Meeting Notes

Notes from 2022 Title 24, Part 6 Code Cycle
Utility-Sponsored Stakeholder Meeting for:

Single Family HVAC

Posted December 4, 2019

Meeting Information:

Meeting Date: Thursday, October 10th, 2019

Meeting Time: 8:30am – 12:30pm PST

Meeting Host: California Statewide Utility Codes and Standards Team

Meeting Agenda:

Time	Topic	Presenter
10 minutes prior to call	Live Attendee Poll	
8:30 am	Meeting Guidelines	Rebecca Aviles (Energy Solutions)
8:35 am	Opening Remarks from the California Energy Commission	Energy Commission Staff
8:40 am	Overview and Welcome	Kelly Cunningham (PG&E)
8:45 am	**CASE Presentation I:** Air-to-Water Heat Pump Compliance Option	Marc Hoeschele (Frontier)
9:45 am	**CASE Presentation II:** Fault Detection and Diagnostics (FDD)	Kristin Heinemeier (Frontier)
10:45 am	*5 Minute Break*	
10:50 am	**CASE Presentation III:** Variable Capacity HVAC Software Revisions	David Springer (Frontier) Curtis Harrington (UC Davis Western Cooling Efficiency Center)
12:20 pm	Closing	Rebecca Aviles (Energy Solutions)

Meeting Attendees:

First Name	Last Name	Email	Affiliation
Statewide Utility Codes and Standards Team			
Utility Staff			
Jim	Kemper	James.Kemper@ladwp.com	Los Angeles Department of Water & Power
Luke	Sun	luke.sun@ladwp.com	Los Angeles Department of Water & Power
Kelly	Cunningham	Kelly.Cunningham@pge.com	Pacific Gas and Electric Company
Codes and Standards Enhancement (CASE) Team Members			
Marissa	Lerner	mlerner@energy-solution.com	Energy Solutions
Rebecca	Aviles	raviles@energy-solution.com	Energy Solutions
Kiri	Coakley	kcoakley@energy-solution.com	Energy Solutions
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Matthew	Haro	matthew.haro@energy.ca.gov	Energy Commission
Payam	Bozorgchami	Payam.Bozorgchami@energy.ca.gov	Energy Commission
Peter	Strait	Peter.Strait@energy.ca.gov	Energy Commission
Stakeholder Attendees			
Chandra	Apperson		Apperson Energy Management
Dan	Johnson		Beyond Efficiency
Chris	Walker		CAL SMACNA
Roy	Eads		CalCERTS
Robert	Raymer		California Building Industry Association
Kristine	Bewley		Carrier
Jeanne	Fricot		Center for Sustainable Energy
Tom	Paine		ConSol
Jon	Hacker		Daikin
John	Barbour		Directions
Jacob	Nielson		Emerson
George	Nesbitt		Environment Design/Build

Aniruddh	Roy		Goodman
Eric	Taylor		Green Net
Dav	Camras		HERS Rater LA
Jennifer	Rennick		In Balance Green Consulting
Aaron	Wagner		Johnson Controls
Andrew	Hjortland		Johnson Controls
Brian	Rigg		Johnson Controls
David	Stephens		Johnson Controls
Jon	Douglas		Johnson Controls
Milica	Grahovac		LBNL
Jon	McHugh		McHugh Energy
Christopher	Ruch		National Energy Management Institute
Soph	Davenberry		NEMIC
Meg	Waltner		NRDC
Lucas	Morton		Pete Moffat Construction
Abram	Conant		Proctor Engineering Group
Arnold	Meyer		Resideo
Vrushali	Mendon		Resource Refocus
Matt	Matheny		S&P
John	Williams		Save
Brian	Selby		Selby Energy
David	Dias		Sheet Metal Workers Local Union 104
Randy	Young		Sheet Metal Workers Local Union 104
Josh	Rasin		SMUD
Curtis	Harrington		~~UC Davis Western Cooling Efficiency Center~~
David	Yuill		University of Nebraska-Lincoln

Kelly	Morairty		
Michael	Hall		
Russ	King		

Meeting Notes:

1. Welcome and Meeting Ground Rules

- *Rebecca Aviles (Statewide CASE Team) presented.*

2. 2022 Process Overview

- *Payam Bozorgchami (California Energy Commission) presented.*
- *Kelly Cunningham (PG&E, Statewide Utility Codes & Standards Team) presented.*

3. Meeting Materials

- Presentation available here.
- Submeasure summary available here.

4. CASE Presentation I: Air-to-Water Heat Pump (AWHP) Compliance Option

- *Marc Hoeschele (Frontier, Statewide CASE Team) presented*
- Chris Walker (CAL SMACNA): Will AWHPs be useful in all climate zones of California? If not, which zones are optimal?
    - Bill Dakin (Frontier Energy): Yes, they are applicable in all California climate zones.
- Randy Young (Sheet Metal Workers Local Union 104): How exactly do you simulate occupancy? No two households are the same.
    - James Haile (Frontier Energy): Resistance heaters and humidifiers operated based on the typical sensible and latent load schedules used by CBECC.
    - David Springer (Frontier Energy): Internal thermal and moisture gains, thermostat settings, and ventilation rates are all consistent with assumptions used in Title 24 compliance calculations (ACM Manual).
- Jon McHugh (McHugh Energy): How is resistance heating modelled for both a standard heat pump and an AWHP? Is there a credit if there is no resistance component to and AWHP?
    - Brian Selby (Selby Energy): Will this measure require a HERS rater to verify 47/17 degree capacity?
        - David Springer (Frontier Energy): To Brian's question, we are not proposing to apply the 17 and 47 deg. ratings in compliance software, but to use a similar approach as proposed for mini-split VCHPs.
    - John Williams (TRC): For resistance heating, considering that "variable speed" or variable power backup heat offers a significant net COP gain over "on-off" backup heat, will there be any credit given for this approach?
        - James Haile (Frontier Energy): I don't believe we're considering variable resistance back up heat for inclusion in the model at this time.
        - John Williams (TRC): Thanks. Can you explain why full-speed heating performance is used at 47F, considering that if the unit is properly sized to satisfy a 17F load, it would never need to run at full speed in 47F condition?
        - David Springer (Frontier Energy): To John Williams - We've seen in Stockton testing that comfort is maintained without resistance heat. Perhaps it would be needed in Climate Zone 16 (the Sierras).

    - Bill Dakin (Frontier Energy): Using the existing air source heat pump model, CBECC-Res estimates electric resistance heating energy based on heating capacity user inputs at 47F and 17F and uses a linear relationship between the two data points.
- Randy Young (Sheet Metal Workers Local Union 104): what makes a HERS rater qualified to do these inspections?
    - Roy Eads (CalCERTS): HERS Raters require specific training for each measure.
    - Randy Young (Sheet Metal Workers Local Union 104): Another drive by inspection?
    - Dan Johnson (Beyond Efficiency) Too many required HERS create a market barrier because installers won't do them, HERS raters are not trained/competent to evaluate.
    - Russ King: HERS raters do inspections that building inspectors don't have the knowledge or tools to do. HERS raters are specially trained for all inspections they do. They are no more of a barrier than a well-trained building inspector. They are only a barrier to contractors who don't do it correctly.
    - Dan Johnson (Beyond Efficiency) Russ, we can't find competent HERS raters in the inner Bay Area...well-trained building inspector is also a barrier, these are few.
    - Russ King: Dan, that doesn't mean all HERS raters are not trained/competent.
- Meg Waltner (NRDC): How do you plan to do the adjustment from the high performance ducted ASHP in the Stockton home to a minimum efficiency ASHP baseline?
    - David Springer (Frontier Energy): We may use a routine from DOE2 that normalizes performance based on outdoor dry bulb and indoor dry and wet bulb temperatures.
- Lucas Morton (Pete Moffat Construction): Regarding attic insulation: installs I see are in a mixture of walls and ceilings. all are unvented rafter assemblies. Regarding pipe insulation: this is somewhat self-enforcing-- condensation from cooling distribution pipes is a pretty quick warranty callback.
- **Poll 1**: **Which AWHP installation elements should have required HERS verifications?** ***Select all that apply.***
- Brian Selby (Selby Energy): Need to reevaluate the compliance process to avoid compliance issues caused by differences between design (CF1R) and installation/verification (CF2R & CF3R)
- Dan Johnson (Beyond Efficiency) Radiant cooling by floor slab is also a thing that's done, so let's include this in our thinking, don't limit to ceiling panels. Since we can already model ASHP with radiant system in CBECC-RES, what is exactly is the proposed change? (Sorry if I missed this early on!)
    - Marc Hoeschele (Frontier): Dan- Is your question if you can model ASHP with radiant or AWHP with radiant?
    - David Springer (Frontier Energy): Dan - Modeling the best performing AWHPs results in performance that is worse than minimum standard, and much worse than what we are seeing in the Central Valley Research Home (CVRH) data.
    - Dan Johnson (Beyond Efficiency) Marc, to clarify, we can model an air-source hydronic heat pump with radiant distribution already. David, so existing model is inaccurate and shouldn't be used?
    - Marc Hoeschele (Frontier): We are planning to move away from the existing and go to an approach similar to the "in process" variable capacity HP (mini-split) approach which is X% heating savings and y% cooling savings relative to the standard prescriptive air source HP (with x% and y% to be determined)
    - Dan Johnson (Beyond Efficiency) So creating "fudge factors" for air-source hydronic heat pump, rather than a physics model?
    - Marc Hoeschele (Frontier): A big challenge with the physics approach is that the technology is still a niche technology and the Energy Commission needs to carefully target its software development resources. The proposed simplified approach will hopefully allow the technology to eliminate a market barrier and then see if more advanced treatment is needed in the future.

    - Dan Johnson (Beyond Efficiency) Informative, thank you! Then existing software results are misleading
- George Nesbitt (Environment Design/Build): You're talking about air source, air-t-water heat pumps that are specifically designed for HVAC and not all-in-one heat pump water heaters?
    - Marc Hoeschele (Frontier): Correct, this is not the stand-alone heat pump water heater.
    - George Nesbitt (Environment Design/Build): So, you'd specifically have the pump. My one thought – how to treat the ducts would depend on where the pipes carrying hot/cold water are. Are they inside or outside of conditioned space? Slightly off-topic, my impression has always been that radiant slabs have performed far worse than usually assumed. One of the problems in the code was that even though slab-edge was mandatory with heated slab, it was showed as 0 since it was a mandatory measure. Therefore, it wasn't installed or enforced. Every time there is a mandatory measure it should show up on a CF1R or it won't be installed or enforced.
    - Marc Hoeschele (Frontier): I agree, if we recognize the radiant panels as ducts in conditioned space then the pipes should be located in conditioned space.
    - George Nesbitt (Environment Design/Build): Is it standard that you can put the equipment, more than standard mandatory equipment efficiency? Initially the equipment was restricted to federal minimum. Is part of this recognizing that there's a standard or that this equipment might have higher efficiency?
    - Marc Hoeschele (Frontier): We're still working on the data analysis. Anticipating that the variable speed will be above the minimum standard. The fixed speed is "to be determined" whether it is above the minimum standard or not.
    - George Nesbitt (Environment Design/Build): How many manufacturers already have their equipment on the market, in California?
    - Marc Hoeschele (Frontier): I believe 5 that are listed.

5. CASE Presentation II: Fault Detection and Diagnostics (FDD)

- *Kristin Heinemeier (Frontier, Statewide CASE Team) presented*
- Dav Camras (HERS Rater LA): The most obvious fault: low air flow across the coil is not listed.
- **Poll 2: If you had to guess, what do you think would be an accurate Compressor Efficiency Multiplier when there is no initial refrigerant charge verification and no FDD? (by definition, Compressor Efficiency Multiplier is 100% if performance perfectly matches rated performance.)**
- **Poll 3: What is the smallest level of efficiency degradation that you think justifies a "truck roll"? (by definition, 0% = no faults/energy use is as expected; 100% = maximum possible fault/maximum possible degradation)**
- Russ King: What is the difference between this FDD and the FID in JA6.1 and how it will be handled by the code?
    - David Springer (Frontier Energy): The FID definition is very specific as to the required components of the FID. There may be some similarities, but the specification we are proposing will be more inclusive of what FDD products are currently available.
    - Russ King: Perhaps doing something with the TXV sensing bulb, like dipping it in ice water or warming it up, would cause a fault?
        - David Springer (Frontier Energy): Yes, unattached or improperly secured TXV bulbs can affect performance. We should investigate whether the fault impact would be detectable at the 15 or 20% impact level.
        - Russ King: It should throw the superheat way out of wack. Also, putting a piece of cardboard over the return grille is easier than closing all the supply registers to trigger a low airflow fault.
    - George Nesbitt (Environment Design/Build): 20 percent on EER may be too high a threshold.

    - Kristin Heinemeier (Frontier): It would be great to have further discussion of these. We need input from stakeholders to determine reasonable input for this. This is a bit of a grey area – anything below 10 percent will be more of a judgment call and we are open to discussion for this.
- Russ King: If the fault severity can be tracked over time by service company, a sharp downward trend could be worth a call even at a lower level of severity.
- George Nesbitt (Environment Design/Build): Should FDI without RC get more credit than no FDI and RC verified?
    - Kristin Heinemeier (Frontier): Again, this is a good question. The 90 percent number could be lowered, my personal sense is that buildings do not perform that well and we should reflect that reality and give room to address credit. Further stakeholder input is welcome, but we are committed at this point to not lowering that number. This might in future years become not a prescriptive measure, possibly even a mandatory measure. For now, this compliance option is a good start.
- Meg Waltner (NRDC): Could you explain again the difference is between "probability of fixing, if detected" and "probability of fixing a detected fault" on slide 77?
    - Kristin Heinemeier (Frontier): If there is a fault and it's 20 percent, then you'll need to degrade it by this much. I can follow up with you later as this does get a bit complex. It's not guaranteed that there will be a fault, it will be detected, and it will be fixed.
    - David Yuill: I think: First one reflects that somebody may ignore and not fix. Second reflects that they might not fix it correctly.
    - Meg Waltner (NRDC): Thanks David -- that explanation makes sense.
- Russ King: HERS Raters complete the CF3Rs. The building inspector should verify that both CF2Rs and CF3Rs are completed using the project status report on line.
    - Kristin Heinemeier (Frontier): Thanks...that was a typo
- Brian Selby (Selby Energy): Will you be addressing FDD network connectivity issues to wifi or other networks?
    - Kristin Heinemeier (Frontier): We absolutely can, and I agree that this might be an important issue and something we could include in our manufacturer certification.
- Jeff Miller (Energy Commission): It seems to me you need a method for evaluating diagnostic protocols for packaged air conditioning equipment December 2012 CEC-500-08-049. was there ever any follow up on the Purdue research on this topic?
    - Kristin Heinemeier (Frontier): The folks at Purdue suggested software-only approach, and initially we said no – we need to have field tests and see what's happening in real life. Now that we have more research in terms of context for lab, I can see how this will be something that we should further pursue.
- George Nesbitt (Environment Design/Build): This could be as simple as the various connected thermostats, for example Nest. They are monitoring people's use. From that, my understanding is that they can detect faults – that you're using more energy based on actual weather or thermostat settings. This might not tell you what's wrong, but the other end of complexity is that it would have to detect all of the different major fault. These are very specific things, then it would have to tell you what's wrong. These are two extremes of how you could trigger the fault.
    - Kristin Heinemeier (Frontier): It's very important to diagnose what the problem is, not just state that there is a fault. We have great technicians out there who can figure out what's wrong once they're on-site and we can provide training for them. The big gap is getting those technicians out on the field. If we could have tools that could detect something going on, that the system is actually performing 20 percent less well than it should be, we could count on contractors to determine what the problem is.
    - George Nesbitt (Environment Design/Build): The skill of diagnosing things seems rarer than just discovering the fault.

    - Kristin Heinemeier (Frontier): This kind of technology would tell you if you didn't actually fix the problem – the data, measurements, would show this. People will need to have that skill to diagnose and successfully solve problem.
    - George Nesbitt (Environment Design/Build): Very high-end systems run through, when you set them up, a series of tests: air flow to get static pressures, static pressures for each zone, also looks at refrigerant charge. It's possible there are some systems doing a fair amount that can tell you that the system is set up within a certain boundary.
    - Kristin Heinemeier (Frontier): Since we're short on time, let's follow up offline.
- Eric Taylor (Green Net): It would be important for the State to only be involved in fault detection specifications. Leave the communications protocols to the industry to figure out. Semtech LoRa RF technology is a good example of emerging technologies. It would be important for the State to only be involved in fault detection specifications. Leave the communications protocols to the industry to figure out. Semtech LoRa RF technology is a good example of emerging technologies. 3.5 miles in City environments.
    - Kristin Heinemeier (Frontier): Good point. Thanks.
- Aaron Wagner (Johnson Controls): Just a quick thought on fault impact vs fault intensity. I would think that it would be beneficial to have fault intensity also be an important indicator on truck roll. It will not have much of an impact to utility usage, but it can have a large impact on the life of the system. Example: If the evaporator airflow is reduced enough that the coil starts icing up, we know that too many freeze thaw cycles will damage the coil. So, protecting the customer equipment as an FDD feature may also help adoption.
    - Kristin Heinemeier (Frontier): Great points! FDD is really important for equipment life, even beyond efficiency. It's also important for things like refrigerant leaks...which have carbon emissions implications.
    - Russ King: Could a fault be triggered based on a drop inefficiency over time rather than a fixed value? E.g., a sudden drop of 10 percent is worse than a slow drop to 20 percent?

6. CASE Presentation III: Variable Capacity HVAC Software Revisions

- *David Springer (Frontier, Statewide CASE Team) and Curtis Harrington (UC Davis Western Cooling Efficiency Center) presented*
- **Poll 4: Approximately what proportion of air conditioners and heat pumps installed in new homes are two-speed or variable speed?**
- **Poll 5: What is the key reason variable capacity systems are installed?**
- George Nesbitt (Environment Design/Build): High end custom variable speed is very common, production probably not so much
- Russ King: I think a lot of variable capacity systems are installed as "upgrades" and sold to homeowners for their efficiency benefits. I think a lot of installers like them because they are more forgiving of poor duct design.
- Eric Taylor (Green Net): Is there any data (white papers) on real time softstart technology all speed ramp based on static pressure or temperature?
    - Curtis Harrington (UC Davis): I am not aware of any white papers on that but perhaps others know of such a study?
    - Eric Taylor (Green Net): This is really good information thank you [in response to presentation].
- George Nesbitt (Environment Design/Build): Do we assume that zoned ducts have more length / area than unzoned systems?
    - Curtis Harrington (UC Davis): We are not assuming a different duct design than manual J.
- Aniruddh Roy (Goodman): Were a separate set of tests performed for single-speed and two-stage systems for the same installed application?

    - David Springer (Frontier Energy): Curtis can answer that better but operating two speed and variable speed systems at maximum speed would produce the same results a single speed system.
- Dav Camras (HERS Rater LA): Have you looked at testing with 100 percent airflow but variable capacity power?
    - Curtis Harrington (UC Davis): We did some testing where we increased fan speed at constant capacity and in general, we found that matching capacity and airflow provided the best results. The airflow rate was 400 cfm/ton
    - Russ King: Were the ducts sized specifically for a zoned system, with bypass damper or without, such that ducts for any one zone could handle almost all of the air, or was zoning just put on a system not designed for it?
    - Curtis Harrington (UC Davis): Zoning was simply added to the duct system. There was no bypass added.
    - Dav Camras (HERS Rater LA): If you are running at 100 percent airflow yet less capacity, I would have expected the CFM/ton to increase to possibly 500/ton which I would imaging increase your efficiency in delivered Btus.
    - Curtis Harrington (UC Davis): That is correct, but the fan power ended up negating those gains.
    - David Springer (Frontier Energy): I would suspect that a variable capacity system at maximum speed would have similar power to single speed system, but we will look into this.
    - Dav Camras (HERS Rater LA): I am operating my own system in an unverified test method using a constant speed blower with two-speed compressor. I don't have all of the tools of the trade that a lab set-up has, but my test shows huge savings potential from modulating compressor capacity and leaving efficient fan with good ducting at 100 percent.
    - Curtis Harrington (UC Davis): As you start to reduce capacity, the fraction of losses become more prominent. When you start to dig into the details and look at the duct model we have built, reducing capacity does not always help and can sometimes hurt. For California if increasing heat ratio, I agree that could be the case. In general, reducing capacity does have an effect on delivery effectiveness.
    - Dav Camras (HERS Rater LA): With constant, high-speed airflow you don't get those losses associated with lower speed delivery.
    - David Springer (Frontier Energy): I see what you're saying. But when you look at the calculations in the ASHRAE duct model, as you reduce capacity the delivery effectiveness goes down, all else being equal. We wrote some papers where we mismatched air flow and compression speed. We can look at more of this data and the paper we wrote on the duct model, including the equations.
    - George Nesbitt (Environment Design/Build): If you keep the airflow high but run the compressor on lower speed, lower capacity, you are reducing delivered air temperature. Your tests on the variable certainly show lower delivery temperature and lower airflows increase heat gain, so would lowering delivery temperature also increase velocity?
    - David Springer (Frontier Energy): We're seeing that this has less of an impact than you would think.
    - Dav Camras (HERS Rater LA): Rather than going for ducts in a conditioned space since this can be challenging for most people, or going to high performance attic, are things we might not want to do. Beyond those, how can we increase efficiency? There are unrealistic set of conditions here. Not very useful.
    - David Springer (Frontier Energy): It's not the same for single speed. The only way to do it would be to increase velocity, but that has an impact on fan power. That and R value. I don't know of anyone looking at that as a measure right now.

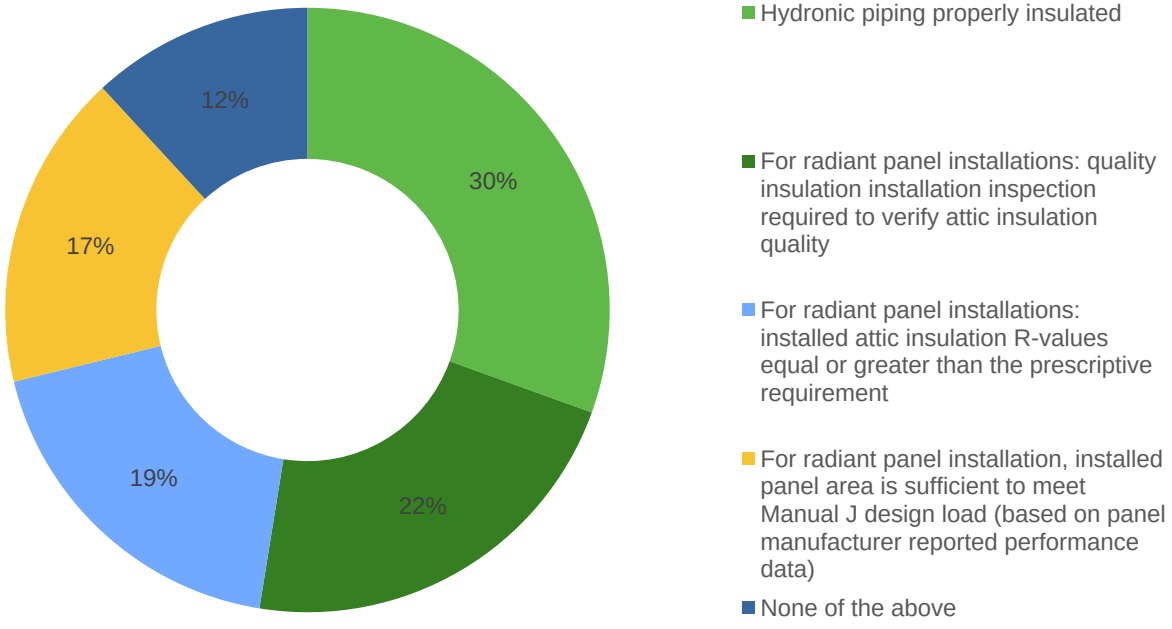
    - Bill Dakin (Frontier Energy): Are you saying you'd like to see strategies beyond what's existing (attics, conditioned spaces)?
    - Dav Camras (HERS Rater LA): Ideally, they'd be within conditioned space. As someone who works in the field. High performance attics are not a fully proven, understood, comfortable with how to do it. Just painting a roof white greatly reduces the attic temperature.
- **Poll 6: When assessing the incremental cost of the proposed change, is it reasonable to assume the cost of DCS or HPA is zero given that they are prescriptively required?**
- **Poll 7: Do you expect this measure to make compliance and verification more challenging?**
- **Poll 8: Are you aware of systems that integrate zone controls with compressor & fan speed?**
- Brian Selby (Selby Energy): Have you considered requiring HERS verified duct design as a prerequisite for using this measure?
    - Curtis Harrington (UC Davis): We are considering having a HERS verification of zoning equipment and ducting design.
    - Dav Camras (HERS Rater LA): I understand/have heard that verified duct design is so overwhelmingly burdensome as applied in the code that it is rarely used.
    - Curtis Harrington (UC Davis): I think the key is that the zoning is verified, not necessarily the entire duct design.
    - Brian Selby (Selby Energy): Dav, the reason most don't use verified duct design is because not many designers don't actually provide duct design schematics
    - Dav Camras (HERS Rater LA): I have tried a few times to go down that path with T-24 consultants but was told design is only a small piece of the verification
    - Dan Johnson (Beyond Efficiency) Industry conflict, I've provided detailed duct design and installers won't build to it---either don't trust the work or it doesn't match their skillset---plus the credit is too small to be worth the effort.
    - Jennifer Rennick (In Balance Green Consulting): Our experience is the same as what Dan said. The verified duct design credit is not worth it, and the builder just does whatever he/she wants to do anyway and then we rerun T24 or they hire someone else who will.
    - Brian Selby (Selby Energy): Dav, interesting... I teach energy consulting classes for ECA and most don't know how to do verified duct design, they also rarely see duct design drawings. We're also seeing some people abuse the credit and enter values that are impossible to achieve in the field
        - Lucas Morton (Pete Moffat Construction): Brian-- I think the low range is already there and it can just be updated to something that's more reasonable than 1 lineal foot. I'll submit a comment to the CBECC-Res team-- I think that could be a perfectly reasonable change
    - Dav Camras (HERS Rater LA): I would love to see verified duct design as something that could be realistically utilized. When a project has a Manual J&D, it should be doable.
        - Brian Selby (Selby Energy): Dav, me too! This should be standard practice. Jennifer I would support that, there should be a low range error in the compliance software.
    - Jennifer Rennick (In Balance Green Consulting): Is there CEC effort to put parameters on the return duct surface area to stop the 1 sf cheat?
        - David Springer (Frontier Energy): Would like details on the "1 sf cheat"
        - Jennifer Rennick (In Balance Green Consulting): On the verified duct design a common cheat we see is a return duct surface area of only 1 sf, which gives enough "bonus" the project complies, but reality is the return duct has like 30 sf of surface area once it is installed to loop up to reduce noise. Seem the software could eliminate that by putting in a lower limit error message.
        - Bill Dakin (Frontier Energy): Thanks for this feedback. We will pass it along.

7. Closing

- *Rebecca Aviles (Statewide CASE Team) presented.*

Poll Results:

Poll 1: Which AWHP installation elements should have required HERS verifications? Select all that apply.



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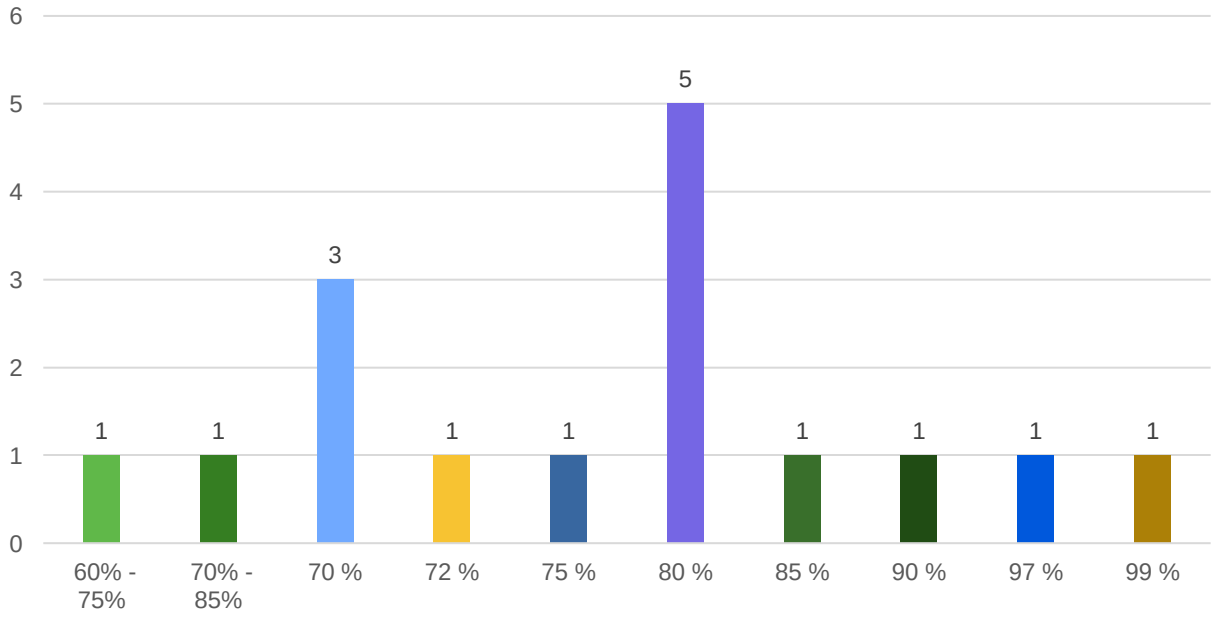

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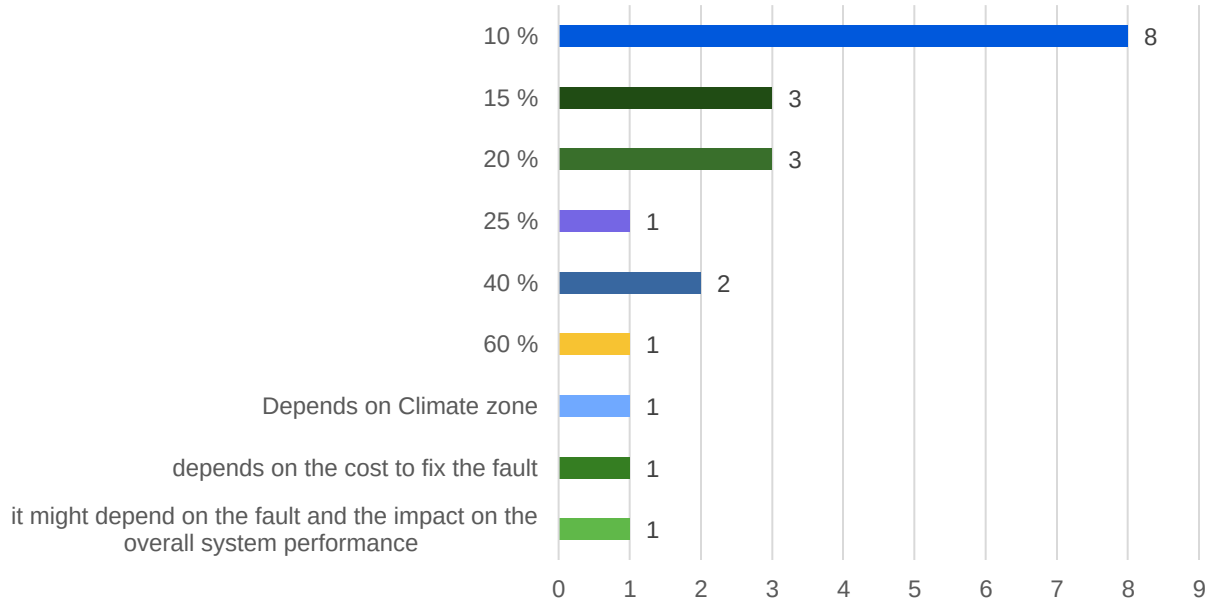
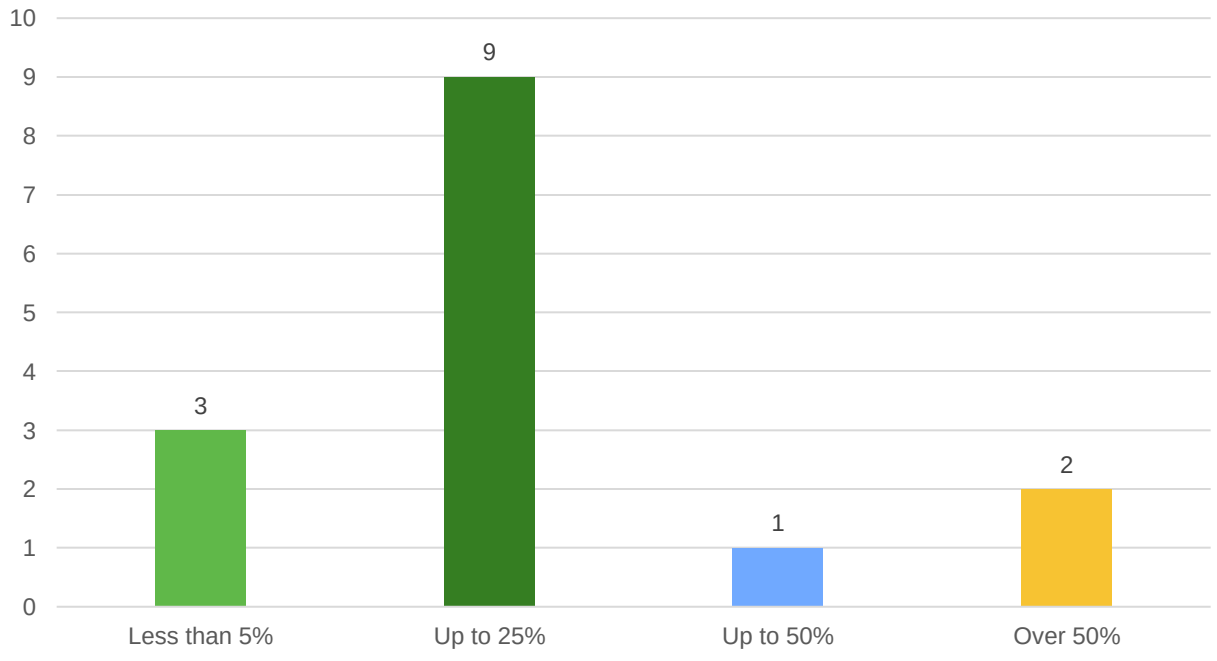
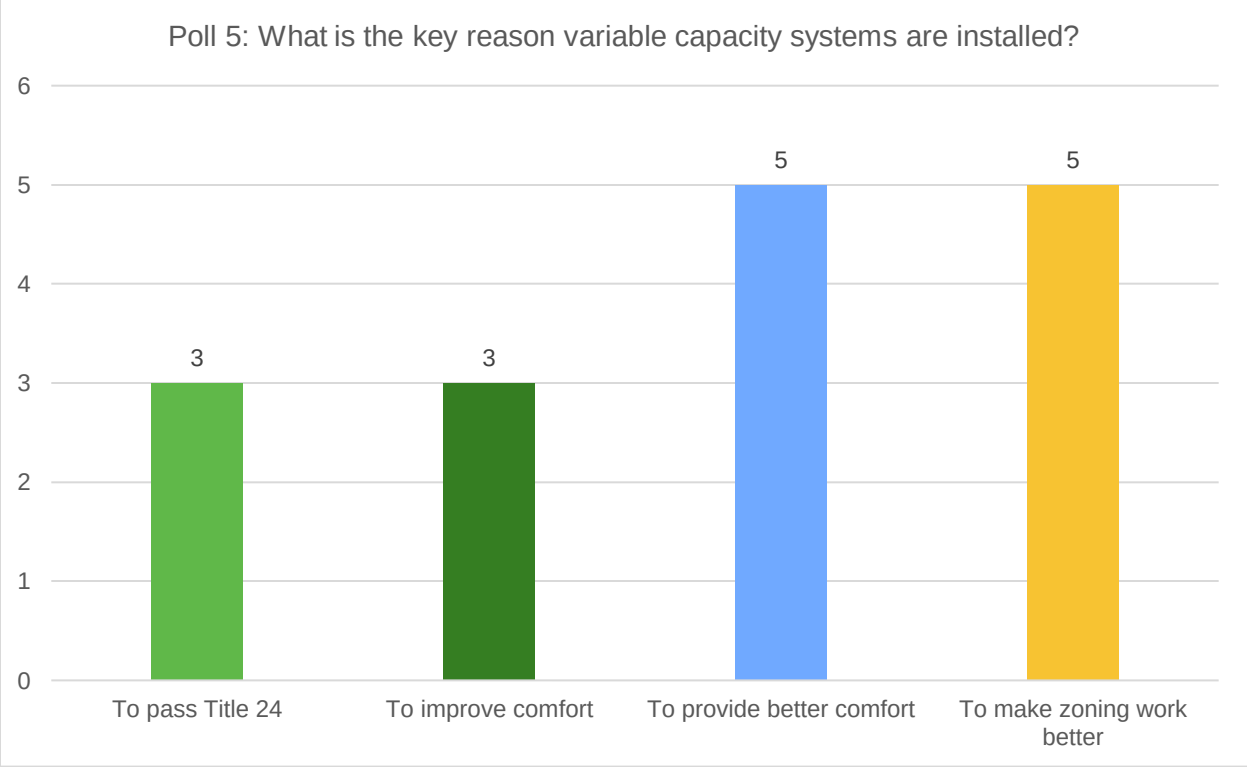
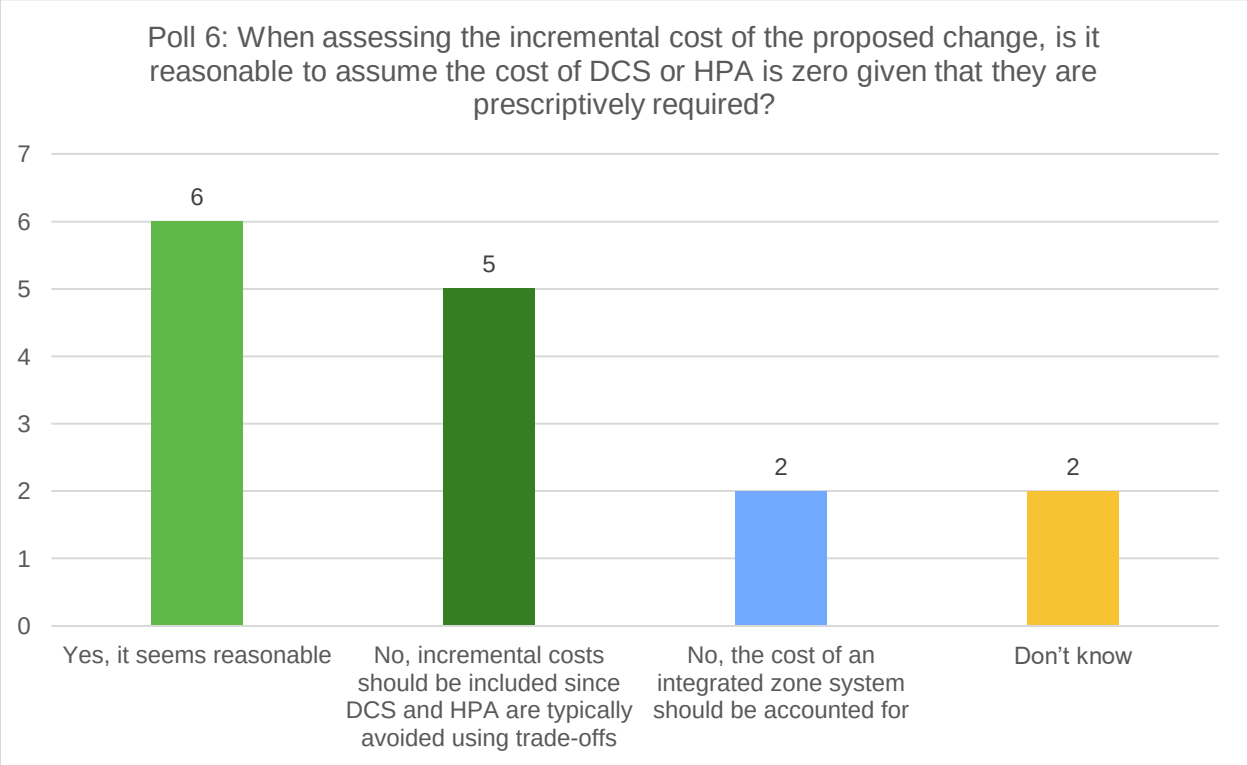


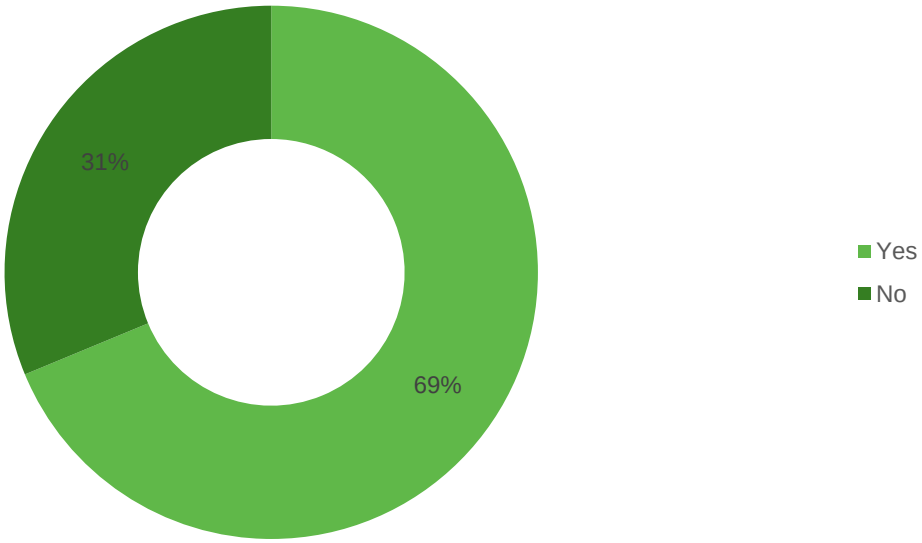
Poll 4: Approximately what proportion of air conditioners and heat pumps installed in new homes are two-speed or variable speed?




Poll 5: What is the key reason variable capacity systems are installed?
6
5
4
3
2
1
0
3
3
5
5
To pass Title 24
To improve comfort
To provide better comfort
To make zoning work better


Poll 6: When assessing the incremental cost of the proposed change, is it reasonable to assume the cost of DCS or HPA is zero given that they are prescriptively required?
7
6
5
4
3
2
1
0
6
5
2
2
Yes, it seems reasonable
No, incremental costs should be included since DCS and HPA are typically avoided using trade-offs
No, the cost of an integrated zone system should be accounted for
Don't know

Poll 7: Do you expect this measure to make compliance and verification more challenging?



Poll 8: Are you aware of systems that integrate zone controls with compressor & fan speed?