaces.

MR. FRANCO: Correct, and we'll go into that in a little bit more detail because we're going to two worksheets really quickly that are related to this. And so, once you kind of visualize that these are kind of the calculations, the next part is kind of some of the inputs. So the two inputs that we looked at are markups and equipment price trends.

So there's a markups worksheet that I

kind of started with when I was doing the slides. It's a very similar setup. You have some input parameters, the markups calculation and then intermediate calculations we kind of already discussed.

In this sheet, for example, for this specific building, it's in region ID 5, and so what it's doing, it's looking the individual results for that region. Once that picks up what's appropriate for that household, it'll go down here and calculate what are the markups that are going to be applied for the equipment prices.

In this case, we have a manufacturer's markup which is fixed, 134, and then we have a baseline and incremental markup which includes sales tax if it's appropriate. And that's what's outputted into the equipment prices. And you can actually go back to the equipment prices -- let's just -- oops, sorry about that -- and match that these two values are the right values that we saw as outputs before including this manufacturer markup.

Now, let's talk about the industry price trend or learning rate. And then, that's this parameter. Now, because we have the standard that's fixed at 2021 which is when we are assuming that the equipment is being purchased, this value is 0.937. It's a fixed value. Obviously if that year changes, then it would be a different value. So that's what's being picked up. Now, the user, if we go back to the summary, has the option built in to actually change that -- the trend. So right now it's looking at a decreasing default. If you put no learning, actually click on that and go back to equipment price trend, it'll change what the fraction will be or what's being looked up. So in this case, it's looking up a different value.

So the equipment price will have a different forecast in that case and you can actually hard code this value if you thought that that value was different. You can actually hard code it to 0.5 or I want one and you can do that as well.

MR. M. HUNT: And this is Marshall from PG&E. So you do not need Crystal Ball for some analysis this looks like if you --

MR. FRANCO: Well, then again, the results that you will see if you don't have Crystal Ball are just for individual households.

MR. M. HUNT: Oh, okay.

MR. FRANCO: Yeah, and it becomes really hard because then --

MR. M. HUNT: Got it.

MR. FRANCO: We don't have an average household. There's all these variables and so it would be a little bit hard to you. Yeah, definitely once you change this, for example, you want to run it and see what happens to 10,000.

MR. STANONIK: So Frank Stanonik, AHRI. So the information you had up above, you were showing cost in MSP in 2013 dollars and then you showed I think the price, right --

MR. FRANCO: This right here would be in 2013 dollars, yes.

MR. STANONIK: Right, and then you

showed what I think was the retail price or something.

MR. FRANCO: This is correct, the retail price 2013 dollars, yes.

MR. STANONIK: So that's also -- that amount doesn't reflect the learning factor.

MR. FRANCO: It does, yes.

MR. STANONIK: Wait, it does or doesn't?

MR. CYMBALSKY: It does, the 2013.

MR. STANONIK: It does, but you put it back in the 2013 dollars.

MR. CYMBALSKY: Yes.

MR. FRANCO: Correct.

MR. CYMBALSKY: It's real dollars, not nominal, yes.

MR. STANONIK: Okay, thank you.

MR. FRANCO: So that takes a look at the equipment prices. So hopefully that's more or less clear. As we go through these very similar the worksheets.

MR. CYMBALSKY: So I think now let's jump to the installation costs. It's probably

where there's more questions. Neil, question?

MR. LESLIE: I do have a quick question and it's going to get into some of the other aspects of this related to the product switching. And that is, where would I find the costs of the heat pump and the electric furnace and the electric water heater and the gas water heater that are all necessarily wrapped up in that impact.

MR. FRANCO: Yes, and obviously I mentioned that we were going to go to that when we go to the fuel switching. But let me just show you where those are at and then we'll go back to it into more detail. So some of those inputs, because they're related to equipment prices, the markups we're assuming they're the same, are in this sheet called equipment prices. And this part of the equipment prices is what we've been talking about, the non-weatherized gas furnaces. Now, if we go to the right, we will find the equipment switching options.

So let me just really briefly talk about

what the options are and what the different components here are. So we're considering a central air conditioner and this would be the retail price of that, a heat pump, this would be the retail price and this is for the individual household. So again, if the household is located in a certain region, all these other factors, this is the cost. Gas water heater, electric water heater and electric furnace. When we go back, we'll go into more detail as to some of the assumptions.

So it's easier to understand because we have to actually see the switching price. But as you have questions, please --

MR. LESLIE: Absolutely. This is Neil Leslie again. Are there distributions of efficiencies for each of those options as well?

MR. FRANCO: Yes, and it depends on certain inputs. So let me just very briefly -- so for example, we consider what the heat pump size is of the equipment. So depending on what the heat pump size, it will have a certain cost. So

let me go down here. For example, if we're looking at a heat pump and we assign a two ton, it will have this as the manufacturer production cost, $900. But if it's a five ton, it will have this cost.

MR. LESLIE: Understood. I guess my question is --

MR. FRANCO: Sure.

MR. LESLIE: Is it only for a 14 SEER heat pump or are there other heat pump efficiencies within this that the consumer might choose to switch to? Am I making sense, I hope?

MR. FRANCO: Yes, yes, that's a very good question and I'll answer it.

MR. LESLIE: And so, if there is information related to a more efficient heat pump, this example, where in the spreadsheet would that distribution be found is my question.

MR. FRANCO: Correct, correct. Yes. Again, this is an equipment and we would go into more detail, but the specific answer to that question is that in this analysis we assume it's

only 14 SEER. We assume that the household that's being switched to, it's the minimum efficiency because that's where the economics might make more sense for that house.

MR. LESLIE: Neil Leslie again. That's why I couldn't find it.

MR. FRANCO: Yes, yes.

MR. LESLIE: Thank you.

MR. FRANCO: Thank you. So let -- sure.

MR. MILLER: Bud Miller. Do you have a learning curve for all that equipment, the electric equipment, et cetera?

MR. FRANCO: Yes. Yes, so let me go and show you that.

MR. MILLER: Okay.

MR. FRANCO: Yes, so for furnaces, we use the furnace learning curve. For central AC and heat pump, we have this central heat pump learning curve which is similar values and for water heaters we have its own learning curve.

MR. MILLER: What is it --

MR. FRANCO: Oh, water heater.

MR. MILLER: Meaning no learning curve?

MR. FRANCO: That's correct, yes. And some of the assumptions, years are used for those inputs are here. For water heaters, it's just one. There's no -- it's not changing, not a variable.

Okay, so we're entering installation costs. It's one of the more complicated worksheets, probably the more complicated worksheets in the spreadsheet. So bear with me as we go through. There are a lot of details that are very specific to furnaces. Almost all other products, it's very -- there's less inputs, let me put it that way and it's less complicated.

So to understand this, the whole what's going on, you do actually need to understand the furnaces and furnace market and how they're installed and things like that. So as we go through, obviously you'll have some questions and we'll try to answer them as best we can. Now, a lot of this goes back to the building sample in the household that we're assigning and that will

actually be the next section.

But let's assume that you have a household that you've selected and it's in a certain region and that you assume that it's a replacement. So you have all these assumptions there citing to that specific household. Again, the setup is we have all these input variables. So this is hopefully -- I'll try to make it not too overwhelming but obviously this is probably a lot, very overwhelming.

So this is the input parameters that come mainly from the building sample and some distributions and some information that comes from other cells. But primarily for the building same. For example, one of the primary things that we're trying to calculate is the pipe length. To calculate the pipe length, it's very complex. You have to understand that it depends on the building type. So what's going on is that let's say you start with 80 percent or lower AFUE furnace that's being installed in an old building. So what we want to do is we want to try to see what's going

on, what would be -- if they're trying to do horizontal or if they could do some type of vertical, what would be the vent length. So a lot of these input variables are trying to determine that.

One of them is, for example, the number of floors in the building or household. And so, that's an input that comes from RECS. RECS actually tells us that this household has one floor. Another input is whether that household has, for example, a basement. Then obviously then the furnace might be installed in the basement and then you'll have one additional floor. Other input variables that come from RECS are for example if it has a high roof or ceiling, things of that sort.

Let me focus on an additional one is the installation location. That does not come directly from RECS but there is a process that we set up to try to simulate where the installation location will be based on RECS variables. Basically, for example, let's say that a household

has a basement. Most of the time, the furnace will be in the basement. So we assume that the furnace is in the basement. When we do that and we run this spreadsheet, we come up with similar results to survey data from different sources. So we assume that that's -- that that works out.

But RECS again does not tell us that the furnace -- that's not a question in RECS. Then after that, then we assume if it has an attic, a certain percent of time it will be in an attic or a garage, crawl space. So we have all these installation locations.

Let me go back to the statistics. Some of the -- those type of variables that are important and to look at, kind of what we're getting into final results, could be available here. For example, this is the installation location. And here, you can see the different installation locations. Each one of these has very specific installation costs that would be associated with them and let me put this a little bit larger so we can all see. This is what our

assumptions is. It's basically a condition.

Actually RECS will tell us if it's conditioned or unfinished or unconditioned, a crawl space, garage, indoor, attic, if it's conditioned or unconditioned. And these are actually the fractions that result from running this model 10,000 times. This is the national. And let me just point out that the same -- you could look at the north region or this is -- okay, I'm not quite sure -- what I'd like to go up -- and the southern region.

So you can actually look at what those are. Now, again, the question about if you wanted to look at all the 10,000, you actually output that and you can actually look each individual household what that input for that installation cost.

MR. MILLER: All right, this -- well, this may be one of the questions I'm getting a little gray area. So in the particular analysis that we're using as an example here, there are some percentage of installations that are in a

commercial building. And in what you're just showing us, I would say those were all installation sites in a residential building.

MR. FRANCO: Correct.

MR. MILLER: Is there a different set of -- let me call them installation options for commercial buildings and I'm trying to envision the CBECS, right. It's a commercial building. So and is that based on what the building looks like or is it still based on where in the building it is for commercial because, boy, that gets really squirrely.

MR. FRANCO: Yes, yes. And obviously when you're trying to do this analysis, you are -- you try to visualize, right, what's going on and what the input variables. And for example CBECS does not actually provide where the building is, like what location as well as with RECS. So what we assumed is it's going to be indoors and depending on the number of floors, we make some number of assumptions about what would be the vent length, so --

MR. CYMBALSKY: SO this is John from DOE. Yeah, we're getting close to over the line. But let me just step back a little bit. So let's just logically think this out. So some residential furnaces are used in commercial buildings. Why would that be? Because they're probably very small buildings that actually look like a house.

For example, a small restaurant or a barbershop or something of the like that would not put a residential furnace in a very complicated, big office building such as this. So based on that logic, I think we did an analysis and I think we need to stop it at that point.

MR. FRANCO: That's correct, yeah.

MR. MILLER: Okay, thank you.

MR. FRANCO: So those are kind of the inputs. Then obviously after you have those inputs, you're making some assumptions and then that's where some of the distributions are coming in. So for example, one is the average ceiling height. Now, we have some NHAB data that shows

there's a distribution and you can actually see the distribution here and fraction of the time it's going to be eight feet.

A fraction of the time it's going to be nine feet and a fraction of the time it'll be 10 feet. And that's based on that data almost 70 percent are going to be picked up as nine feet. For this distribution you can actually see a statistic and the mean would be 9.2 feet, the average. But you're actually picking up the distribution. So some households will be 10 feet. Some households will be nine or eight feet.

MR. SCHROEDER: Can I ask a question on those distributions?

MR. FRANCO: Sure.

MR. SCHROEDER: So that distribution and then there are other distributions on this sheet and others, do those depend on each other and do they depend on some of these other inputs or are they each one as a completely independent variable?

MR. FRANCO: Victor Franco. So almost

all variables in this spreadsheet, I almost want to say that all of them are independent. Obviously there are some dependencies that are associated with them. If there's a strong correlation, you can actually have a correlation variable related to that. But that would require more data in what would be that correlation factor.

MR. CYMBALSKY: I do think it's safe to say that in the 10,000 simulations that are run, that'll be picked up. Those co-dependencies will be, you know, mapped to one another and it's one of the 10,000.

MR. FRANCO: So the distributions themselves are kind of independent. But there's if statements to say that this and this has to match to be able to pick up a certain variable. So there's some logic that tries to pick up the dependencies that are obvious and then there are some that might not be as obvious and you would actually have to have the data to say that this depends on this a certain fraction of the time

with that data. What we have data on, and we have fractions and we can do some if statements, we do do.

MR. CYMBALSKY: Laura?

MS. PETRILLO-GROH: Laura Petrillo-Groh, AHRI. I might be getting ahead or misinterpreting. But does this assume that the mobile home gas furnaces are all -- all have the same installation?

MR. CYMBALSKY: Yeah, that's a different meeting. Sorry. That's a good example of a deliberative question.

MR. FRANCO: So those are the different assumptions for different product classes. And yeah, we're focused more right now on the non-weatherized. But if you see the spreadsheets, the inputs and the variables for both of them are significantly different and that's based on just the application. So we do look at the application and we make those assumptions, yeah.

So obviously there's -- we then need to look at whether the household is commonly vented.

So if you're familiar with furnace installations, some of the furnaces are commonly vented with other products. Here we only assume that they're commonly vented with water heaters. There might be other equipment but here we're just assuming gas water heaters with a gas furnace.

Other assumptions, for example, are there's some apartment buildings and townhouses or condos that might actually have -- they're sharing a wall. The wall might actually be the closest one that the furnace has. So it can't actually be vented through that wall because it will be going through the other apartment. So that wouldn't be a good idea and it actually has to go through a different wall or multiple walls.

So we make some assumptions about what a fraction of the time there will be apartment that wit will be really hard and you have to go through multiple walls or very, very long vent length. So that's taken into account.

MR. CYMBALSKY: So the takeaway there, you know, just to generalize about the

installation, the analysis in the spreadsheet, and you can see the numbers, takes into account the range, the entire breadth of different venting and installation costs associated with that. So I think that was an earlier question, so.

MR. FRANCO: So obviously it's pretty complex. There's a lot of details very specific to furnaces. And I'm just browsing through it, right, but if you have any specific questions, we'll see if we can answer them.

MS. JACOBS: This is Diane Jacobs from Rheem. So you don't know which side is the front of the house. So you're assuming -- you must be assuming the furnace is somewhere and then the closest -- are you putting it like in the middle and then you're finding the closest wall or --

MR. CYMBALSKY: That's deliberative too, so yeah.

MS. JACOBS: Oh, okay.

MR. CYMBALSKY: That'll be part of the NOPR conversation.

MS. JACOBS: Okay.

MR. FRANCO: That's correct.

MR. STANONIK: Frank Stanonik, AHRI. But okay, I'm looking. The example right here, you have two columns.

MR. FRANCO: Yes.

MR. STANONIK: And these are inputs, right?

MR. FRANCO: That's correct.

MR. STANONIK: So what -- oh okay, never mind. Missed the heading.

MR. FRANCO: I'm sorry, and I should have gone over this at the beginning. All of these worksheets have -- because we have two products. No, there are other spreadsheets that you might have like 16 product classes, different products and then you have 16 columns. In this case, we're only analyzing non-weatherized gas furnaces and mobile home gas furnaces.

In the case of installation cost, you can see that the inputs for non-weatherized are a lot more. There's a lot more going on. Mobile home, there's a lot less. It's more simplified

because it's a different installation type.

MR. CYMBALSKY: So is there a table you can point to that shows the values for --

MR. FRANCO: Yes, we're going to go to that. So let me just mention that then there's other inputs that are coming. We assume some AFUE efficiency that's associated with the building, the year that the house was built, the age of the equipment that's currently being installed, what type of wall is being.

So obviously if you have a wall that's wood or something, it's very easy to drill a hole. But if you have a brick wall or you have some other, then it's more expensive. So we have that from RECS. And also we mentioned about if they have commonly vented or not. So we want to know if it has the water heater and what kind of air conditioner equipment for some of the other assumptions that we're trying to make.

MR. SCHROEDER: So in that section I actually just have a question. I think I can stay away from being deliberative. This is Dave

Schroeder, sorry. So in this particular example, we have an AFUE existing of 90 percent, right?

MR. FRANCO: Yes.

MR. SCHROEDER: And that's I think just randomly assigned, right? That's coming out of RECS because that's not in there.

MR. CYMBALSKY: So this home already had a condensing furnace.

MR. SCHROEDER: This home already had a condensing furnace.

MR. FRANCO: Correct.

MR. SCHROEDER: In this case, if you run this model for the 90 percent case, would there be any life cycle impact, you know, in basically the case where they reinstall what they have?

MR. FRANCO: So the differential, because then you would be comparing more between if you're going from 90 to 90, there's no differential obviously. But then if you're comparing 92 to 90, it depends on the assumptions.

MR. CYMBALSKY: It depends on what standard level you picked.

MR. FRANCO: Then there might be a differential.

MR. SCHROEDER: Okay. But if you just picked the 90 standard, then there would be zero.

MR. CYMBALSKY: It would zero, right.

MR. FRANCO: Yeah.

MR. SCHROEDER: Okay. So it would be in the no impact work out.

MR. CYMBALSKY: Correct. It would be in the non-impacted. They're already there, yeah.

MR. FRANCO: That's correct, yeah.

MS. PETRILLO-GROH: Laura Petrillo-Groh, AHRI. What does five mean for installation location?

MR. FRANCO: Yes, and --

MR. CYMBALSKY: So that's back to the original -- I think --

MR. FRANCO: Let's go back to the statistics. Five actually means indoor. There is -- we try to have as much as possible what those mean.

MR. CYMBALSKY: So you go to building --

MR. FRANCO: If you go to building sample --

MR. CYMBALSKY: Right.

MR. FRANCO: There is -- and we haven't gotten there yet but let's just go there now. There is a definition here of the numbers.

MR. CYMBALSKY: Yeah, so this is where you pick up all those parameters you see on the other spreadsheet. So if you wanted to pick up a different set from the sample, this is where you'd come in here and pick the one you want to do.

MR. FRANCO: And here is the list. So for example, five is indoor. Four would be garage crawlspace, basement, conditioned or unconditioned. This would give you the list.

MS. PETRILLO-GROH: And because this is looking at the case for one house and then this goes through the Crystal Ball to assume some distribution of installation in any of those other locations?

MR. FRANCO: That's correct. So a specific household, it's indoor location.

MS. PETRILLO-GROH: Thank you.

MR. FRANCO: Yeah, and in another location obviously it would be something else.

MR. CYMBALSKY: Right, so if you're playing around with the spreadsheet, this is a good question actually. So you come here and you say, actually I want to do this house and then write down what parameters from this table and then you go to the other one and change five to four and you can see the numbers change.

MR. FRANCO: How that would vary.

MR. CYMBALSKY: Yeah, so you'll see you can go house by house to see if it makes sense. If you changed it from the house type and the location, et cetera, do the numbers that you think would change in a positive direction change in a positive direction. So that's like a good error test that you might want to make, so.

MS. PETRILLO-GROH: Thank you.

MR. FRANCO: Thank you for the question. So let me first just go to the final results before going into more details. So at the end of

it, for this case, we've divided them out into certain categories of installation costs. So we've divided them into the basic installation costs and what those are, they're very similar for all furnaces. It's just putting in a furnace, taking the old one out. It's the replacement one.

That's just a basic installation. Then there's some venting costs associated with them and this would be the next column. Then there is if sometimes when you're installing, you're going from 80 percent to a 90 percent and you have commonly vented water heater, you get into something else called orphan water heater and then this would be the associated cost.

In this case, there is no orphan water heater. It's going from 90 to 90 so there is no cost. And then you go into the condensate drainage and that's applicable only to condensing equipment. And then you get the sum of all these and this would be your installation cost only for non-weatherized gas furnaces. When you get into equipment switching, there's additional costs that

are being calculated separately. And again, we're doing two product classes at the same time. Below here you can see the mobile home and they have different assumptions.

MR. CYMBALSKY: So I think now might be a good time to pause for a little break. So let's say five after. Ten minutes enough for everyone? I know -- okay, so quarter after, reconvene.

(WHEREUPON, the foregoing recessed.)

MR. CYMBALSKY: -- today. So just to do an agenda check, so we're going to hit up the product, the fuel switching/product switching next and then head into the NIA. I seriously doubt we'll get to the GRIM model today. But my sense is that these first two spreadsheets have more interest anyway. We could -- like I said, if we need to have another meeting like this on methodology, we're happy to do that at a later date.

Before we turn it back over to Victor on the switching, we had a couple of questions that were asked on the webinar. One of them from Carl,

that's a deliberative question. So we're going to table that for the NOPR meeting. Another question came to

UNIDENTIFIED MALE: Can you tell us what the question is so we know --

MR. CYMBALSKY: It's about the venting and it's very specific about what we considered; for example, sidewalks, streets, average snow heights, et cetera, et cetera. So you know, we'll get into that at the NOPR stage. And then David Peretti asked more specifically about in the water heater costs, can you explain what the water heater is and did you have all these units -- what type of unit it was, what did it have a power vent, et cetera, et cetera, et cetera.

So this is a good segue I think into the next portion of the presentation. And what we can say about switching, it's not going to be much because all of what's going on is mostly going to be explained at the NOPR stage. But I will say that the switching routine is based on economics, okay? And so, if we think about that in a very

broad sense, the economics of a particular consumer to switch, the reason they considered it is because the option in front of them is costly and they're looking for a less costly alternative.

So if you just use that, if we frame it that way and leave it at that, we can't get into any more detail than that. I think what I just said answers David's question in terms of what type of water heater or what type of heat pump they might consider.

Clearly it's an economic decision. They're switching based on an economic decision. What is their alternative? That doesn't -- it probably means that they're least cost people, right? So just think of it that way. I'm not going to answer it anymore beyond that. But I think it's pretty clear that the switching's for a reason and we'll leave it at that.

So back to Victor. We'll hopefully -- like I said, fuel switching, NIA and then we have to -- we have to end at 1:00. So here we go.

MR. FRANCO: Great. Thank you, John.

Victor Franco again. I just wanted to spend five minutes just to go over a little bit all the other worksheets, just very briefly and then we'll go right into fuel switching just to finalize. And I wanted to bring two points into the installation cost. Obviously the installation cost, the calculations and some of the additional assumptions if you're trying to understand this spreadsheet are below, and there's many, many other aspects of it that are going here in this area. And you can see there's distributions and there's assumptions and based on locations and just wanted to emphasize that.

The next is there are some forecast cells. So you can disaggregate what kind of costs are going to the individual household. So if you actually wanted to look at one household or the 10,000 households and look household by household, you can actually do that as well and see what the basic installation, what the venting cost, was it applied, wasn't it applied. You can do that as well.

The actual calculation, there are two parts. One is the detailed part. Actually we're calculating the individual components that go into it. What's the cost of the thermostat? What's a little bit of the gas piping, the connection, the actual installation? And for venting, different types of components that are going into it. Then those are summed up and then they go into this kind of subtotal field, the installation cost component. And then those are totaled up in what we were looking at before the break, which would be this part.

When we come back to fuel switching, there's actually -- below there's a fuel switching component. And similar to equipment cost, those are -- they're different assumptions and they're different costs that are associated with those. The last point because now we're wrapping up the total installed costs is that these costs are then inputted into, again, the payback -- LCC payback calcs.

So if we go into one of these fields,

these are picking up the retail installation cost that we got from those two worksheets. And that gives us the total installed price. So that kind of wraps up that part. The final, final, final is that if you wanted to look again from the 10,000, what is the average, for example, you could go to the summary and then this is the average of everything. Of all 10,000, this is the total installed cost. This is the average from 90 and that's your differential.

And obviously everything that we discus about individual households goes into these -- coming up with these final results. So hopefully in five, maximum 10 minutes, really briefly go. So there' a lot of other inputs that are going into this. Next would be the adjusted final installation cost. There's actually an installation cost data sheet that's being pulled out, some data. This is just data. And then there's a sheet that pulls out labor costs.

And for example, in this sheet you actually have different labor costs for different

regions of the country that's being pulled out into here. And so, for individual households, if you see what the cost is, you're going to get $43 here for example. But if you go to another region, it'll be completely different because it's a different region of the country.

Maintenance and repair is also taken into account. Now we're talking about the operating costs and so this now goes into costs that happen after the installation of the product. There's some different considerations, assumptions that are going into the calculation.

But again, it's a similar structure. We have some import parameters. We have the final results which show the exports. And we have non-weatherized and the switching again. And we have some calculations or assumptions, intermediate calculations that are going on. So obviously we don't have time to focus on everything. But these are very similar. A lot of the products have this type of setup.

Let's go before going to the building

sample, or get -- okay, let me just use building sample really simply. So this kind of ties up the idea of what are the weights that are being used. And this is very important to understanding what data's being pulled and how often it might be pulled. Here, we provide the actual weighting that we're using in the spreadsheet. We actually have two sets of weights. We have a replacement sample and a new construction sample.

This is residential. And in the case for this product, we also have building sample for from CBECS. And a same, we have replacements and new construction. If you go through -- let's go -- for example, there's not a lot of commercial buildings that use residential. So you see a lot of zeroes. So essentially, if it's a zero, it's not being used. But you'll find that there is one, for example, here that has a weight, 139.

So let's discuss a little bit what that weight means. So RECS provides a weight that's based on the actual weight of the stock of that building, the building stock. Now, what we're

trying to do is we're trying to look at the shipments and the shipments in 2021. So we do our own weight, weighting that's based on shipments and that produces a different result which actually matches the number of shipments that are in the NIA spreadsheet.

In this case, we have 3.5 million shipments in 2021. We went to the NIA spreadsheet and this is a result. And then, there' a logic between how many are replacements and how many are new construction that is also provided by the NIA spreadsheet. In this case, it's about 25 percent new construction, 75 percent replacements and about 97 percent are residential and 3 percent are commercial. That all comes from the NIA spreadsheet.

The last part is -- so now that you understand that these are the weights, RECS provides for that building different inputs. So for example, let's say this is a building that's being sampled, building number ID 2 from RECS. These are all the inputs that we use in our

analysis. These are what's being captured. And you can see over here this is actually called export parameters and this is what's being captured. And this goes to different worksheets.

The last thing here to then look at is what's the actual household ID that's being used for this and you need to look at two things. So one is whether this is from the RECS or CBECS. This is actually being pulled from the CBECS sample. This is two. Let's change this to one just to look at a RECS. The household that's actually being sampled is 5,975. So if you want to actually look at that household, you would have to go 5,975, go all the way down and you would see what those inputs are. And those are the inputs that are being picked up for that household.

Hopefully that gives you a little bit of an understanding of what's going on and how you might be able to change to see a specific household. Obviously you could change what's being --

MR. STANONIK: Victor, okay -- so these

first two columns for the RECS data -- okay, so as I understand RECS, it's a survey of certain thousand number of houses, actual survey of houses, right?

MR. FRANCO: Correct.

MR. STANONIK: Twelve (thousand), 13,000, something like that?

MR. FRANCO: That's right.

MR. CYMBALSKY: For the 2009 survey.

MR. STANONIK: Yeah, yeah. Okay, so that's the first column. It's that particular house, right? So then the weighting is what, the estimate of the number of houses nationwide that are like that ID?

MR. CYMBALSKY: Correct.

MR. FRANCO: This column I, yes, it's called end weight. That's actual variable that's provided from RECS.

MR. CYMBALSKY: From RECS and it's the weighting that they use to make the sample to a population.

MR. FRANCO: Correct.

MR. STANONIK: All right, so if we want to - - okay, so I guess -- well, it'd be nice if that was just a percent in terms of trying to understand the effect of the weight, I guess. But okay.

MR. CYMBALSKY: Well, I think for the math to work out you need to have a number.

MR. STANONIK: I got it, yeah.

MR. CYMBALSKY: But sure, you could actually just make another column, sum it up and do your division if you'd like.

MS. JACOBS: Okay, and then the fourth column you said was DOE assigned it their own weight?

MR. FRANCO: That's correct. For each of --

MS. JACOBS: And what's the basis -- how do you come up with 357 instead of 85, 56 or --

MR. FRANCO: So basically the baseline shipment we know by state how many shipments have been historically shipped to certain regions of the country.

MS. JACOBS: How is that related to a house? Oh, you're just going regional?

MR. FRANCO: Yes, regional.

MS. JACOBS: Okay.

MR. FRANCO: Because we have shipments by state and that slightly changes the distribution.

MR. STANONIK: If I can, so would it be fair -- as an example, okay, so the number two, the weighting is what, it looks like 85 or something. Let's say it's 8,600. I'm just looking at the second column. Let's say it's 8,600.

MR. FRANCO: Yes.

MR. STANONIK: If we knew that in the U.S. let's say the mix of heating was 50 percent gas, 50 percent electric and being very simple here, then the weighting for the gas furnace would be half of that number, right, if there were no whole other issues. That's kind of what you're doing, right? Kind of?

MR. FRANCO: Not completely clear your question. But let's say for example there's 110

million households in the U.S. and you're saying that 50 percent are gas. So let's say that's 55 million households. And then this represents 8,600 houses. So if you divide 8,600 divided by 55 million, that gives you the percentage that represents.

MR. STANONIK: Yeah, right. That's kind of what you're doing on a little more sophisticated basis.

MR. CYMBALSKY: Use the mic.

MR. STANONIK: Pulling in shipments because you're looking at what happens -- oh, I'm sorry. Frank Stanonik. But so you're pulling in shipments because you're really interested in what's happening as we go forward in terms of energy savings year to year.

MR. FRANCO: Exactly.

MR. STANONIK: Got it, okay.

MR. FRANCO: And here then how you would do it is from 3.5 million shipments, you divide this 357 and that gives you the fraction of how often this would be sampled probability-wise. So

that hopefully helps you out how this is done. Now, let me just really point out because I know that this might be something that you want to play around with, how you might want to play around with this.

So for example, there's one. So for example, let's say you want to change the residential commercial sampling or you just want to look at residential. This would be the cell that you would change that in and then you would change that part. Let's say that you want to actually change the distribution so that this gets into actually using Crystal Ball. And then, you would maybe change this numbers here and then these actually numbers are being populated down here. Let me see if I can -- yeah.

So these numbers are coming from these cells as the sample. Then you could actually have to change this. Let me see if this doesn't take too long. Okay, great. That didn't take too long. This is the actual looking at the household IDs, 12,000 household IDs and what's their relative

probability of being shown up. So if you change it here, then you would change your sample. So for example, let's say you only wanted to look at households in New Jersey or you only wanted to look at households in California. So then you would take out all households that are not in California or not in New Jersey or something like that. Then you would have to change here the distribution. Then you would be only looking at the impacts for that specific part.

MR. MILLER: Just a process question on that. How would you then do that thing you just said? How would I -- just as an example, how would I just get New Jersey?

MR. FRANCO: So that requires two things.

it's the first thing is the easiest way to do it is you would maybe have an equation here or just have some way of which ones you are picking up or just two columns. Basically you just need two columns. One is the ID column that matches this number and then some kind of weight.

And say, for example, you wanted to use non-weatherized, this, the RECS weight for example.

And so, let's say for example we want to equal this to this. Whoops, let's say, another -- so for example, let's say so every time this pops up, that's a gas furnace. So you have the logic that it's a gas furnace. Instead of using this weight, you use this weight, for example. Or that only households in certain part of the region pop up, something like that. So you have your logic.

Then after that, the way to do it in Crystal Ball is you want to select these two columns as your data fields and you kind of blank out what was there before. Do you want me to go through that or --

MR. CYMBALSKY: That's a lot more time than I think we need to do on that right now.

MR. FRANCO: Okay, great. So yeah, but that's basically how you would do it. So I think that was all to kind of get a sense again. All these are the inputs that are going. We tried to make it so that you know where things are going

to. And hopefully you get a sense that there's a lot of data that's being pulled from RECS.

Now, let's very briefly go -- and this is kind of a question that was asked before a little bit about how the selection of the efficiency of the current household is being conducted. And so, it happens here. This is called the base case AFUE. And so, this would be the AFUE of the household that's installed in 2021. There is -- it depends on the region. We have some efficiency shipments by efficiency, historical shipments by efficiency for each region. So for example, in northern states, they have a larger fraction of condensing. Southern states, they have a larger fraction of non-condensing.

Based on that region, for example, now it's being sample region 21, for example, let's say Texas, it's looking up that 97 percent of the time it's going to be non-condensing. And so, for this household, it actually is picking up 80 percent AFUE as the existing furnace in that.

Now, if you're in a different region -- let's say, for example, you're here in a mobile home, has a different distribution. It's actually picking up 92 percent because it's actually in Kansas and Nebraska. So it's more likely that it'll be a condensing.

MR. SCHROEDER: This is Dave Schroeder. Did you say that those distributions have been projected to 2021 or this is --

MR. FRANCO: That's correct.

MR. SCHROEDER: Okay, so this isn't current. This is 2021 projected.

MR. FRANCO: And now we'll go into the historical part. Just one very brief point. If you notice, there's a lot of tables, lookup tables and that depends on the market. So this one that I was showing is just residential replacement. Obviously if the household is a commercial, it has a different distribution or if it's new construction, the distribution is below. Mobile home has a different distribution.

So that deals with the 2021. Now, if

you want to look at the existing, then this is this sheet. And this sheet again looks by region and looks at historical data and we stop at 2009 because that's when RECS's last year and for commercial 2003. So then you look at the age of the furnace. For example, this one is 2005 because it's 2009 minus four years. It's already four years old and then you will look at the 2005 distribution based on the ID of the equipment. And so, this one is actually pricing ID seven. So that's how that functions.

For air conditioning and heat pump equipment, the historical efficiency comes from these average shipment-weighted distributions. So depending on the age of the equipment, you actually have an average.

MR. STANONIK: Victor, this is Frank Stanonik, AHRI.

MR. FRANCO: Sure.

MR. STANONIK: And John, I may be getting a little again off here. All that information on the right, you said that it's

distribution.

MR. FRANCO: Yes.

MR. STANONIK: That's shipments, though, right, not distribution products in the field.

MR. FRANCO: That's shipments and percent of shipments.

MR. STANONIK: Okay. I just want to make sure we're clear.

MR. FRANCO: Yes.

MR. STANONIK: Okay.

MR. FRANCO: Yes, yes.

MR. M. HUNT: Victor?

MR. FRANCO: Yes.

Mr. M. HUNT: Can I back up just to where we were? The 2021 forecast of installations -- so in New Jersey, the 31 percent that are still going 80, that's because they would have failed in economic tests to move to high efficiency -- no?

MR. CYMBALSKY: This is the baseline. So this is not the standards.

MR. M. HUNT: So --

MR. CYMBALSKY: This is absent --

MR. M. HUNT: Absent anything happening, this is what would have happened in 2021.

MR. CYMBALSKY: Right.

MR. M. HUNT: Okay.

MR. CYMBALSKY: With no regulation.

MR. M. HUNT: With no regulation, that's what would have happened.

MR. STANONIK: Additional regulation.

MR. M. HUNT: Right.

MR. CYMBALSKY: We haven't had a regulation in this space since I've been alive I don't think, Frank.

MR. STANONIK: I'm sorry.

MR. M. HUNT: So moving forward, you mentioned that the -- we're not there yet.

MR. FRANCO: Great, so a couple more topics here. So the next big one is energy use and obviously we don't have time to go too much into energy use. Energy use is very, very similar to everything that we've been talking about, has input parameters, has export parameters. It's actually divided by month. We try to estimate what

would be the monthly and we then compare that to energy prices. We actually have average and marginal energy prices would be the next topic that are by month and we tried to match both the fuel use and electricity use to those prices.

We then have the actual calculations as part of the -- so the more complicated calculations as part of this energy use calcs just for the non-weatherized gas furnace and mobile home. That's part of this worksheet. And this worksheet goes into a lot of detail. It's very similar to the test procedure and assuming how often if it's a two-stage it would be in the high and the low, makes all these assumptions and calculates the end result is -- let me go back a little bit -- is the actual heating energy use and electricity use which would be these two columns.

And then that gets inputted into the previous sheet, which is the energy use. Stop me if I'm going too quickly, but we kind of need to go a little bit quickly. Now, the energy use for the equipment that we discussed are the switching

-- is available here in this sheet. This is again the calculation of the heat pump, CAC equipment and the water heating equipment, either electric or gas equipment and this would go into the sheet.

Very similar, they have some import parameters. You have the calculations and the end result are by month the energy use.

MS. JACOBS: Can you make that a little bigger?

MR. FRANCO: Sure. Yeah, and I'm very sorry because we're kind of rushing through. But please stop me if -- yeah, if there's something that you want to look at more carefully. And here's the export. And obviously there's a lot of input data that goes into that that we're trying to calculate. So here is the monthly. You can see here for electric furnace and we'll see this in a little bit more detail once we get to the switching and then the annual value for this particular electric -- in this household.

Now, there's some data that's being pulled out that's necessary for others. For

example, we need to determine what's the size of the furnace and the air conditioner. This would be the worksheet where that gets determined. We don't have time to go into that detail but that's where this is determined. I'll just leave it at that. Energy prices, this is where those are being determined. These are the energy prices in 2012. This is the reference here, 2012. And we've calculated both average energy prices and marginal energy prices.

Just wanted to briefly go very quickly how that's being done. We have by region we have monthly energy prices. These would be the average monthly energy prices and then both for natural gas and electricity we have marginal price factors either for non-winter and winter. We calculate these price factors. So what happen when you have a region that you're looking at, say for example we're in region 21, we go look up, for example, the prices in Texas. These would be the monthly prices in Texas.

This would be the average. These are

being picked up over here for natural gas fuel. And then, we multiply those times the marginal price factors either if it's a winter or summer or non-winter month. And this would give you the marginal price. In this case, for this particular household, the price for example in January month one would be $9.05. The marginal is $7.67. So it's lower and that's the price that's being applied for that house.

MR. STANONIK: That's the price being applied -- Frank Stanonik, AHRI. Which price is being applied, the nine whatever or the seven?

MR. FRANCO: Yeah, that gets -- just I don't know how much I can go into detail. But the average gets applied to kind of your base energy use and the marginal is to your savings. I think I can --

MR. MILLER: This is Bud Miller. The development of the marginal price factor, can you discuss that?

MR. CYMBALSKY: No, we can't. That's deliberative.

MR. FRANCO: Okay. The last part of that is obviously those are costs for 2012 and then we want to project those to the future. We use AEO projections and because 2012 is the start year, obviously that's one. That's the start year. And then, as we project further, we have this factor. So the number that we looked at before times this 1.075 would be the price in 2021 and then so on as you go further in time. These are projections are by the census division. That's how AEO defines this is the census division.

So the last two parameters before going to fuel switching, well, let's just finish with energy usage. These adjustment factors that we do for climate conditions and there is some weather data also associated with it. And so, those are adjustments that are used in the energy use calculation.

The two other important parameters that are being used are the discount rate. Those are being calculated in the sheet. Again, we have some import and we have some export data and

export data obviously is the discount factor, and the lifetime. And the lifetime is a distribution and these are the parameters that go into lifetime. We have different lifetime for different equipment.

So we have one lifetime for furnaces, one lifetime for water heaters and one lifetime for central AC and heat pump and these are the resulting values that are coming from just doing one run. If you wanted to see some of the statistics, again you could look at defining the assumptions.

And for example, here the statistic is the mean of this distribution is 21.5. You can look at other statistical information. You can actually look at the probability and this is a Weibull distribution and so you can actually see how that looks and more or less 21.5 is right here. So that's and you can go look at the other ones as well.

Similar to -- and these parameters, if you wanted to change that, then you could either

change the assumption or you could take out the assumption and just have a fixed value. So that's how you would handle changing something like this.

MR. STANONIK: Victor, Frank Stanonik, AHRI. And I think this is a general question. When you're running these analyses, does DOE normally use a different discount rate for a new installation compared to a replacement installation on the theory that a new installation, your cost is really I'll say hidden in your mortgage as opposed to a replacement is likely, you know, direct consumer payment, if you will, or I'll say charged at a different rate? I mean --

MR. CYMBALSKY: That'll be a NOPR question.

MR. STANONIK: Okay.

MR. FRANCO: So the next big topic is fuel switching. So we actually have a sheet that's called non-weatherized switching and this is completely different from any other product that we have. So this is something that you would

only see here in the furnaces. Everything else is, as we talked about, is very similar.

So this sheet is kind of like the calculation sheet of switching when it occurs. So again, this is a very, very introductory. There's a lot of details that are associated. I'll try to go as much as I can. But we also want to get into the NIA. But please stop me if there's something that I can answer in here.

So there's some input parameters as before and there's some logic that goes into why we do certain things. Some of them we can't really talk about but I'll try to best present what's here without going too much into the analysis. One thing just to understand the structure is that you have different situations. Let me call it like that.

So you might have a household that's in RECS that has a non -- starts with a non-weatherized gas furnace. All these start with a non-weatherized gas furnace obviously. And then they have either a gas water heater or an electric

water heater. So that'd be the second level. And so, this is, for example, the first is they just have a non-weatherized gas furnace and gas water heater.

For this one, they don't actually have a cooling. They might have a room air conditioner or no cooling, something else. Then the next one that we find is non-weatherized gas furnace and electric water heater. Then there's households that have non- weatherized gas furnace, gas water heater, central air conditioning. Those are usually the most common. Then we have non-weatherized gas furnace, electric water heater, CAC and then the same but with a heat pump. And obviously this is just data from RECS, like that's how the households are currently being built.

From that, obviously we're then looking at what would be the switching options. In this case, the households that we're looking at is a household configuration. So let me go back here. This is kind of the data that's being pulled from RECS. So for this household, it hasn't obviously

all households have non-weatherized gas furnace, gas water heater and a CAC unit and a configuration and it's seven.

An additional thing that this household has is that we assume that this is commonly vented and that comes from some of the assumptions in the installation costs. But because it has these two plus some other considerations, this is commonly vented. So that's another important parameter.

But this is basically a configuration number seven. So if we go back, this is what we were talking about, configuration number seven. So if you're in configuration number seven, you have some different switching options. So this is the more -- the one that has the most options. So you could again go with a non-weatherized gas furnace, which -- so we're only considering the case where you're going from an 80 percent non-condensing to a condensing when we're doing the switching.

So one is that you remain with a non-weatherized gas furnace. But because of the

standard, you have to go to condensing. And you remain with your existing equipment, gas water heater and central air conditioning. But it could be the case that you're commonly vented and it might not work out. You might want to install an electric water heater. So this would be that option. So this is option eight. The next is you actually switch your electric -- you're going from a non-weatherized gas furnace to an electric furnace. You switch your heating but you remain with the same cooling equipment.

Then the next thing is that you could do is -- and obviously you could do gas water heater or you'd switch to an electric water heater. The next thing you can do is you switch to a heat pump so that essentially switches your cooling equipment and you have to have an air handler as well. So those would be the options.

MR. M. HUNT: Victor? Victor, this is Marshall Hunt at PG&E.

MR. FRANCO: Sure.

MR. M. HUNT: The column O, I just don't

understand what the title is, hot water, water heating to number two. What is that?

MR. FRANCO: Yes, yes. Sorry and that probably is more like we understand. But basically what this is telling us or the logic is that whether it's switching to a different water heater. So for example, here it's not switching but here you're switching to electric. And so, this is more for the logic. Yeah. Sorry about that. That labeling there is not that clear.

So once we know that and we have all those switching options, then we can go to the calculation kind of piece of the puzzle here which is this part, column R to -- all the way to column AN, this part of the worksheet. Everything else that we might talk about is the inputs to this. So obviously because it's that configuration, those are the options that are being picked up.

So we start with a non-condensing, non-weatherized gas furnace, seven, and then if we are going to look at 90 percent standard, these would be the options that it could switch to and this

would be the 90 percent and then at 92 these would be the options again but now you're looking at 92 percent non-weatherized, 95 and 98.

So depending on the economics, the ability to switch might change if you're at 98 or 90 because the equipment price might be different and so your economics will change. Everything else here are the inputs. So the two primary inputs that we're looking at here are the operating cost, so it relates to the annual fuel use and the electricity use, and the installation cost -- the total install cost which obviously the retail price, installation cost.

So the first row in each of these switching sub-tables are what we've been talking about. This is the one we were just looking at, the non-weatherized gas furnaces. What's the energy use? This is the energy use. What's the electricity use? This is the electricity use. What is the retail price? What is the installation cost? What's the total install cost?

Then we have what's the maintenance.

This is more of an input to the final result and all these other parameters. When we're actually looking at the switching, whether it's going to be doing a switching or not, then we're looking at kind of a payback criteria. So based on the differential cost of going to a condensing 90 percent versus some of these other options, then you have a certain payback. So let's look at that a little bit more carefully how that works.

So the first thing we want to take a look at when we're looking at this is we're only considering cases where the cost of the equipment you're switching to, the total install cost is less. In the case of this specific household, the only situation that occurs is in this option right here, which I believe is an electric furnace, gas water heater, CAC. And that's why the payback is only being calculated for that.

Everything else is above that. So that's the first thing. Then this switching is basically just the switching payback is just basically the comparison between the 90 percent

and the switching option. And then the switching occurs based on just a switching criteria payback. Let's go back to the input. This is we're using a 3.5 year payback criteria. So based on that criteria, we're saying that it's going to be switching if it takes 3.5 years to pay back going to the gas furnace versus switching to another equipment.

If it takes less than that, for example in this case 0.2, then it's not going to be switching. Let's just see why this is occurring in this case. Here we only have a differential of $200 between this and this, between the 90 percent and the electric. But the differential in operating costs is almost $1,000. So obviously in the first year, like 0.2 years actually here it's not. It's going to be recuperated.

So that's -- it's not going to very happen - - very likely that that's going to happen. And then the model then assumes that that's -- that doesn't occur in this case. So the final output is actually going through all those

in situations and seeing if there's going to be a switching. So for example, in this case we start with a seven option and we end up with a seven. There's no switching, seven, seven.

If there was switching, then it might be like seven to nine or seven to a different number. And this might actually vary. It might be that for this level it might be switching. For the next level it might not be. It just depends on the economics for that individual switching.

MR. SCHROEDER: Can I just ask a question --

MR. FRANCO: So hopefully that finalizes and let's go to questions. Yes?

MR. SCHROEDER: So I'll try to stay away from anything deliberative here.

MR. CYMBALSKY: Name?

MR. SCHROEDER: Sorry, Dave Schroeder. If there are multiple options that, say, cross that 3.5- year threshold --

MR. FRANCO: Yes.

MR. SCHROEDER: Where is the logic

contained that would decide which of those options would get chosen?

MR. FRANCO: So it would be the one that has the best economics of those options.

MR. SCHROEDER: But where in the model? Is that in column D here near the bottom?

MR. FRANCO: This would be I believe in -- and that's a good question. This would be -- this would be right here. As you can see, this right here is looking at that row and that's exactly -- the logic is embedded in here. So it would be the one that has the more benefit. So for example, let's go into a case and see. Let's say either it's going to switch to a heat pump or an electric furnace. Because the economics maybe of the heat pump are very favorable because of the operating cost, we assume that they'll choose the heat pump.

But it could be that maybe the economics, because of the install cost of the heat pump is very expensive for another household, they might actually choose the electric furnace. So it

just depends on the individual case and the economics and it's specific --

MR. SCHROEDER: And this allows for negative numbers as well, right? You can have -- you could have negative cases here where you have a first cost advantage and you have a first year operations cost advantage.

MR. FRANCO: Yes. That doesn't happen. For example, like with an electric furnace. But it does happen for a heat pump. There could be situations where you have a heat pump in a certain region that the economics play out that the gas price -- the electric and the gas prices are very competitive to the electric price and you have actually less operating costs compared to the 90 percent. So for example, in this column, you might have that the heat pump option is less than 590 and that would lead to a negative result in that case, correct. Yes?

Mr. MILLER: Just to make sure I understand the answer of that thing, then in that negative payback situation, there would be a

switch?

MR. FRANCO: In that negative payback, there would be a switch yes.

MR. MILLER: Thank you.

MS. PETRILLO-GROH: Hi. Laura Petrillo-Groh, AHRI. How does this tab interact with the building sample tab?

MR. FRANCO: Good question. So we kind of very quickly went through that. But there are some things that I kind of browsed over that are important inputs obviously. So the first one for the building sample is that it's picking up for that household. It's picking up what type of equipment it's associated with. It's picking up that it's a gas water heater that's in the household and it has a central air conditioner. So that comes directly from RECS for that specific household.

There's also some life remaining -- not -- the existing equipment age that is also being picked up from RECS. Those would be the primary inputs that are directly. But everything else

that's associated, for example, the installation costs, energy use are originally some of the data that to produce those are coming from RECS.

MS. PETRILLO-GROH: If I understood correctly, the building sample only accounted for households with gas. Does the information on fuel switching get fed back to that?

MR. FRANCO: Repeat?

MS. PETRILLO-GROH: If the building -- the building sample tab only accounted for households with gas, will the information from this fuel switching tab get fed back and change maybe the proportions of which homes now have gas in them?

MR. FRANCO: I don't know if I can answer that or not or --

MR. CYMBALSKY: Yeah, I don't -- so the RECS sample -- can you just go back to the --

MR. FRANCO: I can answer but I don't know if -- is it --

MR. CYMBALSKY: Well, you can't answer the second part but just the first part. So go

back to the building sample. So go down all the way to the bottom of that table.

MR. FRANCO: A little bit further?

MR. CYMBALSKY: Just go to the end of that table.

MR. FRANCO: Oh, oh the very end?

MR. CYMBALSKY: End of column H.

MR. FRANCO: Oh, okay. Yeah, I have this thing here. It's kind of bugging me.

MR. CYMBALSKY: Let's do it end down arrow key.

MR. FRANCO: Yeah.

MR. CYMBALSKY: It won't let you go down to the bottom?

MR. FRANCO: Oh, I got it.

MR. CYMBALSKY: Well, there should be 9,000, or 12,000 or whatever. So this is everything in the RECS sample. So there's RECS had 12,083 sample. So we have the whole population of the RECS database. So I don't know what the gas -- I don't know.

MR. FRANCO: Well, this is -- what we're

picking up as we're analyzing, as I think you alluded to, are just the gas equipment. Essentially the switching is if there's going to be switching to electric. So that's already picked up.

MR. CYMBALSKY: Right. So they already have gas and when we apply the standard, the methodology is will they switch. If they do, then that gets fed in and the calculations run from there.

MR. FRANCO: And I'll go actually a little bit to that, how that works in the LCC and then how that works in the NIA.

MR. CYMBALSKY: And logically, once you switch to the condensing furnace -- well, once you have a condensing furnace, you're locked in, right? That's what you showed before.

MR. FRANCO: Yeah. Yeah, if you start with the condensing furnace, obviously you're not switching. It's only in the case when we assume in 2021 that you start with a non-condensing and then there's a potential of switching to something

else.

MS. PETRILLO-GROH: Thank you.

MR. SCHROEDER: Can I ask a quick question about the payback period, not about the assumption behind it but we talked before about the potential for breaking the model if you play with things and change things. Is there any way that changing that 3.5 year number breaks the model?

MR. CYMBALSKY: So I think you can play with the model and I think he showed you the equation.

MR. FRANCO: So you can actually go here. It's a fixed value. You can have this as another number, a distribution, something else. We actually have provided one for replacements, one for new units. You can actually play with that.

MR. CYMBALSKY: You can change it.

MR. FRANCO: The last thing then just to kind of bring everything together in terms of fuel switching is so this is the export parameter.

Let's say that this household does switch and you are actually going to something else. What would happen is you go to the LCC payback calcs.

When we were discussing this, this is again going back to this sheet that calculates the LCC and so something that's very specific to this rulemaking and furnaces is that we're actually calculating the impacts in terms of the LCC. And so, what happens is that if the household does switch, then instead of picking up the 90 percent AFUE as is the case of this household, it will actually pick up what the energy use and economics are of the switched equipment and then that's the final results of what's being done. In this case, it's just being 90 percent.

So there's no switching. But if there was, then it would be looking at the values down here and picking those up to have the appropriate economic characteristics. And when you're looking at the summary results, these summary results include those potential switching.

So the end result, we added this summary

switching tab. The summary switching tab has some statistics to be able to see what's more or less going on, what's switching to what, to kind of understand what's going on. Obviously it's a little bit -- a lot of information. But similar to what we were talking about, you can kind of see, well, the household started with certain fractions and then you have a difference. And you can kind of see the overall switching per fractions. And so, that'll give you a little bit of an understanding of what's going on.

MR. SCHROEDER: Sorry. This is Dave Schroeder. Every house gets run for every different efficiency level, right. And then switching may or may not happen depending on which efficiency level you're at.

MR. FRANCO: Correct.

MR. SCHROEDER: But then there seems to be only one percent switching. So how does that -- how does that work? Is that -- is that at one set efficiency level?

MR. FRANCO: That's a very good

question. So obviously this is a lot of data just -- and we just -- we were trying to have something here for stakeholders to see. This is just for 90 percent AFUE. You can actually have the same table for 92, 95, 98. But then, the number of forecast cells that you have to create to do that balloons to a lot and we just decided to pick one. But you could actually -- when you do -- when we do the run, extract, you can actually look at all the different combinations. And that's an easier way to do it because once you're doing the forecast, you keep increasing the number of forecast cells very quickly to do that.

But hopefully this kind of illustrates what's going on. There's actually a table down here that kind of shows you what's going on by efficiency. And you can see that it varies. So for example, for 98, which would be TSL 5, you can kind of see that there's more switching because you have higher equipment costs versus the other two. So you can kind of get a sense that yeah, it does vary. But all other information provided is

for 90 percent AFUE.

So let's now connect. Let's see how much time we have. We have a little bit less than an hour. So hopefully we can do NIA.

MR. CYMBALSKY: Yeah. So before we go, I have a few questions that have come in.

MR. FRANCO: Sure.

MR. CYMBALSKY: So let's answer them now. So we had a bunch of questions. I'm not going to read all of them. But they're all pretty much the same question. They asked about the data sources for the energy price forecasts, do they change, et cetera, et cetera.

So the energy price forecasts are from the EIA most recent NEMS EIA annual energy outlook. We basically start with our data set and based on how those census division prices change, we change the marginal prices and the average prices, et cetera.

And then, we had a question about could you remind us what year the product pricing is from. So the analysis starts in 2021 and that's -

- it's the forecasted price for the year 2021. Dose the shipment data include imports or just domestic? Yes, it has everything.

And then another question about why the rebuttable presumption showed different results on the summary sheet. It's a different -- a little bit different analysis. I can't go more deeper than that, but that's why they're different.

MR. FRANCO: Yeah, there's obviously some sheets we didn't go to. But this is the rebuttable payback sheet. Obviously that's --

MR. CYMBALSKY: Yeah, that's just a different calculation, so.

MR. STANONIK: John, quick -- Frank Stanonik, AHRI. A quick question. So when you're looking at price forecasts, again, for any analysis you're doing for rulemaking, do you do any kind of a sensitivity analysis to say, well, what if -- what if our forecast really changes by x or y or --

MR. CYMBALSKY: Yes.

MR. STANONIK: You do? Okay.

MR. CYMBALSKY: Okay. NIA, we have 45 minutes and so take it away.

MR. FRANCO: Great. Thank you. So now let's go from -- transition from LCC to NIA. So this is the sheet in the LCC that's kind of the -- one of the more important parameters for the NIA. This is the LCC outputs. So we actually see a copy of this in the LCC spreadsheet, and this will be the some of the major economic parameters for the LCC, for the NIA spreadsheet.

Let's just briefly go and see how this is divided up. We divided it -- so sometimes in some of these spreadsheets, it's just the national results and those are what's being used as the average results for national. Here we actually divided them up into residential by region, south or north, and replacement and new construction. And so, the shipments that are new construction, residential south have those inputs and the ones that are different have different inputs and we're also looking at commercial in the same new construction, replacement in the same regions,

south, north. Sometimes we label south as rest of country and we have south but it really means rest of country.

The inputs as we'll see are fuel use, electricity use, so the energy use, the retail price and installation cost, maintenance repair, which is an annual value and the distribution. So this is a base case distribution. So what this is saying is that 78 percent of shipments in the south are non-condensing for replacements and then you go and you'll have a different value.

So that's looking at it as if there was no switching. So those are the inputs as we're doing switching. Now, if we want to look at the switching input, those will -- there's actually some -- before going to switching, there's a couple other inputs that we actually -- that are from the LCC. So the LCC calculates energy prices. The energy prices is in 2012. It's the average for the same regions. It's the south and then whether it's new construction or replacement. And these would be the values. So again, these

are the average for those households.

Those are the inputs. Then we have standby. I won't talk too much about that. And then we have these what we're calling the switching lookup tables. So this is what is the impact of switching. This is kind of what's going on to just the households that switch.

So let me go a little in detail about what's happening here. So this is kind of the differential of the what's going on between you didn't switch and switched. So first level, efficiency level zero means that it's just a non-condensing. So there's no switching there. So that's why we have zero impact throughout and there's no -- there's a hundred percent. There's no switching to any of this other equipment, so zero, zero, zero, zero.

Now, if you go to the next one, let's say we're going to 90 percent standard. So I forgot to mention this is only looking at households that are at 80 percent. So out of the households that are starting at 80 percent in

2021, 80 percent in replacements in the south residential will not switch, 80 percent of those, 80.7. Those, the actual differential energy use is this. They actually consume a little bit more on average, a little bit more electricity. The retail prices are a little bit -- installation and repair retail prices are a little bit different and the repair and maintenance a little bit different. So these are the differentials that occur.

Now, 5.8 percent actually switched to an electric furnace and this is the impact of that. So they consume 16 million Btus less. The electricity use goes up obviously, or 4,477 and then this is a retail and installation cost differential and as well as a maintenance repair differential. Now, let's go to the next one. Heat pump, in this case it's 13.5, the same situation for heat pump is more efficient. So you see less electricity use. And then, we also account for the difference between when you're going from a gas water heater to an electric water

heater. Let me just before going to that, so just to emphasize this, 5.8 plus 13.5 plus 80.7 adds up to 100 percent. So that's just a heating switching fraction.

Now, when we're going to the water heating, this is like a separate piece of it, 2.5 percent of households switch their water heaters because of the standard in this case and these would be the impacts. So again, they're obviously consuming less fuel use and so gas or LPG and then they're going to use a lot more electricity. So and we repeat that for north, south, new construction, replacements and those are fed into the NIA.

So now, let's open up the NIA spreadsheet and I'll -- let's see. I'll close this. So I won't save it and I'll close it.

MR. M. HUNT: This is Marshall Hunt. So that's total different spreadsheet?

MR. FRANCO: Yes, yes. Total different spreadsheet. So if you go to the DOE website, the LCC is one spreadsheet that you can download and

then this is the NIA spreadsheet. So let me open the NIA spreadsheet. And again, to emphasize, the LCC spreadsheet is where you need Crystal Ball and you're looking at these distributions. The NIA spreadsheet, you don't. There's just this macro that you have to run to be able to get the final results. But you could just use Excel. There's no separate add-on program.

Let's go starting with the structure. So very similar to what we saw before with LCC. We have the results here. The results are labeled based on the different scenarios. These are called trial standard labels here, the labeling here and then there's different scenarios. And the results are kind of the overall results but then you can look at the regional results. So for example, north and south results and if you add those two up, you'll get the national results.

There's two sets of results. There's the national energy savings and the net present value. These are looking at outputs for when you're running the macro and these are specific

worksheets that are just pasted values.

MR. SCHROEDER: How do you get the data form the LCC spreadsheet into this spreadsheet, because it needs the output from that, right?

MR. FRANCO: Yeah, and I'll go through that and that's a very important part, yes. Yes. And if you want, so that's a very important point and that's why I wanted to focus on the LCC output. So for example, let's say something that you really have to do if you want to change something on the LCC and then see the impact in the NIA, you would need to go through that process of transferring those results into the NIA and we'll go through that.

So again, we went through this a little bit. There's some analysis parameters and those are kind of fixed. Those are kind of set up based on how DOE does its analysis and those are not things that you should try to change. The things that you can change pretty easily are the scenarios. So you can change the economic growth assumptions from AEO which changes the shipments

and energy price trends and you can also change the equipment price trends, which there was a question about that. You can go to different scenarios and you can change whether it has fuel switching or not.

Those are the basic parameters that are very easy to change. Now, something that as you go through you can change other things. So for example, the LCC output and we'll try to go through that. And here are some of the instructions to run. But basically, if you wanted to generate new results, you would click here. It goes through the process of going through each region and it generates the final results. It takes about -- and for example, about two to three minutes. So it's much easier than the LCC. The LCC takes a lot longer. So let's go and see. I want to check how much time. Okay, we're perfect.

So since this is a few hours ago, a reminder, there is a lot of different worksheets. But the two primary worksheets are the non-weatherized gas furnace one, this one labeled non

-- NWGF and the mobile home. So gas furnace.

So these are the two main sheets that everything is being calculated in, the shipments, the inputs by year and the actual fuel switching impacts. And those are the ones that we're going to be spending more time on. But there are individual sheets that there's some data that's being picked up. So one of them is the LCC output. Yes?

MR. ADROIT: Henri Adroit with Goodman. I'm just having -- I'm receiving an error message, a runtime error 1004. Can you explain that? It says method range of objet global failed and it gives me an option of either saying end or debug.

MR. FRANCO: We could look at that maybe afterward. I'd need to look at it.

MR. ADROIT: Okay, thanks.

MR. FRANCO: So what we'll -- to answer your question, the specific question about the LCC output, now is a good time. So right now, it's set up as being something that's manual, at least inputted. But basically if you remember the LCC,

this is the same setup. It's set up like the south residential. These are the inputs. And basically what you would need to do is you would need to copy and paste those here in this gray area.

So something important to note, you would need to copy it here. And if you look, these are fixed values. So you would just copy the fixed values. The values up here are the values that are being looked up for the specific region and residential. So if you notice here, it says north residential and it's picking up residential results.

MR. LESLIE: This is in the I don't know what to do about -- this is Neil Leslie, GTI. My version of this same spreadsheet has number ref all over the place in the rows 11 through 19 rather than the values you are showing in there. Is there a way to get that taken care of?

MR. FRANCO: Of course, yes. I mean, it might be that the published version, there was accidentally one worksheet that was deleted which

is the one that calculates. So this one we'll publish right away. Yeah, so you can have that version. Sorry about that, yeah. We thought we'd corrected that but we'll correct that right away.

So that's important because you don't want to paste the values directly in here unless you wanted to do like a national average. Then you would paste it in. You would paste those vales below this gray area and you have to do it appropriate, commercial, south, north, replacement, new construction. And the other parameters up here that you want to take care of is these energy prices. Energy prices would belong here that are coming from the LCC. So sadly you don't have the instructions to do that. They would be published together with some kind of rulemaking. But yeah, you don't have them in the spreadsheet. That might be something to add.

Then if you're interested in standby, the standby results would be here. Now, the switching table results are in a different worksheet which is this one. And it's the same

situation. You have these are the lookup values that are specific and then below are the actual values you want to copy and paste. You want to make sure one thing is that you don't have anything that looks strange. So anything that's like a line or it produces an error. You don't want to have it in here because when it does the macro and it has like N/A here, it doesn't know what to do with it. So you want to just take those out when you're copying and pasting into here because those are -- you're going from the LCC and you're putting it into here. So hopefully that explains how you would manage going from the LCC to the NIA, the inputs.

Let me just briefly go to the other inputs before going to the calculations. Almost all the other worksheets are kind of trends that are being occurred. So in the LCC, we're just looking at everything that's occurring in 2021. But obviously the shipments are for 2021, 2022, '23. So the trends are basically from the inputs that we're getting from the LCC. That would be

our base year, and then how that varies for the shipments in 2022, how that varies for 2023.

In this case, we're looking at the equipment price trend. Now, obviously if you change it to some other scenario, you'll get different indices. Now, let's look at for example the next one would be energy use trend. So the 2021 is your base year.

Then you have a different trend. Let's say for example the fraction of condensing market share. 2021 would be the base year which would be these values and then you have some different fraction in the subsequent years.

MR. LESLIE: Just as a general on this particular spreadsheet, since we have not yet been able to -- Neil Leslie, sorry. There are similar issues with the number referencing around. I'm hoping and assuming that when you put this up soon that those e will have been taken care of along with the way that we can actually use it, right?

MR. FRANCO: Of course, yes, yes.

MR. LESLIE: So we can really do that.

Thank you.

MR. FRANCO: Yes, yes, yes. Of course, very sorry about that.

MR. LESLIE: We did not want to bother you with that right now. Our main focus was on the LCC spreadsheet. But wanted to deal with that at this discussion. Thank you.

MR. FRANCO: Thank you.

MR. M. HUNT: This is Marshall Hunt, PG&E. IS there a particular person who we should contact with these kinds of spreadsheet issues? It might help to have -- okay, thank you, John -- a clearinghouse person. Thank you, John.

MR. FRANCO: Thank you. So let me just go through a couple of these and then we'll just focus on the NIA. So again, fuel prices or energy prices. Again, there's a trend. So 2021, there's a certain price and then there's different values and that trend is being applied. Let me see.

There is a forecast of housing starts. That's -- well, this is more in the realm of shipments. So now we're getting to shipments. So

in terms of shipments, there's some historical data and there's other inputs. So as we go into shipments, then these are the inputs. Lifetime in terms of the retirement, those would be a different set of assumptions here.

The end results of everything that's going on are in some of these worksheets. So we're not going to talk about these. But if you clicked on here, these would be kind of the end results. So if you're looking at the summary of shipments of everything, maybe you would go into here.

You would -- if you're looking at something else, you might go into some of these intermediate worksheets. So for example, some of these actually produce the results that are being shown in the summary. These are just like outputted from the macro and these will change as you change the spreadsheet assumptions. And these -- some of these are populating in the NIA summary.

So as you can see here, this one is

using intermediate for NIA plus. So if you wanted to understand where those values are coming from, those are coming from there.

So that kind of summarizes how this different worksheets. Now let's get into the whole spreadsheet. So this is a little bit -- a lot of information but hopefully we'll structure it so it's easy to understand where things are coming from. So the first part is we have inputs, different inputs that are coming from different parts. The first part of the inputs are more related to the economic and energy use.

So for example, this is just looking up at 2021 for the northern region. So again, this is divided by region, north and for the sector residential. What would be the inputs in 2021? So efficiency level one, 80 percent efficiency. This is the annual fuel use, the electricity use, the retail price, installation cost, repair cost and then this is the base case efficiency. So that's just for 2021. And after that, you're projecting, after that period.

As part of the shipments analysis, you have some imported values. And what this gives us is mainly the fraction of demolitions, so houses that are not being replaced. So that kind of decreases the number of replacements and number of households that potentially could be new owners. So this is the primary purpose of the calculations going on in here.

So let's go into the main calculations sheet. So starting column T all the way to, well, there's a couple of -- let's see, column T to I'd say DD, this column right here. All the calculations that are here are related to the base case. So the current -- if there's no minimum standard. So the shipment, all the inputs, so that's like your baseline, you're calculating the base case.

The next set of calculations are related to the standard cases. And when you're looking at the spreadsheet, you have to understand that it's only looking at one of the standards that you're looking. So you'd have to change -- if you wanted

to look at a specific standard case, you would have to change. For example, instead of 90 percent, you want to see three results for 92 for the north, replacement. You'd have to change the variables to see that. In this case, it's just looking at 90 percent.

And these are all the -- and we'll go through a little bit what these columns mean. So that's how that's divided up. Now, at the very end, there's a standby which is a different area of this. And then there's the equipment switching. And so, the equipment switching, kind of the new shipments that are going to electric equipment or electric wiring equipment are being calculated here and the impacts and ten they're being brought back into the main calculation. So that's kind of the three areas.

So in terms of if you wanted to change some of the assumptions, it might not be -- you would probably want to change the assumption, for example, on the LCC outputs, do different outputs you want to change some of the trends in the other

sheets. Here, it's more the actual calculation. So it's I'll go through it but it might be a little bit more difficult to change the assumptions here. But let's walk through it a little bit.

So again, this is just for -- I believe this is north residential. We're only looking at north residential. So we go through and calculate. First we look at the historical shipments. And for that area of the country, these are the actual historical shipments that are being picked up in that worksheet, historical shipment for the north residential. Then at a certain point after 2013, that's the last year we have historical shipments, we start projecting our shipments. These are the projections. So by 2021, we're projecting that 1.659 million shipments would go to the north residential.

How is that constructed? So it's very similar for all rulemakings. Usually there are at least two components, but sometimes three to the shipments model. The main components are the new

construction market and the replacements. But then you have either new owners or early replacements. You have some other things that are going on in the market. So we actually for this analysis we have three. And basically we have new construction which is labeled new units. We have new owners or our understanding what new owners, the difference, and the replacements. And those three inputs if you add these three up, will give you 1.659.

So each one of those has different set of assumptions. Let's briefly go into where some of this data comes from. So basically new units basically it's how many housing -- how much new housing is occurring in a country and how often that's a gas furnace, for example. And so, it's basically that situation. Let's say for example in the north it's 60 percent of new construction is gas furnaces, times the number of new construction. So that gives you this number, 352. So that's basically what's occurring there.

Next part is replacements. Basically

replacements, we have remember the lifetime. From the lifetime you can get kind of a retirement factor because our lifetime is based on distribution. So then, that gives us a sense of how many units are being replaced. Now, in here we also take into account households that are being demolished. So there's some households that are being replaced but there's also some households that are being demolished and no longer replaced. They're something that's occurring in the market.

So this gives -- this takes that into account as well. And then based on the information that's available, we make what fraction of new owners are in the market and that -- the total of these three is what gives us again the 1.659. Now, if you kind of go merge replacements and new owners, this is the fraction in the north. This would be the new units for that specific year, 2021. This is again the north replacements. This is actually accounting for the stock that's being installed and how the stock

increases. It's just for visual purposes. The main result is the shipments here, 1.659.

So now based on that let's just go into the energy use and the other inputs, the equipment cost, the installation cost and how that's being used. So basically, the energy use components are divided up into replacements, new units and those inputs again are coming up from here. So let's go back here. It's probably easier to go here and see.

So what we're saying is that these inputs, 33 percent of the time or 33 percent of shipments in 2021 are 54 million Btus, 6 percent are at 48 because they're already 98 condensing, 16, 47, 45. So if you sum product, this and this, that gives you the weighted -- shipment-weighted energy use for 2021 and that's your base case. So once we talk about standard case, obviously you're not going to have this first row and then everything either ships or rolls up or something happens to it and you could have different distribution of your shipments.

After 2021, then we get into -- well, maybe the energy use changes or something happens. So then there's a trend that's being multiplied. So 2021 is just based on LCC but then after that there might be some other inputs and then the energy use changes after that period. And you can kind of see that there's some changes here and let me just point out two of those changes.

So one of them, the primary one is that there is a base case efficiency transfer. So there's a trend of how many households are condensing furnace. So originally, maybe this is 60 percent of the furnaces are at 90 percent or above. But then the next year it'll keep growing. So historically there's been the trend going towards condensing. So we follow that trend. Then there are also efficiency trends. So for example, the building shell or how households are built is they're built better, more robustly and those are also an input and that also decreases the energy use over time. So as you can see, the energy use even at the base case decreases over

time. So that's that part.

Now, let's go to the last few components, the equipment cost and installation just as this is both. The same thing happens here. We add up the installation and repair. We multiply it times the fraction that's occurring. There's only a minor detail here is you're multiplying this times the base case, this times the base case and adding up together. But for the retail price, there's a trend. So for that, for only the retail price, there's in the case - - in the reference case here there's a decreasing trend in the price. So that's the only difference. And assuming that installation cost is fixed.

So now let's go to maintenance and repair. The same thing occurs and as we discussed, you're multiplying. So it's shipment-weighted. The only difference here, as you can see, there's a difference in the price, is based -- this is only based on because there's going to be more condensing fraction. So we're almost done. So now, what we want to do is kind of aggregate all

that and get the operating cost and get the total installed cost to calculate either the national energy savings or the net present value.

So calculate the national energy savings, obviously we only need the energy use. And so, we kind of tally up the energy use which is essentially the per unit energy use that we were discussing before, this, either the fuel or the electricity times the shipment. So basically if it's new, for example, here we're multiplying the 343 number times the million units and then the fuel, the same or to the replacement new owners. And that will give us these final numbers which are the -- so that's why this is in quads. Oh no, I went too far. Sorry.

Let's see. There we go. So this is still base case. So these are the quads that are for the energy use. Then the equipment costs are the same. So this is again retail and installation, total installed cost. Those per unit times the number of shipments. So this deals with the NES. Now, when we get to the NPV, we

also want to calculate the operating cost. So the operating cost, obviously you have to multiply the energy use, these totals, times the fuel price or electricity price. And you pick up the appropriate values. You multiply them and you get these results. And that basically those are the final results to if you add these all up.

So this is 2021. You go all the way down. If you're only looking at equipment costs, it only goes to 2050 because you're only purchasing up to 2050. But then if you're looking at operating or energy use, you have to wait until the end of the last unit and so then that goes beyond that. And that kind of summarizes the base case. But what you want to do really is compare your base case to your standards case.

So before there's switching, before taking into account switching, here the standards case, the shipments are the same. So this is without asking into account switching. So if you compare the shipments here to the shipment before, they're exactly the same. And the inputs are

dependent on what you're looking up in terms of the standard. So your starting point will be different. So instead of taking into account this line here, if you're looking at the standard level two here, 90 percent, then you're only multiplying these and these and then depending on what product, it might be that it's the 33 is rolled up or there's kind of a shift that's occurring.

And so that very product specific even energy level if there might be some other assumptions that are going on there. And then, that's how those per unit costs are being generated. The same thing occurs then when you're trying to account for the national energy use which would be these and then the equipment cost.

Then so because we're looking -- we want to do the savings. So that's the interesting -- that's where the interesting aspect of looking at this is looking at comparing the base case to the standards case. And this is where it's basically a differential between the standards case results and the base case results. This is where this is

being calculated and you get energy savings or operating costs. You add those all up to 30 years. There's some discounting based on whether you're using a 3 percent discount or a 7 percent discount rate. That is also accounted for.

The macro -- one of the other things that the macro does is other than just doing this north, south and replacement/non-replacement, commercial/residential, it also takes into account whether it's 7 percent or 3 percent discount rate. So it does all that in that macro.

MR. M. HUNT: Victor, this is Marshall Hunt. We selected the standards case way back on column FM I think. Is that true?

MR. FRANCO: Yes. YES, yes. So this is T is base case, starting the base case inputs.

MR. M. HUNT: Okay, T.

MR. FRANCO: And then the actual kind of results are being kind of the aggregated results of all shipments are this part.

MR. M. HUNT: FM-4 and it's appeared other places. That's a scenario we're looking at,

right? That's the efficiency level?

MR. FRANCO: This is FM-4. Oh, don't actually know what that means. I don't know. That's just a one.

MR. M. HUNT: So but you have to run different runs to select the different test standards levels, correct?

MR. FRANCO: Yes, correct. Correct.

MR. M. HUNT: And that's selected where? Is that way over?

MR. FRANCO: It's actually selected in a different sheet.

MR. M. HUNT: Oh, okay.

MR. FRANCO: Yeah, and we can go there. Just one second.

MR. M. HUNT: Way over there.

MR. FRANCO: Yeah. So we'll get to that to change. Yeah, no that's important because if you wanted to look at different assumptions obviously. So that's kind of that's how that's set up. And this is what the output of the results that you're getting at the very end. So

if you wanted to look at for that specific and what's going on, how this adds, disaggregating electricity and gas and looking at the different details, this would be the place.

Now, this also accounts for fuel switching. So now what we'll talk about the fuel switching component and now it interacts in here. so if there - - if you select that you're doing fuel switching, which right now it's defaulted to fuel switching, then it will pick up those results and then put them in there in the standards case. So let's take a look at the fuel switching component. Okay, so we're not going to be talking about standby. But if you're interested in standby, this is where the results would be calculated.

Let's go to equipment switching. So equipment switching is somewhat similar. Essentially what you want to do is you want it to calculate how many homes are getting impacted and what would be kind of the differential impact. So for the homes impacted in terms of non-

weatherized, they would be here. So I'm just going to kind of go through the structure first and then it depends if it's a replacement or a new. Then if it's electric furnaces, this would be kind of the place that would play into. Heat pump and then electric water heaters.

And as you can see, everything is replacement, new, that's being calculated and the aggregated results kind of are towards the end where you have quads and thousand million watt-hours and you have the equipment cost and maintenance repair cost. And that's kind of -- this is the setup.

Okay, so we have five minutes. So we'll go really quickly and hopefully I have more than a couple minutes to any questions. So let's see how to summarize this. Basically, there's a lot obviously to talk about here, a lot of details. So remember we were looking at what the fraction would be that switched.

So this is the fraction that would be at non-weatherized gas furnaces in 2021, 85 percent,

73 percent of the replacements and new. So remember we have the fractions are different between new construction and replacements. And so, those would be the ones that don't switch, right? Those would go to non-weatherized gas furnaces. Then if you go to electric furnaces, then these are the fractions, 3.5, 7.5. Then if you go to heat pump, these would be the fractions.

And again we're looking at replacement, residential, residential north results. Okay, so those would be the fraction of shipments that would be impacted. Before that, the actual number of shipments that are impacted depends on the fraction of non- condensing. So the total number of shipments and replacements is this number. The total number of new is this number.

So if you recall, if you add these two up, that's the total number of shipments. Then 33 percent of those are non-condensing. So those are the ones that are impacted. So that's 520,000 replacements. And -- oh stop, let me correct that error, and then 35 percent of this number would be

the new construction. And of those, of the 35 percent times this, 85 percent or 73 percent of those would go to non-weatherized gas furnaces. So hopefully the accounting more or less you understand more or less. So for example, let's go here.

So if you multiply those fractions, 73 or 85 depending on replacement or new construction, you get -- you end up with this number for replacements or this number for new construction. So those are the ones that are switching to non-weatherized gas furnaces and the ones that aren't impacted. And then, you have the same for electric and the same for heat pump. So 11 percent times all those fractions and you get these are the actual impacted replacements and impacted new construction.

The rest is similar to before. It's just looking at the switching, the switching impacts, how much as. So for example, because you're decreasing your gas use by switching, there's a negative impact. And because you're

increasing your electricity usage, increased electricity use. That then is inputted into the standards case cost and is a part of the energy savings or equipment and operating costs. And I think that's about it. There's more details but I'm kind of --

MR. CYMBALSKY: Why don't you show Marshall where you have to specify what standard level?

MR. FRANCO: Oh, yes, yes. That's it.

MR. CYMBALSKY: Because I think that's important for everybody.

MR. FRANCO: That is very important, yeah. So there's this sheet at the end that's called summary of results. And here there is what's called TSL. So there's going to be two things that you need to consider when you're doing this. So usually what DOE does is you have the trial standard levels and you have different efficiencies that are associated.

So you go to summary results. If you want to change this manually, you can. There's no

problem with doing that. So let's say we want to look at TSL 1 and we change it there. The results will change. Here's some kind of like preliminary results that are just the addition of the numbers and you can actually see --

MR. M. HUNT: That's what's left?

MR. FRANCO: Yeah.

MR. M. HUNT: And you run them one at a time?

MR. FRANCO: If you wanted to go one at a time. Yeah, yeah, you could just go and then two and see how the results here are going to be changing depending on the region? Right now we're in the north. So it depends on there it's going to be changing the impact.

UNIDENTIFIED MALE: (Off mic.)

MR. M. HUNT: Magic physics.

UNIDENTIFIED MALE: A hundred and ten percent efficiency.

MR. FRANCO: Now, if you wanted to change -- you wanted to look residential commercial, you would change it here in this other

one which is called labels. And I just also wanted to point in the labels, you can see the mapping of the trial standard levels to the efficiency levels. So for example, what does TSL 1 mean? So then here you would see that TSL 1 means this, efficiency level one, efficiency level one or two and three and two because this is in the northern region.

And it might change between the north and the south because you could have regional standards as well. So this is where you would go and maybe change -- maybe you want to have a different combination. This is where you could change that.

MR. CYMBALSKY: Okay, so this is where you can cook up your own standard. Okay, so it's 12:58 and we have a hard stop unfortunately. And so I just want to end here and thank everybody for coming. We do have a parting gift for all of you who've stayed. On your way out, there'll be a shopping basket full of printouts from the meeting. It's mostly screenshots of what Victor

went through.

But I know some people would prefer to have a hard copy. We didn't want to hand them out at the meeting because I really think it's better that you focus on what he's talking about and where he's talking about it as opposed to flipping through sheets. But please pick one up on the way out. Again, if there is a follow-on that, you know, we need to come back and do some more of this, we're open to that. So feel free to request.

As for the questions, we mentioned that the questions that were sent in prior to the meeting. I went through the list and I'm pretty sure we answered all of those that we could as we went through the meeting. So if you feel that there were questions that weren't answered, you know, just get back to me and we'll see how we'll handle that. But I think I just went through the list of them and I think the ones that we were able to answer, Victor went through in his work and kind of pointed them out. So --

MR. MILLER: This is Bud miller and speaking I think now for APGA and AGA, we appreciate the tutorial. This is not really the meeting we had asked for or planned for or anticipated and unfortunately many of the questions that we submitted have not been answered. But it's my understanding, and correct me if I'm wrong, that when the proposed rule does issue, we'll get the answers to those questions that we feel have not been answered today and there are many of those frankly.

MR. CYMBALSKY: That's right. And so, I think, you know, there are 20-some odd questions and I think only maybe half a dozen or a little more than that we consider that we answered. So yes, at the NOPR meeting would be the more opportune time to ask the questions that were specific to assumptions and the numbers that are in the spreadsheet.

MR. MILLER: And would you anticipate that would be held within what, x days after the proposed rule issues? When would you anticipate

that to be held?

MR. CYMBALSKY: Right. So for the NOPR, there will be a 90-day comment period as agreed to in a settlement. We will choose a day within the 90-day comment period, maybe in the middle. I don't know if you have a preference. Do you want it in the beginning or the end? That's --

MR. MILLER: I would think sooner rather than later. I mean, there may be a need for more than one meeting. But these basic questions that we needed answered were to get as much understanding of the spreadsheets as possible as early as possible. So I think we would like the initial meeting to be early in that comment period and there may be a need for subsequent meetings and we hope you're open to that as well.

MR. CYMBALSKY: Okay. Well, we'll think about that. I mean, the caution there is you'll need time to actually digest the NOPR. So I think that's most stakeholders need, as I've heard from everyone, lots of time to digest it.

So we hope that by putting out these

analytical tools ahead of time we're giving you a running start on what the data look like and also we hope that this meeting was helpful in that you can go back now and play with the spreadsheets and have a better understating of how the analysis works.

So that was the intent of this meeting. I know people wanted more information about the proposal. But that's simply just not possible for DOE to do at this time. And again, at the NOPR stage, we will be obviously entertaining those types of questions. So thanks everyone for coming, and I hope you did gain some knowledge of the spreadsheets because that certainly was our intent. Travel safe. Thanks.

(Whereupon, the foregoing adjourned.)

CERTIFICATE OF NOTARY PUBLIC

I, CHAZ BENNETT, the officer before whom the foregoing deposition was taken, do hereby certify that the witness whose testimony appears in the foregoing deposition was duly sworn by me; that the testimony of said witness was recorded by me and thereafter reduced to typewriting under my direction; that said deposition is a true record of the testimony given by said witness; that I am neither counsel for, related to, nor employed by any of the parties to the action in which this deposition was taken; and, further, that I am not a relative or employee of any counsel or attorney employed by the parties hereto, nor financially or otherwise interested in the outcome of this action.

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CHAZ BENNETT
Notary Public in and for the
Commonwealth of Virginia

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I, BENJAMIN GRAHAM, hereby certify that I am not the Court Reporter who reported the following proceeding and that I have typed the transcript of this proceeding using the Court Reporter's notes and recordings. The foregoing/attached transcript is a true, correct, and complete transcription of said proceeding.

November 12, 2014 Benjamin Graham
Date Transcriptionist

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