CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Notes from 2019 Title 24 Part 6 Code Development Cycle Utility-Sponsored Stakeholder Meeting for Residential Domestic Water Heating Topics

Posted December 13, 2016

Meeting Information

Meeting Date: October 26, 2016

Topics Discussed: Residential Water Heating Topics

Meeting Time: 10:00 – 3:00

Meeting Host: California Statewide Utility Codes and Standards Team

Attendees

First Name	Last Name	Contact	Organization
Statewide Utility Codes and Standards Team			
Utility Staff			
Jim	Kemper	james.kemper@ladwp.com	Los Angeles Department of Water and Power (LADWP)
Marshall	Hunt	mbh9@pge.com	Pacific Gas and Electric Company (PG&E)
David	Roland	David.Roland@smud.org	Sacramento Municipal Utility District (SMUD)
Randall	Higa	randall.higa@sce.com	Southern California Edison (SCE)
Chris	Kuch	chris.kuch@sce.com	Southern California Edison (SCE)
David	Rivers	david.g.rivers@sce.com	Southern California Edison (SCE)
Javier	Mariscal	Javier.Mariscal@sce.com	Southern California Edison (SCE)
Adam	Manke	amanke@semprautilities.com	Southern California Gas Company (SoCalGas)
Raad	Bashar	rbashar@semprautilities.com	Southern California Gas Company (SoCalGas)
John	Barbour	jbarbour@semprautilities.com	Southern California Gas Company (SoCalGas)
Daniela	Garcia	dgarcia3@semprautilities.com	Southern California Gas Company (SoCalGas)
Codes and Standards Enhancement (CASE) Team Members			
George	Burmeister	george@coloradoenergygroup.com	Colorado Energy Group
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California Energy Commission Participants			
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Adrian	Ownby	Adrian.Ownby@energy.ca.gov	California Energy Commission (CEC)

Peter	Strait	Peter.Strait@energy.ca.gov	California Energy Commission (CEC)
Other Participants			
Ayman	Abdel-rehim		A.O. Smith Corporation
Dan	Snyder		A.O. Smith Corporation
Frank	Stanonik		Air Conditioning, Heating and Refrigeration Institute (AHRI)
Russ	King		Benningfield Group
Mark	Stimson		Bosch Thermotechnology
Chad	Sanborn		Bradford White
Eric	Truskoski		Bradford White
Bruce	Wilcox		Bruce A. Wilcox, P. E.
Andres	Guevara		Calendtadores de America
Bob	Raymer		California Building Industry Association (CBIA)
Peter	Biermayer		California Public Utilities Commission
Tom	Enslow		Adams Broadwell Joseph & Cardozo representing the California State Pipe Trades Council
Jeanne	Fricot		Center for Sustainable Energy
Megan	Cordes		ConSol
Charles	Fletcher		Delco Sales
Daniel	Beauchemin		EcoInnovation Technologies Inc.
George	Nesbitt		Environmental Design/Build
Danny	Parker		Florida Solar Energy Center
Karen	Sutherland		Florida Solar Energy Center
Jonathan	Leonard		Gladstein, Neandross & Associates
Eric	Adair		Hearth Patio & Barbeque Association
Jim	Lutz		Hot Water Research
Jeff	Kleiss		Lochinvar, LLC.
Doug	Smith		Los Angeles Housing Department
Pierre	Delforge		National Resource Defense Council (NRDC)
Robert	Choi		Navien
Kyra	Weinkle		NORESCO
Randy	Oshiro		Noritz America
Edwin	Huestis		Pacific Gas and Electric Company (PG&E)
Gerald	Van Decker		RenewABILITY Energy Inc.
Rod	Buchalter		RenewABILITY Energy Inc.
Medhavin	Potdar		Rheem
Owen	Howlett		Sacramento Municipal Utility District (SMUD)
Jeremy	Crane		Signature Sales Inc.
Kelly	Murphy		Steffes
Rick	Caruso		Swing Green, Inc.

Meeting Agenda

Time	Topic	Presenter
10:00 – 10:15	Introduction	Daniela Garcia (SoCalGas)
10:15 – 10:30	Compliance Improvement	Adam Manke (SoCalGas)
10:30 – 12:15	Drain Water Heat Recovery (DWHR)	NegaWatt Consulting
12:15 – 1:10	Lunch Break	
1:10 – 2:45	Compact Hot Water Distribution Design	Marc Hoeschele (Davis Energy Group)
2:45 – 3:00	Review and wrap-up, next steps	Daniela Garcia (SoCalGas)
3:00 – 3:05	Adjourn Water Heating Meeting	
3:05 – 4:30	Optional Demonstration of Hot Water Lab for In-person Participants	Gary Klein

Key Takeaways and Action Items

1. **Overview**
    a. No key takeaways or action items.
2. **Drain Water Heat Recovery**
    a. Field data from a multi-family installation would be useful to study since that application is more cost effective and is possibly a slightly more complex installation. We received one lead during the meeting, a UC Merced dormitory that a TRC employee was involved in, and we are following up on it. If we cannot get input from UC Merced, we will extend our search by reaching out to DWHR manufacturers to find other multi-family installations.

    b. Testing of a 2" diameter unit would be worthwhile since those small devices provide installation flexibility (they fit in 2”x4” walls), are well suited for graywater or graywater ready systems, are well suited for low flow showerheads, and may potentially be more cost effective. We have already added a 2" device to the list of devices for DEG and PG&E to test in the lab.

    c. The domestic hot water draw schedule has a large impact on the savings and there is some showering event data that has surprisingly low or high flow rates. We jointly need to ramp up our collaboration with the CBECC-Res team.

    d. Pipe distances to and from the DWHR device might yield significant cost and heat loss. We will assume a standard plumbing layout for our two prototype buildings, do takeoffs of the incrementally additional piping, and estimate cost and pipe heat loss.

    e. Utility-funded DWHR training for building inspectors, energy raters, and designers is recommended, and that utility-funded training programs should be implemented through proven local government and builder associations (CALBO, CBIA, etc.) where possible.

    f. Potentially requiring a minimum CSA rated effectiveness, such as Manitoba and Ontario have done (their minimum is 42%), is an important decision for us to make.

    g. Action Item: The DWHR CASE Team will consider the relevant requirements in the California Mechanical Code and the California Plumbing Code when developing proposed code changes for Part 6 of Title 24.

h. Action Item: DWHR CASE Authors will reach out to the Canadian directory of DWHR units to understand the product approval process.

i. Action Item: DWHR CASE Authors to reach out to DWHR manufacturers and collect and report data on minimum efficiency ratings.

3. **Compact Hot Water Distribution Design**
   a. Water savings need to be quantified.
   b. There are some concerns that the proposed method can deliver a compact solution without HERS inspection.
      i. Complete additional plan reviews to bolster analysis.
      ii. This proposal is not likely to guarantee a compact distribution system. Instead, a house will qualify if it is much easier to install a compact system than a non-compact system
   c. Consider a two-tiered compact strategy (level 1- no HERS verification, level 2- HERS verify no >3/4" piping and no pipes in attic).
      i. Further discuss and refine eligibility criteria with stakeholders.
      ii. Explore available research in more detail to determine if demand recirc is equal or better in energy performance than non-recirc standard practice (some stakeholders believe that this should be an alternative to compact.
      iii. Investigate need for additional detailed simulation modeling to better align preliminary compact savings estimates with CBECC hot water usage assumptions.

Meeting Notes

Overview of 2019 Title 24 Development

- Daniela Garcia (Southern California Gas) presented the overview presentation.
- Adam Manke presented on Compliance Improvement.
- Presentation available here.

Comments and Feedback

1. Frank Stanonik (AHRI): Are there specific compliance problems with the existing Title 24 water heater requirements?
   a. Tom Enslow (representing the California State Pipe Trades Council): There are compliance issues related to unqualified installers who do not build systems to code. Many alterations occur without people pulling the necessary permits. Permit compliance needs to be addressed. Building officials and plumbing officials need to be trained on how to verify compliance.

Drain Water Heat Recovery (DWHR)

- Marc Esser, Bo White, George Burmeister, Eric Sikkema, and Peter Grant (Utility CASE Team) presented.
- Presentation available here

Comments and Feedback

1. George Nesbitt (Environmental Design/Build): The proposed prescriptive requirement is only looking at DWHR units that recover heat from showers, right?
    a. Utility CASE Team: Not exactly. The recovered heat must come from the shower drain water, but other fixtures could also be connected. The preheated water leaving the device can connect to the cold side of the shower mixing valve, to the water heater, to both, or any of those options plus other fixtures. However, the energy software will not calculate the harm or benefit of those other fixtures.
2. Jim Lutz (Hot Water Research): What draw schedules were used for the residential analysis?
    a. Bo White (Utility CASE Team): We are using the draw schedules from CBECC-Res, which were updated in summer 2016. You can find the files inside CBEC-Res 2016.
    b. George Nesbitt (Environmental Design/Build): Title 20 just reduced the maximum shower flow rates. Does this reduce the savings potential for DWHR? Consider that lower flow rates may increase shower length?
    c. Utility CASE Team: Yes, flow rate and shower duration impact savings. Our approach is to use the hot water draw schedules included in CBECC-Res 2016, which incorporate assumptions about flow rates, shower duration, and number of showers. The 2016 draw schedules in CBECC-Res are based on an M&V study by Aquacraft. The flow rate for some showers is substantially below 2 gallons per minute (gpm), and none are intended to be higher than 2 gpm (although a few are and we are coordinating with the CBECC-Res team to determine if this is appropriate).
3. George Nesbitt (Environmental Design/Build): Multifamily seems like a better application than single family. Most single family is slab on grade, DWHR only works when the bathroom is on the second floor, and not all houses are multistory. The HERS performance credit is a myth in California.
    a. Utility CASE Team: Correct, as you will see on one of the upcoming slides. We do not want to disallow the use of DWHR in single family, though as a number of scenarios are beneficial for either type of building.
4. Frank Stanonik (AHRI): Is the benefit of DWHR the same for tankless water heaters and storage water heaters?
    a. Utility CASE Team: The type of water heater doesn't matter, but the water heater's efficiency does. Water heater efficiency is modeled as usual in the software. The DWHR algorithm will output revised water heater input temperatures and/or revised hot water demand and the existing CBECC water heater algorithms will use that data to account for energy savings.
5. George Nesbitt (Environmental Design/Build): With most single family being slab on grade, DWHR only works when the bathroom is on the second floor, and not all houses are multistory.
    a. Utility CASE Team: Correct, the proposed requirement would only apply to two-story houses. We are only considering applications for vertical units because there is no industry-standard test procedure to verify performance and quality of horizontal units.
6. George Nesbitt (Environmental Design/Build): The HERS performance credit is a myth in California.
7. Tom Enslow (representing the California State Pipe Trades Council): The California Mechanical Code (Title 24, Part 4) and the California Plumbing Code (Title 24, Part 5) are both based on model standards developed by the International Association of Plumbing and Mechanical Officials (IAPMO), and the requirements are harmonized. The mechanical code includes

requirements on drain water heater exchangers. It is important that the mechanical code, the plumbing code, and building energy efficiency standards are cohesive and the requirements are not contradictory. For example, the mechanical code includes requirements for drainwater heat exchangers. The Part 6 requirements should be harmonized with existing mechanical code requirements.

a. Gerald Van Decker (RenewABILITY Energy Inc.): IAMPO requirements do not provide clear direction on the technical or performance requirements for DWHR units.
b. Bo White (Utility CASE Team): The Canadian Standards Association (CSA) tests provide clearer direction.
c. Action item: The DWHR CASE Team will consider the relevant requirements in the California Mechanical Code and the California Plumbing Code when developing proposed code changes for Part 6 of Title 24.
    i. We see that 2016 CPC 606.1 states "Drain water heat exchangers shall comply with IAPMO PS 92. The heat exchanger shall be accessible.". We will point this requirement out to the manufacturers but do not think it needs to be duplicated in Title 24 Part 6. We will study the implication of the "accessible" clause.

8. Kelly Murphy (Steffes): If all (total) hot water energy consumption across all of California is hypothetically set at 10 kWh / day with the thermal capture in the shower sent back to the water heater, what share or percent of that total (all use) 10 kWh is recovered?
    a. Utility CASE Team: The ratio of shower water vs. other water varies depends on the building configuration and other factors, and so does the percentage you are asking for. Heat (and energy) recovery depends on configuration.
9. George Nesbitt (Environmental Design/Build): Does testing show any issues with temperature control at the shower head?
    a. Utility CASE Team: Not that we have seen so far, but we are not running specific tests for that. We assume that temperature control at the shower valve works well, even if there are small fluctuations in the "input" temperatures.
10. George Nesbitt (Environmental Design/Build): Project Green Home in Palo Alto installed a DWHR unit. You might be able to get data from that site.
11. Meeting Participant: DWHR has benefits beyond energy savings. As a secondary benefit, they also preheat water so it increases capacity. This may help in situations where the tank is under sized. It could also provide eliminate the need to install a small storage tank in conjunction with tankless water heaters. DWHR is more cost effective than installing a bigger heater or adding more storage.
    a. Utility CASE Team: We will mention that as a benefit but do not intend to take credit for reduced equipment size in the cost effectiveness calculation since it is not guaranteed to influence the equipment capacity chosen by the designer.
12. Rick Caruso (Swing Green, Inc.): We have measured the impacts of installing DWHR units on water heating systems that use tankless and storage water heaters. Data suggests an overall decrease in the number of water heating cycles for both gas and electric water heating. DWHR units improve water heating system performance, address capacity limitations, and can extend the lifetime of the water heating equipment due to reduced cycling. Resource can be found here.
    a. Utility CASE Team: We will study those benefits.
13. Gerald Van Decker (RenewABILITY Energy Inc.): A few comments. Title 24 should include potable water-side pressure loss requirements, such as those included in International Energy Conservation Code (IECC). IECC requires compliance with CSA 55.2 and testing according to CSA 55.1, which has labeling requirements for efficiency and pressure. The largest markets for

DWHR are in the UK and the Netherlands. France has compliance credits for DWHR. Payback is quicker the colder the inlet water is. Life expectancy is 200 years or more, we say 50+ years for products that are compliant with CSA 55.1.

14. Owen Howlett (SMUD): Presumably the amount of heat recovered depends on the distance from the shower and from the water heater? Does this measure need to be combined with waste piping requirements?
    a. Utility CASE Team: Yes, distances between the shower and the water heater matter. Currently, we ignore any potential heat recovery during the time it takes for the shower to meet setpoint and heat loss in pipes. However, we plan to calculate those savings and losses. We don't plan to add DWHR-specific pipe length requirements and don't plan to change the pipe insulation requirements except perhaps on the device itself. If you have any suggestions and supporting data for a different idea, please do share that with us.
15. Jim Lutz (Hot Water Research): Are you going to talk about prototype buildings and installing vertical systems on the first floor if there is a basement?
    a. Bo White (Utility CASE Team): Our analysis will be conducted using the two-story single family prototype. If there are showers on first floor, they would be excluded from the analysis. Basements aren't common. It is an optimistic assumption that all showers are on the second floor and are configured to allow for an equal flow configuration. We are only looking at vertical DWHR, so showers have to be on the upper floor. In software, we intend to include an input where users will indicate the number of showers that will be connected to the DWHR unit. We do not have data on how much one shower is used versus another. The master must be tied to DWHR because it is assumed that the master shower is used more than other showers.
    b. George Nesbitt (Environmental Design/Build): The number of showers and which showers (i.e., master shore v. guest shower) are connected to the DWHR unit will make a difference in energy benefits. Encouraging designers to install showers in a central location would help for compact distribution design and DWHR savings and should be encouraged.
        i. Utility CASE Team: We concur. We plan to require that the master bathroom is connected and to include a user input in the energy software for percentage of showers that are connected.
16. Jim Lutz (Hot Water Research): Do 2-inch DWHR units perform better with lower flow showerheads?
    a. Peter Grant (Utility CASE Team): We do not have an answer, but we are expanding the scope of lab testing to investigate further. The lab testing scope has now been expanded to include a 2" diameter unit
    b. Bo White (Utility CASE Team): You want the DWHR unit to match the pipe size, or turbulence could result.
    c. Gerald Van Decker (RenewABILITY Energy Inc.): Two-inch diameter units can work for multifamily, however four inch is more common and needed for the main drain.
    d. Daniel Beauchemin (EcoInnovation): The majority of installations are three-inch in drain diameter. The DWHR unit is usually installed on the main stack close to the water heater. I would not recommend installing DWHR units in a closed wall due to mechanical fittings and potential leaks.
        i. Marc Esser (Utility CASE Team): That is an interesting point, we are presently assuming no access panel is needed. Do you have a defensible data source that supports the need for accessibility of the device?

1. Utility CASE Team: We are now aware of the accessibility requirement in 2016 CPC 606.1 as mentioned above, and will study it.

ii. Gerald Van Decker (RenewABILITY Energy Inc.): I disagree with Daniel's suggestion that units should not be enclosed in a wall. Enclosing in a wall is the most common method needed in California because you do not have basements. Systems are all pressure tested to 160psi, and do not leak when properly made. There is no additional risk above any fresh water fitting in the home.

iii. Daniel Beauchemin (EcoInnovation): You need to have access for inspection, or if there are changes in a wall cavity.

17. Gerald Van Decker (RenewABILITY Energy Inc.): For a given CSA B55.1 efficiency, total costs will decrease by 20 to 30 percent over time.
    a. Utility CASE Team: If you have a defensible data source for this, please send it to Bo or Marc at the email addresses shown in the presentation. We are presently not figuring significant cost drops over time in our lifecycle cost calculations.
18. Tom Enslow (representing the California State Pipe Trades Council): I assume these costs are for new construction, not retrofits?
    a. Utility CASE Team: Correct. This measure would not be cost effective for most retrofit scenarios due to the significant overhead in replacing drains and additional plumbing across the building.
19. George Nesbitt (Environmental Design/Build): A shower on the first floor could be served by DWHR, but the drain from the shower on the first floor would only work with a horizontal device (assuming no basement)?
    a. Marc Esser (Utility CASE Team): Correct, but we are only considering vertical units installed on the second floor or higher stories at this time since horizontal units do not have an official test procedure and quality standard like vertical does.
20. Tom Enslow (representing the California State Pipe Trades Council): Why is the scope limited to vertical systems?
    a. Bo White (Utility CASE Team): There is a CSA technical specifications and test methods only applies to vertical systems. There are no technical specifications or test methods for horizontal units, which means there is no standardized means to evaluate the energy performance or quality of horizontal units. We need energy metrics derived from a standardized test method to calculate energy performance and develop a ruleset for the compliance software. Vertical devices are also further along in development. We are only aware of one manufacturer that does horizontal. Vertical can be installed horizontal, but savings are diminished.
    b. Marc Esser (Utility CASE Team): There is also a lack of proof of persistency of savings over life cycle period. Further, a lack of maintenance cost information (assumed 0 for vertical, but horizontal can have issues due to clogging and/or reduced performance as soap builds up). We are not discounting it as an effective technology, we just do not have enough information to analyze it as a measure at this time.
    c. Gerald Van Decker (RenewABILITY Energy Inc.): Vertical units are about twice as cost-effective and does not require maintenance. There is also no proper test and labelling standard for horizontal. That said, in the future, we are interested in pursuing requirements for horizontal units. All vertical systems can also be installed horizontally.
    d. Daniel Beauchemin (EcoInnovation): You can expect 10 percent efficiency drop on horizontal installations.

21. Medhavin Potdar (Rheem): Your cost benefit analyses based on a prototype building with a storage water heater?
    a. Bo White (Utility CASE Team): The type of water heater doesn't matter. We are going to implement algorithms into the software, and use draw schedules to calculate the effect on temperature that is going back to the water heater or shower head. If it is going back to the heater, then the algorithm in place will use temperature like it does already. We have ground water temperatures in the software, and it can accept variable intake temperatures to calculate variable savings. At the shower head, we suspect the existing algorithms can also use the revised cold water temperature to recalculate hot water demand but will confirm with the CBECC-Res team.
22. Medhavin Potdar (Rheem): Another issue is clogging. Since there are so few installed, there may be other issues not yet realized.
    a. Bo White (Utility CASE Team): It would be more likely to have clogging in horizontal devices.
    b. Gerald Van Decker (RenewABILITY Energy Inc.): Horizontal units are also prone to fouling. That needs to be investigated in the field. We have never seen clogging or fouling of vertically installed DWHR units.
    c. Bo White (Utility CASE Team): For vertical units, we assume no maintenance costs. DWHR units use copper in the inner pipe, but they do not require more maintenance than a regular pipe. It is important that they are installed correctly.
    d. Meeting Participant: Many people use Draino, which is corrosive and may have implications on copper pipes.
        i. Bo White (Utility CASE Team): We can speak with manufactures to investigate maintenance issues further, including implications of using Draino.
23. Gerald Van Decker (RenewABILITY Energy Inc.): Are there many newly constructed multifamily buildings that have one water heater per dwelling unit?
    a. Utility CASE Team: we don't have a statistic for that, but yes, some multifamily buildings have individual water heaters for each dwelling unit. Not all have central water heaters. George Nesbitt concurs as well per his comment on the topic.
    b. George Nesbitt (Environmental Design/Build): Some multifamily (even high-rise 4-5 stories) have individual water heaters, some central. It seems to vary, for various reasons. A multifamily requirement / credit would have to vary on whether the heater is central or an individual heater.
        i. Utility CASE Team: We concur. For multifamily with a central water heater, the energy modeler will state which residential units are connected to the DWHR unit and the percentage of showers in each unit that are connected. For the multifamily with central water heating prototype, we plan to assume that all showers in the four second floor residential units are connected and that the piping configuration is unequal to the shower heads.
    c. Gerald Van Decker (RenewABILITY Energy Inc.): In multifamily, with individual water heaters, equal flow can and should be installed. Therefore, please study both unequal flow and equal flow for multifamily.
        i. Marc Esser (Utility CASE Team): We are. The results are pending further calculations, and will be included in the CASE Report. Our methodology for calculating equal flow for single family and multifamily with individual water heaters for each dwelling unit is exactly the same. The only difference is that our

prototypes for single family and multifamily have different floor areas and number of bedrooms.

24. Meeting Participant: Will you be considering the energy impact of DWHR units installed in recirculation systems?
    a. Bo White (Utility CASE Team): No. Distribution system should not impact savings from DWHR unit.
25. Jim Lutz (Hot Water Research): Warm-up time is included with shower length in the software.
    a. Bo White (Utility CASE Team): The schedules in CBECC-Res include start time, duration, and flow rate. Duration includes the full duration of draw through the showerhead, regardless of water temperature (i.e., includes warm-up time), and flow rate is modified using the standard distribution loss multiplier (SDLM). The CBECC-Res supporting documentation states the assumed floor areas and, therefore, SDLMs. We use these SDLMs to determine the actual flow rate and the duration of heated water. So far, our savings calculations are based only on the heated duration but we plan to estimate the additional savings during the warm-up period.
    b. Gerald Van Decker (RenewABILITY Energy Inc.): Important NOTE: there is very, very little penalty from startup. DWHR units reach steady state very quickly. They start at room temperature and are close to room temperature during steady state. We have an official explanation for this. However, there is a little bit of energy lost once the shower stops...that flows down the drain and its heat cannot be captured.
        i. Utility CASE Team: Our lab testing includes and quantifies these considerations. In our current calculations, we are ignoring any potential energy savings during the time it takes for the shower to meet setpoint temperature, but we plan to approximate the reduced savings during this period. We use the standard distribution loss factors from Title 24 for a given building in our calculations. We plan to use the appropriate factor when a home has an improved distribution system. As of now, we do not plan to exclude that last bit of heat that cannot be recovered after the shower ends. If you have data or documentation on that, please share.
26. Gerald Van Decker (RenewABILITY Energy Inc.): What diameter is the DWHR unit from this test? The smaller the diameter, the better the wetting will be on the drain-side, even for showing events that are far apart. Also, after use, you do get better wetting.
    a. Marc Esser (Utility CASE Team): The lab tests are using 3-inch units, but we plan to test 2-inch units as well. We concur that pre-wetting resolves the issue but many showers begin without a pre-wet drain. Might you be saying that a used device gets better wetting than a new one? If so or if you have any data on this topic, please share.
    b. Jon McHugh (online): If greywater is isolated from black water (use grey water for irrigation) does this allow the use of two inch DWHR and does this reduce the partial wetting flowrate?
        i. Bo White (Utility CASE Team): Yes, you can use a 2-inch unit if you separate black water. The minimum allowable diameter is three inches if black water (i.e., toilet water) is not separated. If it is only tied to showers, then use a two-inch pipe and check plumbing code for modifications based on which other fixtures are adding to shower flows.
        ii. George Nesbitt (Environmental Design/Build): According to the Uniform Plumbing Code, which is the basis for the California Plumbing Code, two-inch drains can handle four showers if horizontal and eight if it is vertical.

iii. Marc Esser (Utility CASE Team): We have not studied wetting on two-inch devices so I do not know the answer to the second part of your question. We plan on studying this in Phase 2 lab tests.

27. Frank Stanonik (AHRI): What is the time period for the therms savings presented?
    a. Bo White (Utility CASE Team): They are per year, before applying TDV.
28. Raad Bashar (SDG&E): Do the cost estimates include additions to the heat recovery unit, such as piping costs, or extensions for plumbing?
    a. Bo White (Utility CASE Team): That is account for in parts and labor. We assumed $100 but that might be on the low end. We can redo the calculation and enter the number of feet assumed, then apply a RSMeans rate. The parts cost is for piping.
29. Gerald Van Decker (RenewABILITY Energy Inc.): As mentioned, the installer training is absolutely critical to avoid maintenance problems, and to reduce installation costs. Installers must be added as a market actor.
    a. Utility CASE Team: Good suggestion, thank you. Builders are included.
30. Rheem: Do we need to consider contractors?
    a. Bo White (Utility CASE Team): Builders are included.
31. George Nesbitt (Environmental Design/Build): Would the DWHR have to be connected to the shower only, or could the pre-heated water be connected to sinks also?
    a. Utility CASE Team: Our calculations assume pre-heated cold water serves only the shower and/or water heater. There is nothing that precludes connecting sinks but the incremental benefit is likely to be very minimal though.
    b. Gerald Van Decker (RenewABILITY Energy Inc.): It would recommend that Title 24 not require a connection to the shower *only*. We typically recommend running all the water in the house through the unit, except the kitchen sink.
    c. Daniel Beauchemin (EcoInnovation): We recommend that the DWHR be connected to the cold water inlet to the shower when, which allows for cold water preheat. It ensures energy recovered is not used to water the lawn when taking a shower.
    d. George Nesbitt (Environmental Design/Build): So the DWHR would have to be on only the shower drain and cold supply only to the shower?
        i. Utility CASE Team: That is one possible configuration. Please look at slide 2 for typical scenarios.
32. Jon McHugh (McHugh Energy): The rationale for a HERS Rater inspection is poor installation could lead to condensation in the wall from pipes. Why is this different than having other cold water pipes in walls? They do not require a HERS rater for looking at cold water pipes and cold water pipes are not required to be insulated.
    a. Marc Esser (Utility CASE Team): Correct installation is very important for as designed performance; we are still evaluating (quantifying) the impact of the various installation parameters when well done vs. when poorly done. A final determination of installation requirements will be made at a later time based on that evaluation, and, of course based on the feedback we are getting from stakeholders and market actors, today and offline.
33. Jim Lutz (Hot Water Research): Is this going to be requirement that DWHR units be listed under Title 20?
    a. Danny Tam (CEC): No. DWHR units are not regulated by Title 20. We could keep a separate list using the Title 24 process for Manufacturer Certification for Equipment, Products and Devices: http://www.energy.ca.gov/title24/equipment_cert/.

   b. Bo White (Utility CASE Team): There is a Canadian directory. But that is not comprehensive.
   c. Rod Buchalter (RenewABILITY Energy Inc.): Canadian manufacturers submit their data, and it is based on CSA approved units. Manufacturers are encouraged to submit products, but they are not required to do so. I also wanted to emphasize the cost of installations are heavily impacted based on whether the plumber is trained. Training is needed for better adoption, and pricing will be more reasonable as more plumbers receive training.
   d. Action Item: DWHR CASE Authors will reach out to the Canadian directory of DWHR units to understand product approval process.

34. Gerald Van Decker (RenewABILITY Energy Inc.): Please compare your model with the ANSI/RESNET hot water model. Also, please compare and report on the percent of energy saved.
    a. Utility CASE Team: We did a comparison during Phase 1 of lab testing and determined that our methodology is in some important cases more sophisticated and accurate. However, for the prototype buildings, we will compare our calculations to RESNET. We will also calculate percent of domestic hot water energy saved.
35. Daniel Beauchemin (online): Are you looking at specific minimal efficiency levels for the code on DWHR units?
    a. Marc Esser (Utility CASE Team): We will require CSA compliance and we are considering requiring minimum effectiveness levels similar to Manitoba's and Ontario's energy code, if there is a prescriptive requirement. Both require a 42 percent minimum efficiency. We plan to talk to the DWHR industry to get input here.
36. Chris Kuch (SCE): When you say DWHR applies to retrofits, what would trigger the requirement for alterations? Does that have to meet same cost-effective criteria as new construction?
    a. Bo White (Utility CASE Team): You can install as a retrofit. Our calculation is for new construction. For any scenario it is not mandatory, it will likely be a compliance option for single family and a prescriptive requirement (which can be traded against other measures) for multi-family.
37. Rick Caruso (Swing Green, Inc.): installations are more efficient at recovering heat because modern plumbing systems have vent tube that result in water being pushed to the pipe walls so that warm water leaving the shower makes contact with the interior surface of the drain pipe. Horizontal units are not as effective at heat transfer because the warm water sits at the bottom of the pipe. In most applications in Colorado, we keep the mechanical room unfinished so you can easily access pipes and perform retrofits. The installations take 30 to 40 minutes and require two cuts of PVC and a replacement hook up.

Compact Hot Water Distribution Design

- Marc Hoeschele (Davis Energy Group, Utility CASE Team) presented.
- Presentation available here

Comments and Feedback

1. George Nesbitt (Environmental Design/Build): If you eliminate HERS verification then you eliminate the ability to enforce compact distribution system requirements.
   a. Marc Hoeschele (Utility CASE Team): That is valid point. CalCERTS data suggests that only 0.01 percent of registry entries are using the 2013 compact hot water distribution

compliance option. This is a very low uptake. Our research suggests that eliminating the HERS verification might help increase uptake.

   b. Peter Grant (Utility CASE Team): The proposed eligibility criteria would not include field verification of compact distribution. Instead, it requires all of the fixtures and water heater to be close together, meaning that installing a compact distribution system is both easier and in the plumber's best interest since it reduces the length of pipe to be insulated.

2. George Nesbitt (Environmental Design/Build): Compact design is hard to accomplish because there are fixtures on all ends of the house. Recirculation systems are sometimes installed, but not modeled in the software. This is a compliance issues. Some tankless water heaters have built-in recirculation pumps (e.g., Noritz); the software does not estimate energy use from those water heaters correctly.
   a. Marc Hoeschele (Utility CASE Team): Those are good points. We have tankless manufacturers here. A lot of newer systems have recirculation pumps built in. We have also heard of situations where recirculation systems are installed, but not modeled for T24 compliance. The Energy Commission is aware of this compliance issue.
   b. George Nesbitt (Environmental Design/Build): Non-demand recirculation is not allowed prescriptively. Yet they are installed. This is another compliance issue.
3. George Nesbitt (Environmental Design/Build): Most plumbing is laid out in the field by the installer. It can be difficult to determine code compliance if there is no plumbing plan, the installer lays out the system on-site, and the plumbing is covered before an inspector visits the site.
   a. Marc Hoeschele (Utility CASE Team): I agree.
4. Tom Enslow (representing the California State Pipe Trades Council): Enforcement is an issue. We should avoid compact hot water requirements that are based on the volume of water entrained in pipes. Compliance with a volume-based requirement is too difficult because it requires calculations that are not otherwise completed and installers often need to alter the designs in the field. A requirement based on pipe length and size is better than a volume-based requirement.
   a. Jon McHugh (McHugh Energy): I suggest reviewing the IECC requirements for compact hot water distribution requirements for commercial buildings (IECC Section C404.5.1 1 Maximum Allowable Pipe Length Method). It has a look-up a table that presents maximum allowable pipe lengths for given diameter pipes with associated entrained volumes. IECC allows the use of either a method based on pipe length and diameter or a method based on calculated entrained volume.
   b. George Nesbitt (Environmental Design/Build): Volume of water in the pipe is more important than length. Short, large-diameter pipes are sometimes worse than long, small-diameter pipes.
5. Raad Bashar (SDG&E): Have you considered incorporating solar heating into the compact design proposal? For example, could solar thermal be used instead of a second water heater?
   a. Marc Hoeschele (Utility CASE Team): We are not considering a requirement that would couple solar thermal and compact distribution design. Title 24 already includes a method for builders to get credit if they install solar thermal systems. The modeling ruleset for solar thermal systems does not interact with the modeling rules for water heating distribution system losses. There are two separate pieces that influence model performance. As we move towards ZNE, solar PV provide more energy benefits than solar thermal, so the limited roof space will likely be occupied by solar PV systems, not solar thermal systems.

6. Jim Lutz (Hot Water Research) Are you using the existing distribution loss multipliers in CBECC-Res for baseline calculations?
    a. Marc Hoeschele (Utility CASE Team): Yes.
7. Jim Lutz (Hot Water Research): How did you evaluate energy impacts of moving from one floorplan to another? (slide 25)
    a. Marc Hoeschele (Utility CASE Team): We used the compact distribution credit multiplier from 2016 Title 24 Standards (0.7 factor), but modified the baseline assumption to reflect that all hot water pipes were insulated, which will be required starting January 1, 2017. We completed 150 HWSIM runs to develop results for a variety of floor plans and usage profiles. The proposed 0.7 multiplier is intended to be an average across all the cases.
    b. Jim Lutz (Hot Water Research): The approach sounds vague. I would hope to do a more careful look using new draw patterns, and more example floor plans. The water heating models are complex and use layers upon layers of assumptions and "patches". How can you justify savings if you are using flawed models?
    c. Marc Hoeschele (Utility CASE Team): New buildings do not have occupants yet, so the exact draw patterns cannot be determined. Applying a standard draw pattern allows for a standardized approach at looking at the distribution system performance. We are open to recommendations on how to improve our modeling approach. This is the first cut. In addition, the new CBECC-Res draw patterns are not at all specific about where the hot water is consumed; it only distinguishes between showers, sinks, dishwasher, etc. Agree that all of this analysis is complicated and builds upon assumptions.
8. Marc Hoeschele (Utility CASE Team): Does it seem appropriate to establish an eligibility criterion so that approximately one-third of existing layouts that have water heaters in the center of the garage would meet the proposed Equivalent Length criteria requirements?
    a. No response.
9. Raad Bashar (SDG&E): What will the water savings be?
    a. Marc Hoeschele (Utility CASE Team): In the range of 0.5 to 2 gallons per person per day, but it will depend on the system type (recirculating or not) and house layout. We will present more detailed hot water savings estimates in the CASE Report.
10. George Nesbitt (Environmental Design/Build): How can you verify that the correct length is installed? You can present a max length on plans, but is an inspector going to measure the installed length?
    a. Marc Hoeschele (Utility CASE Team): Verification would occur at the plan check stage. Title 24 consultants would review and confirm that the layout meets the Equivalent Length criteria based on plan measurement. The Equivalent Length criteria method does not consider the actual length of pipes. There would not be a field verification. The goal is to make the compact distribution credit more accessible, which means simplifying the compliance process.
    b. George Nesbitt (Environmental Design/Build): Then the building would still receive the credit even if the installer installs three different trunks and longer lengths than needed.
    c. Marc Hoeschele (Utility CASE Team): You could not use pipes over ¾-inch diameter unless you have a recirculation system. As proposed currently, we would rely on the honor system for installers to comply with pipe sizing requirements. We could consider a HERS requirement to field verify that pipes are ¾-inch or smaller.

   d. George Nesbitt (Environmental Design/Build): While I think "compact design" is important, it does not reduce enough water waste. Maybe we should require demand recirculation systems, and have tighter compact design as a tradeoff.
   e. Marc Hoeschele (Utility CASE Team): Demand recirc will save water, but will likely consume more energy than a standard non-recirculating system.

11. Jim Lutz (Hot Water Research): This is a question for George Nesbitt. How onerous is the WaterSense inspection test used to verify that no more than 0.5 gallons of water is wasted before hot water arrives at the furthest fixture from the source? It seems like a quick test that does not require open walls. If a HERS Rater on site, would conducting that test add much to expense/effort?
    a. Marc Hoeschele (Utility CASE Team): The WaterSense requirement establishes a maximum volume at the tap before water temperature rises 10 degrees.
    b. Jim Lutz (Hot Water Research): It the WaterSense technique requires verifying if it is compact, and you do not have to measure pipes, is that easy enough and reliable enough of a verification method?
    c. George Nesbitt (Environmental Design/Build): There are some challenges with the WaterSense test. How do you know which fixtures is most distant from the water heater? The water heater is not installed until the building is totally finished, and at the time of inspection building does not have a utility account, so the water heater is not turned on – you cannot measure temperature rise. If the building fails the test, what do you do about it; pipes are already covered. If we design plumbing to be recirculation systems, we would get better results.
12. Tom Enslow (representing the California State Pipe Trades Council): There is a problem with no HERS test. George made a good point about the limited options for corrective action if the fails after pipes have been covered. Verification is important. We need standards based on what installers do in the field. When you have limits on the lengths of pipes of various diameters, that is easier for people in the field to follow. We need to think about compliance.
    a. Marc Hoeschele (Utility CASE Team): The current proposal eliminates all field verification. We could consider a verification to confirm the pipe diameter requirements are met (i.e., no 1" piping).
13. Marc Hoeschele (Utility CASE Team): There are concerns about the energy penalties of recirculation systems. You need to bring recirculation loop close to fixtures, which requires more piping. There is heat loss throughout the recirculation loop, and circulating water requires energy. This is documented in our DOE Building America study.
14. Payam Bozorgchami: What are the current repercussion if a HERS Rater finds the building does not meet compact design requirements?
    a. Marc Hoeschele (Utility CASE Team): It would seem that almost all cases, the Title 24 calculations would need to be rerun to reflect that the compact criteria were not met. May require other features to comply.
15. Jim Kemper (LADWP): This proposal relies on a plumbing plan check. Homes that are average sized do not receive a plumbing plan check. This would add a new step to an already complex code verification process. Compact design requirements belong in the Plumbing Code, not the Energy Code.
    a. Marc Hoeschele (Utility CASE Team): We are saying the plan check would be part of the Title 24, Part 6 review process not the Plumbing Code plan check process. The applicant would need to provide measurement on the plans, which would help the plan checker confirm compliance with the Equivalent Length criteria.

   b. Jim Kemper (LADWP): It would require additional submissions from a plumbing check group, and a building group. The compact design requirements in Part 6 of Title 24 would create conflicts with other sections of Title 24. Plumbers do not look at Part 6 of Title 24.
   c. Marc Hoeschele (Utility CASE Team): We are getting away from pipe length and diameter. All we are asking for is a plan measurement. The distance from heater to master bath, to kitchen, and that all hot water pipe is ¾-inch or less.
   d. Peter Grant (Utility CASE Team): The proposal is not based on detailed plumbing schematics and length of installed pipe. It is solely based on an architectural plan view, and the straight-line distance from the water heater to the fixtures.
16. George Nesbitt (Environmental Design/Build): The location of the kitchen and bathroom do not always have a direct impact on pipe lengths. I have seen a project where the water heater was five feet from the sink, yet because they used a long run of large-diameter the wait for hot water was 45 seconds or more. You would think that situation would be compact, but it wasn't. We have to verify the actual pipe sizes and lengths.
17. Danny Tam (CEC): Could you have two different credits: one for a plan check, and a higher credit if there is HERS verification?
   a. Marc Hoeschele (Utility CASE Team): That is worth consideration.
18. Meeting Participant: If we want to bring the water heater closer to point of use, could that be a compliance option?
   a. Marc Hoeschele (Utility CASE Team): There are strict criteria for point-of-use water heaters, and it does require multiple heaters. It could be possible to satisfy two bathrooms with one heater if they are back to back. It is restrictive but available.
19. Jim Lutz (Hot Water Research): There could be additional electricity savings from tankless water heaters that are not captured in your estimates; if they are not making as much hot water, they are using less electricity and less gas.
   a. Marc Hoeschele (Utility CASE Team): Those savings are determined in the recovery load calculation. The compact design would reduce the recovery load; therefore, savings would be realized.

Other

1. Pierre Delforge (NRDC): I want to present a concept proposal, regarding heat pump water heaters (HPWH) and demand flexibility. Right now we can use HPWHs through the performance path. The problem is it assumes it runs till draw occurs. Since they usually run during peak, we have opportunity to use thermal storage capacity to delay charging, and avoid evening peak and maximize the use of solar PV in afternoon. Another benefit to increase cost effectiveness is charging when TDV is low. It is also a solution to help reduce carbon emissions. Perhaps include a compliance option in code for controlled HPWHs that is different from uncontrolled HPWHs, like HVAC, or lighting. The load profile could be adjusted to reflect use at low TDV times and none during high TDV times.
   a. Jim Lutz (Hot Water Research): In the performance calculation method, it would be easy. The water heater could read TDV value and base usage. The hard part is fitting requirements that rely on how people use the controls into the Standards. The same problem applies to demand response. For example, how do you know the control strategy will still be intact after a power outage? Does the water heater reset? What happens when the water heater is replaced – can you be sure the new water heater will have the same

functionality? Once you have that figured out, it is not hard to put in performance method.

b. Peter Grant (Utility CASE Team): From a technical feasibility standpoint, most HPWHs do not have demand response functionality. There are some in the Pacific Northwest on modules, CTA2000-45, an open source. The technology isn't here yet, but it maybe soon.
c. Pierre Delforge (NRDC): Putting in code could be a market incentive.
d. Bruce Wilcox: I put in a HPWH recently. As the homeowner, I have no access to how the water heater is programmed.
e. Danny Tam (CEC): This is an area were interested in. As far as prescriptive standard, timing is an issue. We need draft proposal by April of next year. We might be able to provide an explanation of how you can use HPWHs to achieve the prescriptive energy budget in the Compliance Manual.
    i. Payam Bozorgchami (CEC): Manuals are adopted later in the cycle so it gives more time.
f. Jon McHugh (McHugh Energy): There is history of not providing a compliance credit for demand response controlled devices. Savings from controls depend on how the controls are used whereas savings from efficiency measures will be realized regardless of user behavior. For this reason, there is a desire to prevent efficiency measures to be traded against control measures in the performance approach. So, controls requirements are mandatory and not included in the prescriptive or performance approaches. Combination of HPWH and DWHR has lower TDV energy use than tankless water heater.