DOCKETED	
Docket Number:	19-BSTD-01
Project Title:	Draft 2019 Alternative Calculation Method Reference Manuals and Compliance Software Tools
TN #:	227284
Document Title:	Beyond Efficiency Comments Appropriate Electric Baseline
Description:	N/A
Filer:	System
Organization:	Beyond Efficiency/Dan Johnson, AIA
Submitter Role:	Public
Submission Date:	3/6/2019 4:33:23 PM
Docketed Date:	3/6/2019

Comment Received From: Dan Johnson, AIA
Submitted On: 3/6/2019
Docket Number: 19-BSTD-01

Appropriate Electric Baseline

Additional submitted attachment is included below.

Appropriate Electric Baseline: Comments on the 2019 ACM & Compliance Manual Updates

3/6/19

Dan Johnson, AIA
Beyond Efficiency Inc.

Beyond Efficiency is an engineering and energy consulting firm, handling around 100 different building projects in some phase of design or construction, at any given time. Our staff credentials include Res and NonRes CEA, PE, licensed architect, LEED- and GPR-Rater, and EIT.

Priority comment

Please provide an appropriate all-electric baseline (Standard design) for Proposed Non-Res and High Rise Res (HRR) designs that have efficient electric space heating and/or efficient electric water heating. **This will enable designers to eliminate fuel gas from their projects, in accordance with the State of California's climate protection goals.**

The Low Rise Residential (LRR) performance modeling appears to be fuel neutral; however, **this needs to be extended to Non-Res and High Rise Res (HRR) during this code cycle**.

Please provide Standard HVAC systems in the Non-Res ACM that reflect **actual HVAC systems being commonly used in California**, cost-effectively, similar to how the Standard HVAC has been selected for LRR. For example in LRR, gas furnace and split heat pump are actual system types that are commonly installed. They are treated agnostically and matched by the Standard design.

Additional comments are divided into the following sections:

Table of Contents

A. ACM Low Rise Residential (LRR) CBECC-RES

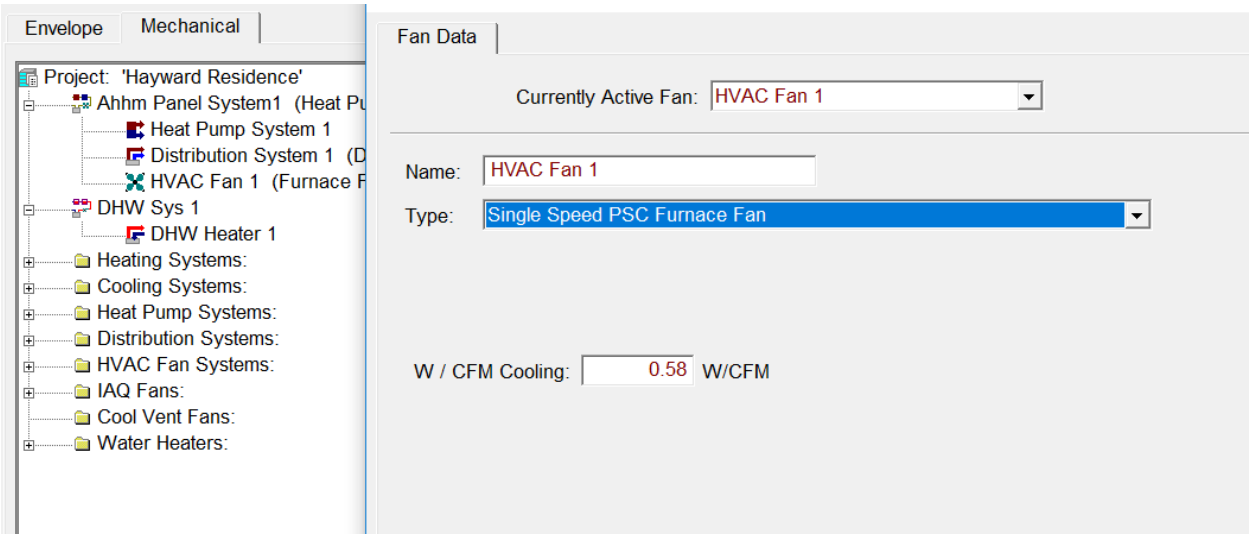
1. **Software doesn't allow Quality Insulation Installation (QII) to apply to altered walls** in a remodel situation. Please provide QII credit for altered walls in a remodel. I request this not to get compliance credit, but to engage the HERS rater during construction, as an educational resource for the builder, which is useful toward the goals of some projects, regardless of code compliance.
2. **Please generate the CSE reports in a comma-delimited format (CSV) for faster importing to spreadsheet analysis**
3. **Zonal control credit**, LRR, not compatible with radiant floors? Currently only for gas furnace? Hydronic distribution is an inherently zoned system. I am using an air-source heat pump to make hot water using electricity, compatible with the State's decarbonization roadmap. CBECC-RES says I can't take zonal credit for a heat pump hydronic floor heating system. **This is confusing the distribution method with the heat source.** Zonal control also fails when using ductless heat pumps, which inherently have individual thermostats for each fan coil. Enable zonal control for zoned systems, don't confuse heat/cooling source with distribution method.
    - Current workaround is to input a separate System for each Proposed Zone, to force the software to give each one its own thermostat.
    - For a similar reason, zonal control may be moot for multi-split heat pumps: because we need to input ducted, multi-split heat pumps as multiple Systems for HERS testing (despite the indoor units sharing a single compressor), then the Zonal Control is moot because each Zone will be set up in the model as a unique split System anyway.
    - Split heat pumps can use zone dampers; therefore we need Zonal Control enabled for heat pump forced air, not just for fossil-fuel forced air.
    - We need zonal control credit for hydronic heat pump systems
4. **Solar heat gain coefficient in CZ3**. Should match Proposed, should not be set to a predetermined value**.** If the Standards do not regulate SHGC, then the Standard SHGC should be set equal to the Proposed SHGC.
    - Res ACM for Climate Zone 3 uses a Standard Design solar heat gain coefficient (SHGC) of 0.50, which is a passive solar window, despite the Standards not regulating SHGC in Climate Zone 3. As it is, any Proposed SHGC not equal to 0.50 will create either a penalty or credit, which is not appropriate for a feature that is not regulated by the Standards.
    - This also makes compliance hard to troubleshoot, unless the modeler knows that "not regulated" actually means "Standard=0.50". If the Standards want windows that are 0.50 in Climate Zone 3 (passive solar windows), then this value should be listed in the Prescriptive TABLE 150.1-A COMPONENT PACKAGE-A.
    - Setting Standard to 0.25 to match other CZs perpetuates the same problem,

centered on a different specific value; in this case as well, TABLE 150.1-A for CZ 3 should list 0.25 if this is the Standard design.
- Please set Standard window SHGC in CZ3 to match Proposed, since this value is not regulated

5. **Heat pump clothesdryers**. Need ability to specify electric heat pump clothesdryer in appliances, with energy inputs from Energy Guide label, same as DW and refrigerator. Need inputs for dryers kWh/yr (HP vs. resistance electric) Oh wait, I see that inputs are available in the interface, but disabled anyway. So EDR includes a standard suite of appliances that can't be set to match the Proposed appliances? And why trade building envelope against consumer appliances?
6. **Prescriptive skylights are not for sale**. I can't find any skylights for sale that meet Prescriptive code U-0.32. Therefore it's not cost-effective to run a Standard design using this U-value. Most products have U>0.40. Prescriptive should be set to U-0.40 or greater. A product search in NFRC catalog finds zero products from Velux (most popular skylight manuf---and the only one stocked at Home Depot?) with U≤0.32. Therefore the Standard skylight should have a U-value >0.40, unless there is a lower-U cost-effective product on the market.
7. **Skylights allowed prescriptively are not matched by Standard in Performance model.** Standard needs to match Proposed skylight area, up to the Prescriptive allowance. Every skylight that I model is taking a hit in Performance calc compared to imaginary Standard, which has no skylights. They are matched with a Standard opaque roof. Why is this, when Prescriptive code gives me an allowance for skylights. I thought the intent was for the Standard Design to be the Prescriptive design. Kind of feel robbed, cheated, or abused by ACM.
8. **Floor area must be entered at both the Dwelling Unit Type and each specific instance under "Zone"?** Creates potential for errors; time consuming interface
9. **HVAC auto-sizing**. LRR CBECC-Res Multifamily HVAC forces me to autosize and oversize by 2x, which is not user-editable. 2x is way outside industry guidelines for equipment sizing, which start at 0.9x and end at 1.25x. Why is Proposed equipment sizing not taken as a user input? A Proposed design choice to oversize a heat pump for high efficiency at low ambient temps cannot be used as a compliance variable? An oversized furnace that short-cycles at reduced efficiency doesn't count against compliance? Also, equipment sizing is being calculated, oversized by a factor that is outside industry norm, and sizing is not reported back to user through interface? Please report auto-sizing back to user.
10. **Please report auto-sizing back to user** through the interface
11. **Dishwasher & cooking required**. I can't turn it off. I have staff housing that has no cooking, no laundry, and no dishwashers in the dwelling units. I also have accessory dwelling units (ADUs) alongside single family homes, with no laundry or dishwasher in the ADU (see comments on modeling all ADUs as Additions). I can disable laundry machines, but can't disable dishwasher and cooking in CBECC-RES. Now we have cooling & heating energy & EDR affected by cooking appliance energy that doesn't exist, plus incorrect information being put onto the

forms.

12. **Multi-split heat pump systems and HERS**. With regard to multiple indoor fan coils, each with its own thermostat and “zonal control,” ganged on to a single outdoor compressor. How many “systems” is this? If there is only one outdoor unit, then it's legitimate to think we have one system. However, the HERS may need to run duct tests on several distinct indoor "systems" (ducted split fan coils sharing one outdoor unit). Modeler sets up the compliance model as one System with multiple zones, based on outdoor unit; HERS Rater needs CF2R forms with multiple Systems, based on indoor units. Need to push out definitions that “System” refers to the indoor units, not the outdoor unit. If several Systems share an outdoor unit, this is irrelevant for compliance and HERS; dummy outdoor units would be input to the software.
13. **CBECC-RES "Single Speed PSC Furnace Fan".** Please change the wording on this, which is overly specific to one particular machine. Furnace means a fuel-burning air handler. Most of our projects use heat pumps. "PSC" is only one specific motor technology, with partial and declining market share; expanding market share of ECM motors is consistent with IEPR roadmap, etc. (https://www.achrnews.com/articles/136459-fer-standards-require-electronically-commutated-motors). A generic term like "Default-efficacy fan" would create less confusion for the modeler and avoid putting false information onto the forms, which creates more confusion downstream. Responsible Person cannot sign that this model represents the Proposed design.



14. **Forms**: CBECC-COM allows a comment field to explain modeling workarounds due to software limitations. This "notes" feature is available in native CBECC-RES, but not exposed in EnergyPro. Issue for vendor. Refer to other comments on **vendors not exposing all features** of underlying CBECC functions.
15. **Corridors in multifamily**. We’re not able to model double-loaded corridors that are **ventilated but not heated or cooled**. CBECC-RES and CBECC-COM. If the corridor has no heating or cooling in the Proposed design, then it is Indirectly Conditioned Space. There is no way to model Indirectly Conditioned Space in

CBECC-RES, choices are Conditioned or Unconditioned. If Conditioned in the software has a different definition, meaning anything not Unconditioned, then this should be clarified in the Definitions in the Standards. (See more discussion under NonRes ACM.) Perhaps corridors in CBECC-RES need to be included in, or divided amongst, the dwelling unit Zones? But then we have a ventilation and heating/cooling mismatch between the Proposed Design and what gets input into the software. Perhaps corridors should be ignored for compliance? But they have significant fan energy for ventilation (and heating/cooling where applicable) that should be included---how?

16. **PTAC and PTHP have different fed standards than split HVAC**. Yet Proposed PTHPs are matched by split heat pumps in the Low Rise Res Standard design. Split systems have a more efficient federal standard. So a minimally compliant PTHP will fail against the Standard design, which is a higher efficiency than the Prescriptive requirement for PTHPs. Suggested: when the Proposed HVAC is PTAC or PTHP, use the correct federal standard in the Standard design. PTAC compared to split AC in Performance, though Fed Standard for split AC is higher. For small dwelling units (Apartments and ADUs), the split AC capacities on the market are oversized for the application (violate CALGreen and ACCA sizing rules), therefore PTAC/PTHP are used, to reduce capacity toward actual loads. **PTAC takes a penalty compared to Standard design which is default split AC**.
17. **IAQ fan not counted in analysis for some compliance types**. E.G. addition alone, a standalone garage conversion ADU, has an IAQ fan. (Does code require it?) This end use is listed as zero for compliance (both Standard and Proposed), **which puts more weight on water heating (appliance) compliance** (see Small Dwelling Units: Water Heating Emphasis in this document).
18. Remodel / “Alteration” projects that add an IAQ fan where none exists, do not get this fan integrated into the compliance model when using EnergyPro. (Interface doesn’t pass fan into CBECC-RES model. However, user input into native CBECC-RES does accept the fan and incorporate it into analysis.)
19. **Metal-framed assemblies**. CBECC-RES: provide ability to model metal-framed assemblies (roof, walls, floors) in low-rise res. We have this already in CBECC-COM.
20. **Shading objects - consistency**. Shade from trees and nearby buildings **must** be accounted for with regard to solar PV production / solar access; however, shade from trees and nearby buildings **must NOT** be accounted for, with regard to cooling load on the building? If nearby buildings / large trees are accounted, the cooling load on the building would drop, which would reduce the need for solar PV to match this electricity consumption. Result: potentially oversizing solar PV for a cooling load that doesn't exist. This also de-legitimizes "shading" by adjacent buildings and trees as a cost-effective and useful energy efficiency measure (EEM). This efficiency measure has been used effectively by architects for thousands of years. Proposed *CASE* evaluation: *Cost-effectiveness of TREES and ADJACENT BUILDINGS for reducing peak cooling electricity.* Offer

compliance credit vs. the Standard design (set to unshaded).

https://www.flickr.com/photos/44292341@N03/8118878644

For CBECC-COM, we create the “complex geometry” in Sketchup using the OpenStudio plugin, **including exterior shading objects like other buildings in an urban context.** CBECC-COM accepts these through the import process; they become EnergyPlus shading objects; and we’re off and running. No similar means to generate exterior shading in CBECC-RES, producing results described above that have less fidelity to reality.

21. **CBECC-RES Cooling T-stat setpoints**. You can't buy a thermostat that has this many setpoints, stepped across so many hours. Performance modeling uses a T-stat workout that cannot be duplicated in real life; thus the results are not useful for investment decision-making.
    - In addition to fictional stepping, the setpoints are generally too hot: people won't have 80F+ in their homes at midday, and may not tolerate 78F overnight while sleeping.
    - It doesn’t make sense in 2019 to hit the thermostat hard with a big cooldown at 4pm, when the 4-9pm EXPENSIVE Time-of-Use pricing window is just opening. The cooldown needs to occur earlier.
    - Precooling during low TOU rates makes more sense anyway. The Standard T-stat should run precooling. The Proposed T-stat should do the same, and the house's thermodynamic response to this scheduling should be a compliance variable (i.e., a house with more thermal mass and better window shading might draw lower TDV with precooling than the Standard house. This credit should be awarded.) Some real world examples of precooling in practice:
        - *If you live in an an area that offers TOU rates and/or VPP then a programmable stat makes a LOT of sense. More areas are getting smartgrid technology, this is what will drive which thermostat works best for your region. For us the Energate works best because it's the stat our*

local utility uses to communicate with. No upfront cost (they even pay for installation) is icing on the cake. http://energateinc.com/products-sol-products-smart-thermostats.php

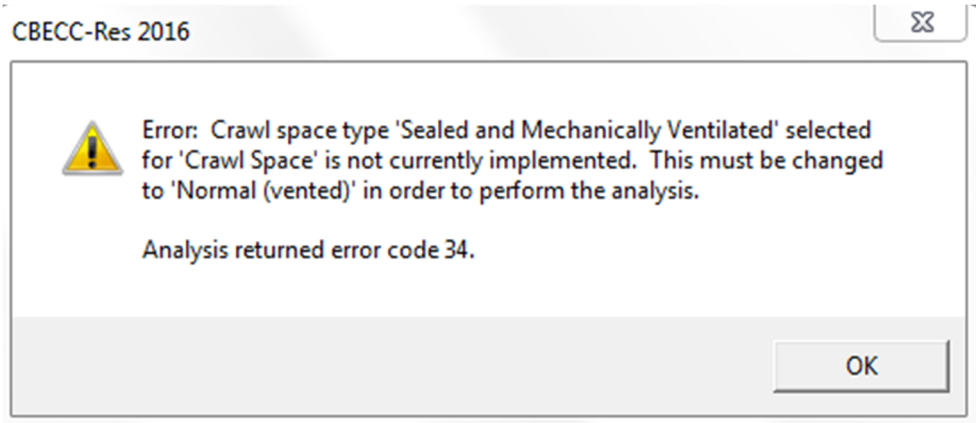
- *Pre-cooling doesn't make sense? How does removing heat from the home for 2 hours when power costs 4.5cents not save money vs paying 23cents to keep the house @ 75? Say the stat is 75, and TOU is 2-7. Dropping the temp from 75 to 73 from 12-2 means **the house will need to warm back up to 75 before the system cycles a single time at the higher rate**. Our local utility recommends a **2 degree drop for 2hrs prior to the TOU rate hike**. They arrived at these numbers from last summers "smart study" where they installed energy monitoring equipment in volunteers homes to see what works and what doesn't. Our schedule is somewhat unpredictable so the thermostat is difficult to program for occupied/unoccupied periods. Our utility is much more involved with conservation/TOU/VPP plans than most because they are trying to delay the construction of another power plant. So for them it's more about the investors bottom line than just getting government subsidy money. (https://www.energyvanguard.com/blog/50152/If-You-Think-Thermostat-Setbacks-Don-t-Save-Energy-You-re-Wrong*)

22. **Standard mass wall doesn't match Proposed**. RES ACM translates Proposed **exterior** insulation on mass wall into **interior** R13 wood furring on 6" conc. Note that Exterior and Interior insulation have different Prescriptive requirements, and the Standard is holding the Proposed to an incorrect higher standard. Please correct the Standard insulation placement and R-value to match the Proposed wall type. Prescriptive Table says the Prescriptive mass wall with exterior insulation is R8 exterior insulation, not R13 interior insulation. Thus in Performance compliance, the Proposed wall is compared to a standard higher than the Prescriptive requirement.
23. **Mix of wall types, mapping to Standard**. What if the house is a mixture of wall assemblies, does each get mapped to the correct prescriptive U-value etc? Or is one assembly type chosen arbitrarily, and applied to every Standard wall? Does CBECC-RES compare a Proposed mass wall to a Standard **wood frame** wall, or properly compare to Standard **mass** as in the prescriptive envelope Table?
    - If I have a mix of assemblies on the Proposed design, each with a different Prescriptive U-value, then each should be compared to this Prescriptive value in the Standard design (e.g. mass wall to mass, frame wall to frame: apples to apples). However, Standard design appears to take one assembly arbitrarily and apply it to the entire building (e.g. all Standard walls become mass walls, even if the Proposed has a 50/50 mix of frame and mass walls). This creates a Standard area-weighted U-value that differs from what would be prescriptively required
24. **Battery storage**
    - Why is battery storage limited only to buildings that have PV? If the purpose

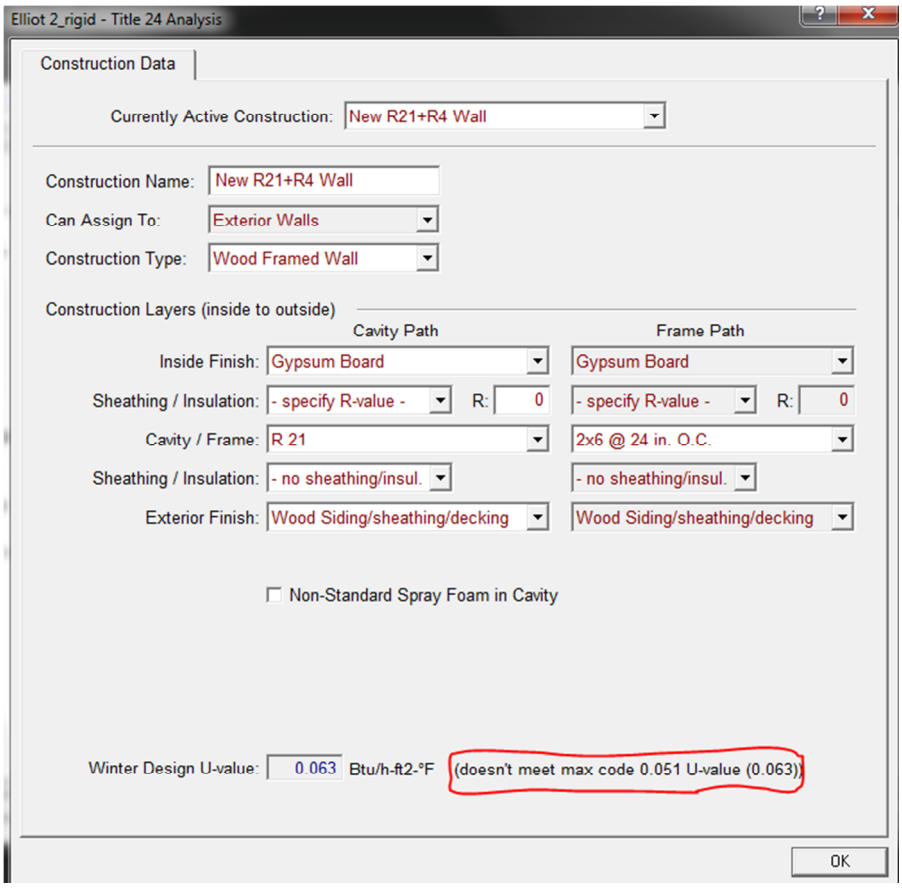
is to store the excess PV generation from midday on the grid, then this should be deemed a valuable grid service regardless of the PV generation capacity installed behind the meter. Energy storage should be available as a credit regardless of presence of solar PV. But not at the expense of compromising the envelope

- **Limited to only chemical batteries?** Why not thermal storage in DHW or building structure (preheat/precool)? Surely all three of these rely on occupant behavior to run it properly. The latter two methods appear far more cost-effective. How did chemical batteries sneak past the cost effectiveness sniff test? How did a user-operated feature become a compliance credit? Similar to whole-house fan, which might or might not be operated
- **Chemical battery failure, improper operation, abandonment, re-sale;** yet the building passed the Energy Code being carried by the battery storage credit; envelope probably does not meet Prescriptive code
- **Battery storage should also encompass thermal storage** in CBECC-RES buildings. It feels like the ACM is picking technology darlings instead of enabling the public to innovate to a given performance criteria. e.g. residential hot water or chilled water storage in lieu of chemical batteries; what happened to the Ice Bear AC unit? Other types of energy storage should be enabled in the software, to create a market, encourage commercialization of these systems; as with chemical batteries

25. **Enable air leakage testing for multifamily Low Rise Res**. It makes no sense that I can do leakage testing credit for two units (=duplex, two energy models), but not for three (=multifamily, one energy model). Equipment exists, procedures exist? The work would be even more cost effective due to fewer mobilizations per dwelling unit, and sampling. Use sampling protocol that we already have in RESNET. Air leakage testing by HERS is already REQUIRED in some instances for High Rise Res. Let's align the policy here.
26. **Cannot model conditioned crawlspace**. If this doesn't work in the software, how about a note like "Conditioned Crawlspace – not implemented" in the UI (not an error message at runtime). Then, need to publish an explicit workaround in Compliance Manual. Such as: *Model the crawlspace as a conditioned Zone, not a "crawlspace." Model the earth+vapor barrier "floor" as a slab-on-grade.* Etc.



27. **U-value Interface is misleading**. Fixed Already? Thanks for reporting the U-value of the total assembly, very helpful. However, the flag "doesn't meet max code" is misleading, it should say "doesn't meet Prescriptive code." The mandatory minimum or "max. code" is an even higher U-value. See screen capture below:



28. **EnergyPro blocks the creation of the CBECC-RES .ribdx file**; perhaps also the .cibdx file. A project running in EnergyPro would previously generate these files for user QA and troubleshooting, but no longer. This should be prohibited by the CEC; it's supposed to be an open platform. It appears they have hidden the .ribdx file on the low rise res side so that the Epro $7 fee is the only pathway to creating a certified XML file

for upload to the HERS registry. We've stopped using Epro because of this.

29. **Interoperability with Openstudio and the EnergyPlus universe**. Allow CBECC-RES to import the SDD XML file that is generated by the Sketchup Openstudio plugin (the same file imported by CBECC-COM). Align the XML grammar used by CBECC-RES and COM into a common grammar. This will accelerate modeling, provide better QA opportunities, and better visual communication among designers.
30. **Each dwelling unit with a unique HVAC system type must be modeled as an independent zone**. This creates modeling problems because we do a feasibility model for code compliance using one system type across an entire multifamily building. If the mech engineer changes two dwelling units in a bank of 8 dwelling units into ducted systems from unducted, then we need to rebuild the model to break these out into their own thermal Zone.

B. Materials & Assemblies Library

1. **Need to have Cross Laminated Timber** CLT in library of materials. I'm using "Log 6in" for walls (not quite right) and there is no "Log" option for roofs. If I approximate the R-value, I don't have the right heat capacity. I end up using thin concrete walls & roof with exterior insulation to approximate the thermal properties of the CLT.
2. **Need to have COB** in the Reference Appendix and software library of materials. Cob is an earthen construction material with published values, which has construction codified in the forthcoming ICC.
3. **Two framing layers**. Need to be able to model two framing layers, for double-stud party walls and floors, and for exterior walls. If not possible, then we need explicit guidance in Compliance Manuals or software on how to approximate two framing layers. Looks like this was just added to CBECC-COM, but not yet in CBECC-RES?
4. **TJI roofs and floors**. Need TJI roofs and floors (framing factor etc.) in assemblies library. These have higher R-value (i.e. less thermal bridging) than solid-sawn, due to less thermal bridging through the web
5. **Mass on two sides**. Can't model wall with mass on two sides of insulation. Strawbale R30 with 2" clay plaster both sides. The real wall has 3x as much heat capacity as the JA4 strawbale.
6. **Massless materials**. Does CBECC-RES actually include the heat capacity of composite materials in the simulation, or are the composite materials incorrectly "massless" as in CBECC-COM? Please check that composite materials retain the heat capacity. It appears the heat capacity is dropped to zero for composite materials (RES and COM), which produces an incorrect simulation.
7. **Composite materials are “massless” when translated into EnergyPlus**. For a typical wood-framed Proposed apartment design, 4 stories of wood over concrete “podium” at Level 1, the entire residential portion becomes massless in EnergyPlus. Only the drywall is counted. (Think of how many tons of material the wood framing + insulation actually is.) Every wood assembly with cavity insulation is input as a composite material; composite materials get stripped of mass; the Eplus model has incorrect thermal response because it has no mass; furthermore it’s probable that un-modeled interior partitions and furnishings are not included for mass effects in the Eplus simulation. Therefore it’s probable that the Eplus model is constantly running heating or cooling because it has no thermal lag (building heat capacity). I haven’t studied the outputs in detail but this is a serious vulnerability and compromises the model’s predictive (= policy) value.

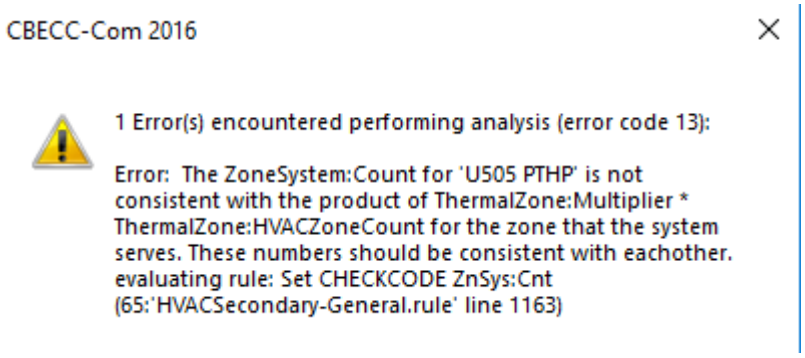
C. ACM Non-Res & High-Rise-Res CBECC-COM

1. **Service DHW circulation loop & pump energy are omitted from NonRes compliance**, but the same circulation system plays a heavy hand in HighRiseRes compliance. Include service DHW circulation loop in NonRes compliance. See also water heater fuel-type issue.
2. **Standard (service) water heating is always a gas heater, when Prescriptive code is fuel-neutral?** This is wrong. This seems like a freebie to the gas industry. Change ACM so that Standard DHW fuel type = Proposed, same as Prescriptive Standards
3. **PTAC and PTHP have different fed standards than split HVAC**. See discussion at CBECC-RES, same issue
4. **Prescriptive requirement for Air Barrier** for non-res buildings in CZ 10-16 cannot be traded in the Performance method because "air barrier" does not appear in the non-res ACM. See comments on Standards below; please resolve redundancy and overlap with Mandatory air barrier requirement set forth in 110.7; if Air Barrier is Prescriptive it should be tradable in Performance calc.
5. **Enable QII credit for High Rise Res**. If QII is cost effective for Low Rise Res, it will be even more cost effective when applied with sampling to High Rise Res.
6. **Enable Air Leakage credit for High Rise Res**. Same arguments as pertain to QII. See also Compartmentalization discussion. It appears that HERS air leakage testing is required for some ventilation system types in high rise res. At the very least, we need leakage inputs in the user interface for HRR.
7. **QII and exterior rigid insulation**, for ACM: If Proposed design has an assembly with exterior rigid insulation and no cavity insulation, what effect does the "QII" toggle have in the performance simulation? Currently the exterior CI is already given full credit for its R-value, unlike cavity insulation, which is de-rated without QII? What if I have mass walls with exterior rigid insulation, and no cavity insulation, what is the effect of "QII" toggle?
8. **Corridors should not have occupants assigned in ACM, because these spaces have no occupant load in the Building Code**. Corridors exist so that occupants in other spaces may egress; the occupants are either in the other spaces, or the corridor, but not both. The ACM assigns occupants to both spaces, which is incorrect. This is true for many other space types as well, including parking garages, the ACM gives them an occupant load and a ventilation requirement. Standards 120.1(a)1 says that **spaces not normally used for human occupancy do not require ventilation**. “Not normally used for human occupancy” includes corridors, restrooms, garages, storage, etc. Please align the ACM to the Standards and the building code. This drives a domestic water heating load in the corridors?.
9. **Why do unoccupied spaces need to be assigned a water heating system?** In a commercial building, aren’t we double-counting the DHW demand if we count the

occupants both in the office and in the corridors?

10. **The terms "Conditioned" and "Unconditioned" and "Indirectly Conditioned"** used in CBECC-COM do not agree with the definitions of these terms in the Standards. For example, unheated and uncooled interior corridors in a High Rise Res building. Per Standards, they are within the thermal boundary of the building, but if they have no thermal control equipment, they are "indirectly conditioned."
    - In CBECC-COM, if we call these "conditioned," then the Standard Design applies a heating/cooling system and tries to meet loads. We get unmet hours for the Proposed, and an unfair compliance advantage.
    - The Proposed corridors are ventilated with a supply and return fan to meet code. If we call them "indirectly conditioned" then we can't run ventilation or the model freaks out and creates an error.
    - If we apply the definition of "unconditioned," <10 BTU/hr.sf heating or <5 BTU/hr.sf cooling, then we can call these corridors "unconditioned" in CBECC-COM, but then CBECC-COM thinks that corridor lighting is in unconditioned space, not tradeable, and it treats the interior corridor walls as demising walls (separating conditioned and unconditioned space, requiring insulation). Adjacent surfaces are not demising surfaces, any more than the walls of a broom closet that separate it from the room are demising surfaces.
    - Please adjust definitions in CBECC to correspond to Standards. We need to input many space types as "indirectly conditioned," with (perhaps) ventilation equipment but no thermal conditioning, completely within the thermal boundary of the building, using tradable lighting.
11. **Skylight area in residential, divergent policy paths**. High Rise Res, Standard matches Proposed skylight area, up to 5% skylight to roof area ratio? In Low Rise Res, all skylights are penalties because they are compared to Standard opaque roof. A 3-story res building takes a penalty, but a 4-story res building gets a pass?
12. **Relocatable classroom modeling burden, consistency of rotations**. Why does a relocatable classroom (multiple orientations) require 8 rotations (45º each), while a dwelling unit (multiple orientations) only requires 4 rotations? It's a lot of work to manually do 3 climate zones x 8 model runs for a relocatable classroom, and the time spent is in excess of the computational time because the modeler will start to multitask due to the simulation delay. Suggest requiring only 4 rotations for relocatable classroom, or make houses 8 rotations: at least be consistent. CBECC-RES has batch processing and automates the 4 model runs; CBECC-COM has neither?
13. **CBECC-COM zone multipliers vs. HVAC multipliers**. Need ability to have one zone served by multiplied HVAC units. Similar to how we input lighting. Example, I have a single-orientation bank of apartments, say 10 dwelling units with identical exposure, I make them one thermal zone. My Proposed HVAC is 10x package terminal HP units. **If I gang these together into one dummy unit with 10x capacity, then the dummy unit can often be subject to different Standards than each real unit individually (e.g. efficiency criteria, economizer).** I can’t input 10 individual zonal systems serving one thermal zone. I can’t model 10

thermal zones because this is time- and computationally intensive for no benefit. I can't use a zone multiplier because the façade has variation and each unit has different windows, bays, corners, especially end units. Preferred behavior: one thermal zone, 10x identical PTHP units, input as one zonal system with 10x multiplier.



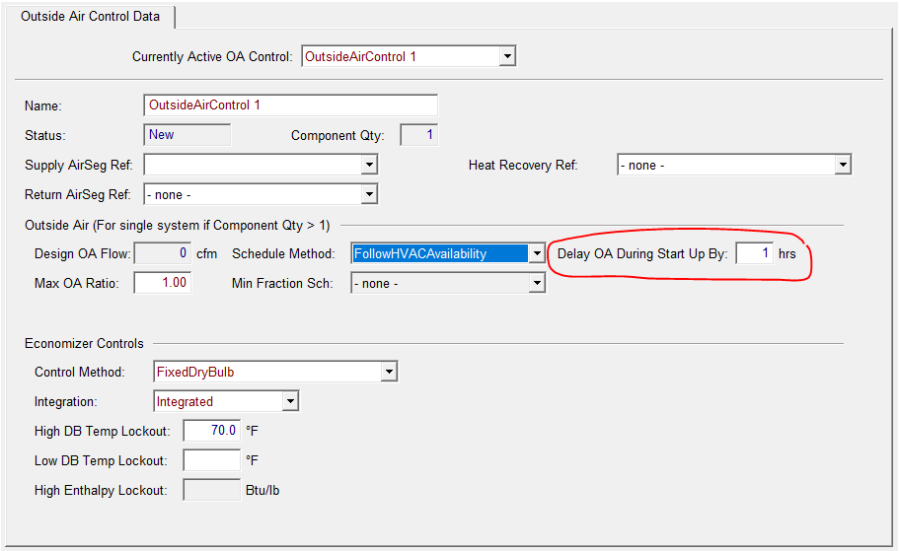
14. **The Rated EER and COP of PTACs, PTHPs, and mini-split heat pumps already include the fan energy, yet fan energy must be input separately as a Supply Fan in a Zonal System**. Energy modeler needs to do a separate calculation to remove the fan energy from the rated efficiency numbers, in order to input the fan and compressor separately.
    - Not an issue in CBECC-RES (low rise res) where interface allows a heat pump with no Fan and no Distribution.
    - For many unitary and split HVAC units, the fan power is already included in the EER and HSPF/COP figures from the manufacturer. These devices are typically ductless, and have no total static pressure or fan horsepower. In this case, would the user input zero fan power?

15. **Standard design High Rise Res, for outside air ventilation** meeting XX code section, runs a continuous exhaust fan with a passive inlet. This is not allowed in the code, which requires that outside air testing (per XX) be performed at the inlet, not the exhaust fan; only a hermetically sealed dwelling unit would pass; therefore a supply fan is required to meet ventilation; the Standard design needs to be a supply fan of *n* Watts/CFM, running 24/7, similar to how CBECC-RES handles IAQ ventilation.

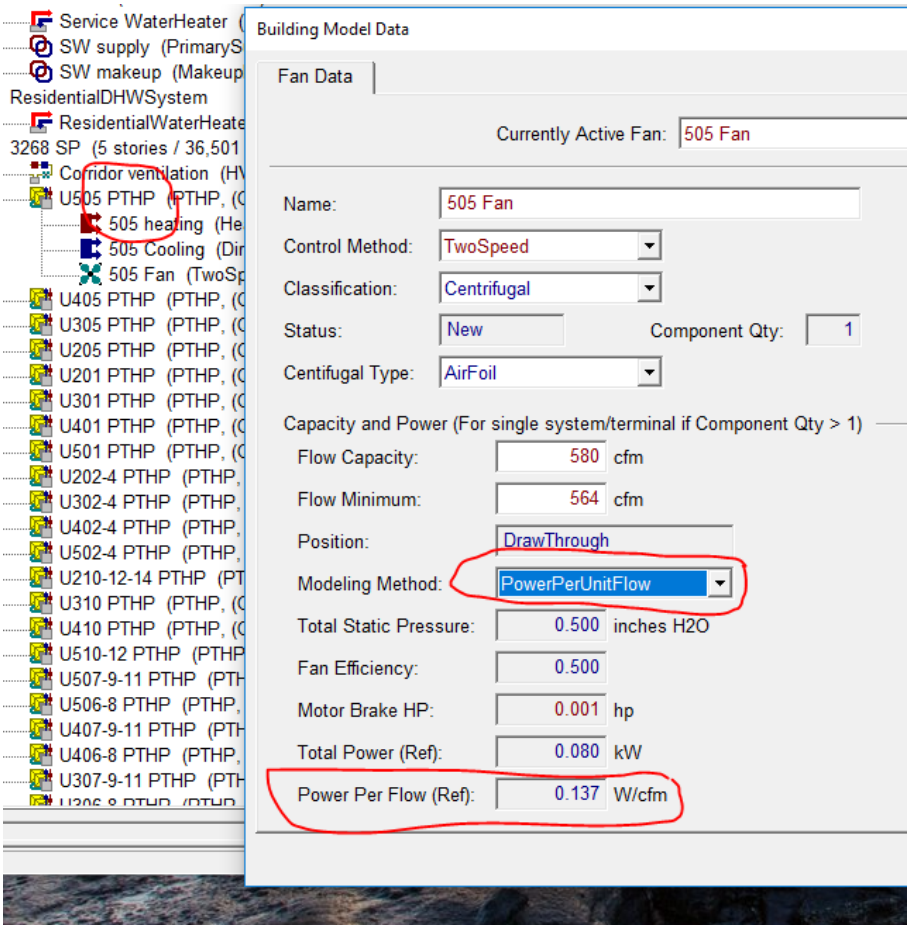
16. **2019 ACM for High Rise Res should have reduced infiltration to match the required HERS leakage/compartmentalization test**, if the Proposed or Standard outside air system is not balanced ventilation. In 2016, the Standard High Rise Res outside air system is an exhaust fan with passive inlet. To be true to reality, this system needs to run >X CFM at the exhaust fan in order to pull a field-verifiable X CFM through the passive inlet, with an acceptably unclogged inlet filter condition (assuming we have unintentional makeup "fresh" airflow backwards through the range hood, dryer vent, and residual leaks to other units). The dwelling units also need the reduced infiltration that would be created by the required compartmentalization test.

17. **Can't model a fan-only operation used for ventilation by a fan coil or PTAC in an apartment?** The proposed fan runs 24/7 to induce outside air. This applies to ducted split DX system, ducted 4-pipe fan coil, and PTAC that draw outside air into the return plenum passively by negative pressure. Designer needs to specify minimum flow rate, say 270 CFM, to induce fractional outside air of, say, 65 CFM, into the return plenum by negative pressure. Using fan watt draw of, say 0.58 W/CFM for the supply fan. Compared to 0.58 W/CFM watt draw of the Standard Design exhaust fan + passive inlet system, which only runs at the Prescribed 65 CFM minimum ventilation flow rate, in this example. The Proposed design, if able to be input correctly, uses 4x the fan energy. (2019 disallows a continuously running fan coil.) [note this is prohibited in 2019 Standards, but used extensively by engineers for High Rise Res under 2016 code].
18. **Penalty for non-interlocked windows** – already removed for HRR? Absurd.
    - This penalty says that **occupants will leave windows open**, therefore we will simulate *infiltration in excess of the outside air requirement* as a penalty on the HVAC system.
    - However, in the amendments to ASHRAE 62.2, the code authors say **occupants will leave windows closed,** therefore we cannot rely on window operation as a means of providing outside air, therefore we must seal the apartment and blower door test, then run a continuous exhaust fan on the sealed apartment, in order to provide outside air.
    - The code and ACM can't have it both ways.
19. **Please explain the "Delay OA During Start Up By 1 hr" check** box in the CBECC-COM interface. The code §120.1(c)2 requires a pre-occupancy purge, providing AT LEAST 1 hour of OA before scheduled building occupancy. Is there a conflict here?

    *§120.1(c)2 Pre-occupancy. The lesser of the minimum rate of outdoor air required by Section 120.1(b)2 or three complete air changes **shall be supplied to the entire building during the 1-hour period immediately before the building is normally occupied**.*



20. **PTHP/PTAC unitary heater/AC shall be input as a Power-Per-Unit device (W/CFM)** (According to 2016 ACM) but this appears to be disallowed by the software. This device does not have ducts; it does not have a total static pressure or fan horsepower. **The fan power is already included in the EER and HSPF/COP figures from the manufacturer.**



21. **Standard design walls in ACM are always metal framed, regardless of Proposed design**. (5.5.4 Exterior Wall Type) Metal framed Prescriptive is U-0.069, while wood framed Prescriptive is U-0.059 (Table 140.3-C), about 15% better. If the Proposed wood-framed walls were properly compared to a wood-framed Standard meeting the wood-framed Prescriptive U-value, then many of our clients would need to improve their wall assemblies to meet the Prescriptive requirement, which is in everyone's best interests. **They've been getting away with not meeting the Energy Code for wood-frame walls because of this ACM error.** A wood-framed, 4+ story midrise apartment building is getting a free pass on a crappy Proposed wall U-value that doesn't meet Prescriptive code, because it's compared to a Standard that is 15% worse than the Prescriptive requirement imposed for wood-framed walls. This means High Rise Res wood-framed walls that do not meet the Prescriptive requirement are getting about a 15% credit in ACM.
22. **Couldn't you take compliance credit for long-time-constant shell** (*Passivhaus*)

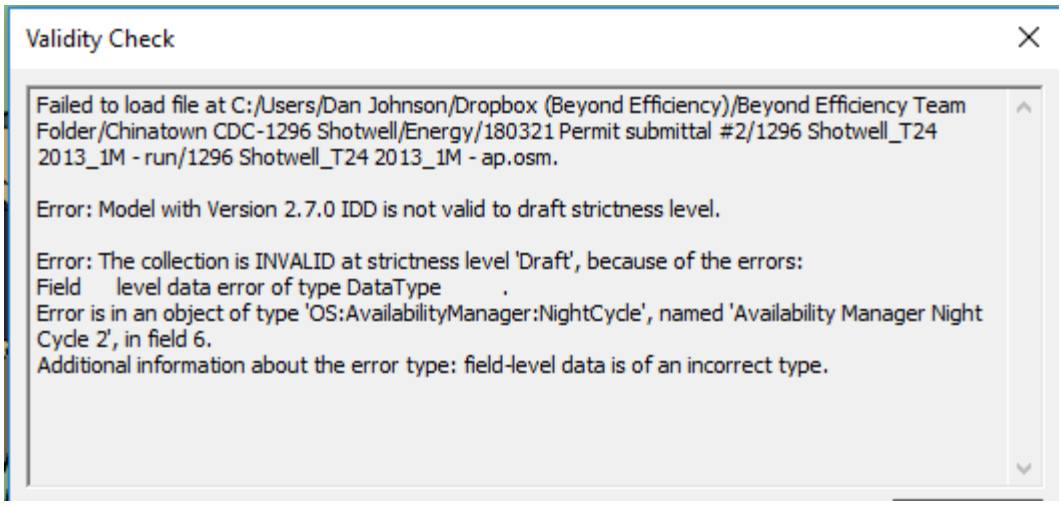
using existing ACM framework? the envelope model is there, but:

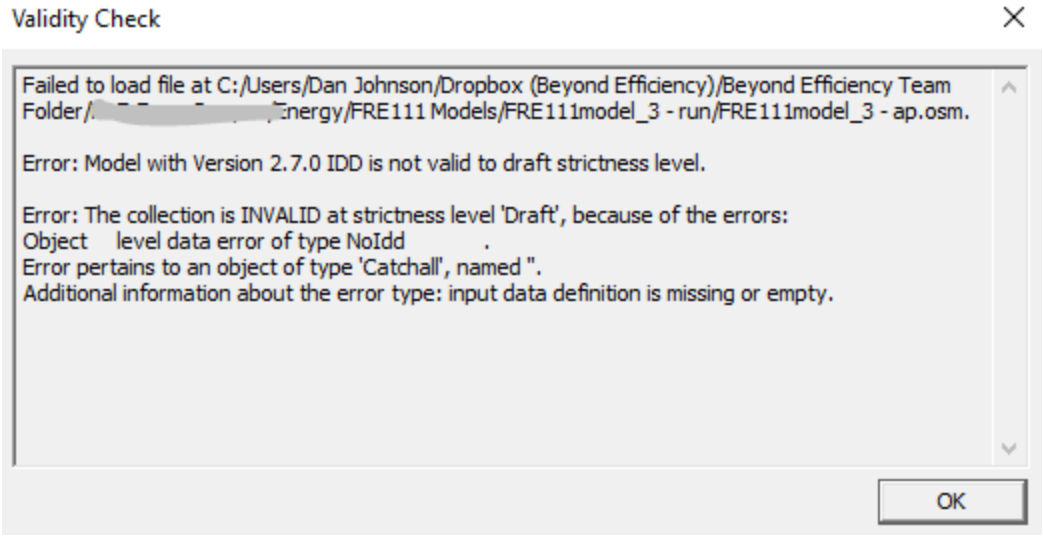
- There's no means to preheat or precool in the simulation (except limited night vent cooling – which results in increased heating energy and worse performance overall in most of our models CZ3 and CZ12)
- T-stat settings may be inappropriate for efficient buildings?
- Interior thermal mass is not accurate?

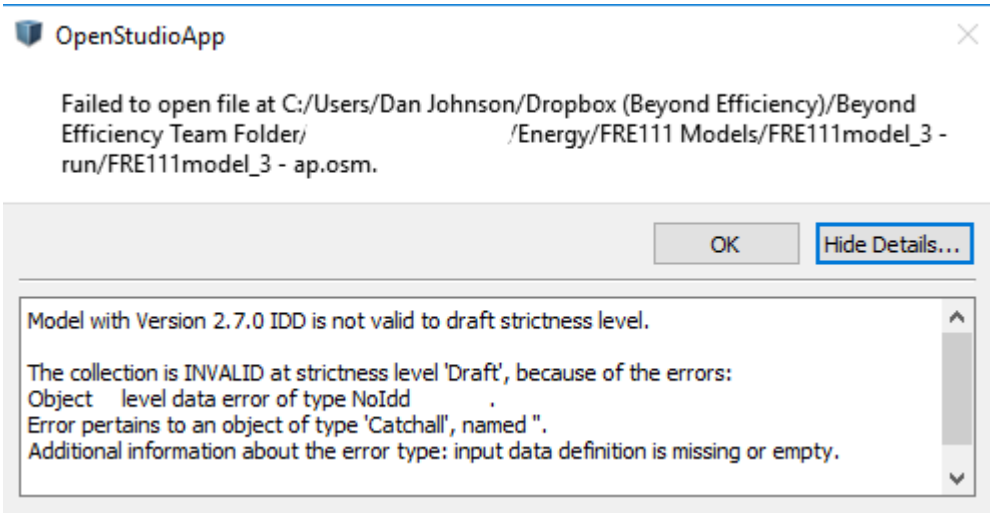
23. **There appears to be no daylighting compliance credit possible**. **Is this the intention?** I can cut my lighting energy in half by good daylighting design, but because the Standard gets the same benefit, I show no compliance improvement? If I put a discretionary skylight or window in my Proposed design, this creates a Primary and Secondary Daylit Zone, for which daylight dimming is Mandatory or Prescriptive, respectively; the Standard model will add the same skylight or window and match any reduction in lighting energy that I achieved in my Proposed. If I can't show savings in TDV for my daylighting improvement, then I can't sell the additional daylight EEM to the owner or incentive funder.
24. **Many of the Eplus capabilities are locked out**, not exposed in CBECC-Com. And much of the CBECC interface is not exposed in EnergyPro. EnergyPro is not exposing the CBECC-COM or RES complete interface for the user; probably in an effort to do the minimally compliant recoding of their own interface. We still can't do radiant floors, etc. Why the move to Eplus, if it has not added any new capability for system types...
25. **Slab on grade heat transfer model is not accurate.** [Explain why, what to do about it.] Does it use F-factor or UAdT? F-factor method is not great, but it's consistent with industry. Should use the F-factor method. Should use direct outdoor temperature, not the incorrect ground temp monthly schedule.
26. **We don't need a more precise algorithm** (EPlus) because this is not the limiting factor in achieving better buildings on the ground, when the **input defaults are so far off** (e.g. domestic hot water in non-res buildings), and **some systems are not even modeled as designed** (e.g. hot water distribution losses do not become zonal gains).

    - A perfectly accurate (=predictive) model is still not the limiting factor for achieving building performance; we have non-compliance issues with mandatory measures during construction (e.g. pipe insulation, oversizing, building leakage, outdoor air), could have spent Eplus money (the investment in aspirational modeling accuracy) on code enforcement and saved more kWh & therms.
    - Just get Home Depot to carry 1" pipe insulation rather than 1/2", and we will have saved more carbon and energy than the entire move to EnergyPlus?

27. **In HRR & Offices, everything is about fan energy. Good fans can make any design comply. Is this realistic or intentional?**
28. **CBECC-COM generates a defective OSM file.** Can't open the OSM file generated by CBECC-COM. Not in the current OpenStudio version 2.7.0, not even in the native version 1.11.3. CBECC-COM generates a defective OSM file. Examples below. **A major piece of functionality and interoperability is broken**, not good! Please fix ASAP.

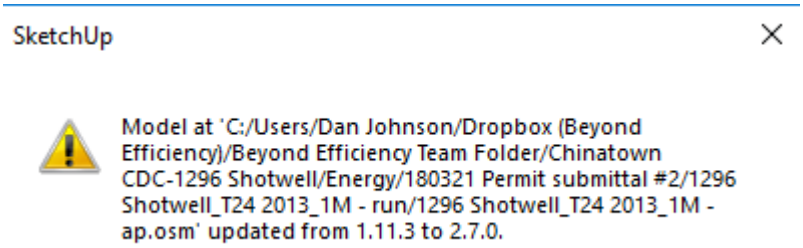






29. **Neither can the IDF file be imported into or opened in OpenStudio**, for same translation errors “INVALID at strictness level ‘Draft’, because of the errors…”

30. **CBECC-COM generates OSM files in version 1.11.3**, which is quite outdated; the current version is 2.7.0+. When opening in OSM or Sketchup, the software must update the CBECC-COM-generated file to user-installed version. Any plans to generate OSM files in the current version? Or, are we keeping the old version for backward compatibility?



31. This means we need to have two versions of Sketchup and Openstudio installed in the office. One that has current functionality, for creating models (SKP 2017 and OSM 2.7.0), and one that is still able to open and import the IDF files from the old formats generated by CBECC-COM (SKP 2016 and OSM 1.11.3).

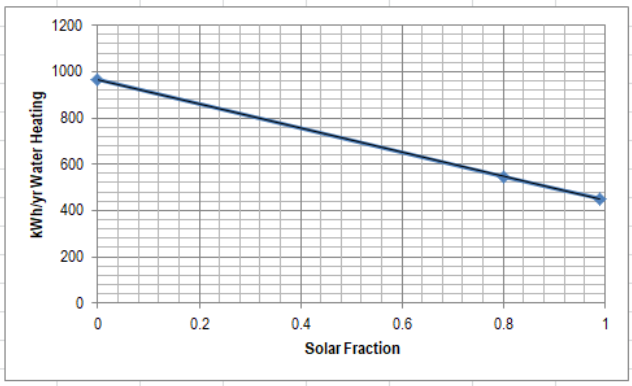
D. California Residential Water Heating engine

1. **Circulation system and tank losses are not coupled to the building's thermal balance (in NonRes ACM).** The 40% waste in multifamily circulation needs to appear as a heat gain, so that designers can improve this system and see the compliance credit.
2. **We need ability to input actual Proposed recirculation controls.** If we can't show savings from Proposed controls, then we can't sell a better system to the owner. For central system, need ability to model actual proposed recirc controls, e.g. *Caleffi 116 thermostatic balancing valves with a pressure-regulated, variable-speed circulator*. There is usually more energy and TDV "in play" in central water heating than in envelope measures for multifamily, yet user ability to model the Proposed design is mostly locked out. Tremendous ability to input actual HVAC and envelope, but **next to no ability to input actual DHW circulation system and controls**.
3. **No ability to input actual piping configuration.** Assumptions listed below are built into the ACM, providing designer **no ability to take credit for energy conserving designs**, therefore no way to sell these designs on projects driven by compliance margin (= Affordable Multifamily using CTCAC funding). From Res Compliance Manual, 5.4.2.1,

   > *With the new prescriptive solar water heating requirement this cycle, it is especially important to consider the integration between the hot water recirculation system and the solar water heating system. Based on feedback from industry stakeholders, most solar water heating systems are configured only as a preheater of the primary gas water heating equipment. In other words**, recirculation hot water returns <u>are usually</u> plumbed back to the gas water heating storage tanks, not directly into the solar tank**. This means recirculation loop designs should be based mostly on the building layout and are relatively independent of the solar water heating system. On the other hand, gas water heating equipment and solar tanks should be located close to each other to avoid heat loss from pipes connecting the two systems. The preferred configuration is to place both the gas water heating equipment and solar tanks on the top floor near the solar collector so that the total system pipe length can be reduced. As noted before, minimizing pipe length helps reduce domestic hot water system energy use as well as system plumbing cost.*

   - The text quoted above results in a user-input 100% Solar Savings Fraction reducing the DHW system fuel gas consumption by only 60%. The chart below shows that nearly half of the heating power is still available for conservation, after 100% SSF has been applied.

Solar Fraction	kWh/yr
0.99	452
0.8	547
0	966



- If 40% of the system's fuel burn is wasted in the piping system, **please expose this system in CBECC to engineers' efforts to improve it**.

4. **Central Multifamily Recirc. Control choices:** There are no control options in there representing what people actually build. Nobody understands the prescriptive control options
   a. Almost everybody builds Aquastat control, but this is not a control option in the ACM. **At least put the Aquastat option into the software for comparison.** Aquastat control means that the recirc pump runs whenever temperature in the pipe at the sensor location falls below a setpoint, with auto-off when setpoint is attained. This is an intermittent pump. Increasing pipe insulation would reduce its run time, and also reduce heat gain to the spaces. None of this can be modeled.
   b. Education: Reference Appendix is the only description of control types; it doesn't include aquastat description for comparison, this would help with education
   c. Some HERS Raters consider aquastat to be a type of "on-demand" and qualify it as such, giving these buildings a huge free pass on compliance.
   d. Nobody has ever done "temp modulation" or "time & temperature…with monitoring". Our plumbing engineers and plumbing tradespeople have never heard of this. Can the CEC point to more than one building in the state that has this control system? How did this get to be a compliance option?
5. **"On-demand" using a flow switch** and auto-off thermosensor
   a. is not done, because of owner concerns about wait times for people (4am showers) after a long period of no draws.
   b. ACM gives a flat 80% reduction in pump energy for "on-demand" regardless of number of units in the building and diversity of draws, or actual piping layout? A similarly intermittent aquastat-controlled pump is defined to use 5x more pump energy, seriously? The aquastat would have more run time overnight, when there are no draws, but pipes go cold with typical periodicity; **the overnight run is not enough to generate the 5x pump energy.** This is broken.
   c. To make "on-demand" a more common practice, try an incentive around

on-demand, rather than the ACM bludgeon

d. Enforcement/Education: **HERS Raters think an aquastat is "demand-control".** Modelers, TRC, et al., don't know what demand-control means; in our experience, modelers choose this option in the software in order to pass. HERS Rater "verifies" it in the field.

6. **Changes in algorithm at software update mid code cycle**, made compliance unpredictable.
    a. very different between 2016.2.1 and 2016.3.0 SP? We could previously pass on water heating with condensing boiler, 25% less fuel burn than Standard 80% boiler = Prescriptive solar thermal 20%. Now the algorithm is different and hard to make Proposed water heating even match the Standard, inputting the prescriptive water heating.
    b. **Seems wrong that "Demand control" and solar fraction** are equivalent in code compliance. High eff boiler vs. standard is not able to overcome the difference between continous recirc. pumping vs. on-demand pumping
7. **Education issue, not ACM: Sensitivity to recirc. pump power**, but ACM doesn't describe the Standard recirc pump power. It appears to match the Proposed. Standard pump runs at 20% the time vs. Proposed, on demand-control. 0.2 x 20W = 16W difference vs. 0.2 x 200W = 160W difference. Pump right-sizing is removed as a compliance variable, except for the 5x penalty for aquastat control vs. the unicorn "on-demand".
8. **Pump power input:** just input HP, not (BHP x efficiency), because the latter data is not published by manufacturer. If the modeler is supposed to look up typical ASHRAE 90.1-compliant motor efficiency and input this as a fictional guess, then the software should just do the work for you.
9. **2 loops vs. 1 loop is broken**; 2 loops is higher energy consumption, put in 1 loop to get credit. Documentation says that Standard uses 2 loops. Education: it's hard to find a diagram of this anywhere, for engineering reference
10. **Should be able to accurately model the topology of the Proposed recirc**. **system.** Losses are UAdT; software needs to know "A"…Not an issue with duct systems, and hydronic piping, ignore losses? assume losses contribute to cooling or heating?
11. **Heat pump water heater on central DHW loop.** Need ability to model this in both Res and NonRes ACMs
12. **Solar thermal average annual SSF and electric penalty**. The Res and Com ACM's do not use an hourly model for solar-thermal, so there is a big TDV penalty to solar thermal systems that use electric backup heat. Getting penalized for electric backup on solar thermal because average annual SSF is used in the ACM. Every draw is discounted by the annual average SSF. In the actual building we have >100% SSF in summer hours with expensive electric TDV. ACM applies the "annual average" SSF to every hour of the year. Expensive TDV hours should have 100% SSF. But these are incorrectly assigned the annual average SSF, so

there is still an electric water heating load that gets penalized in the TDV. In other words, the calculation engine just multiplies, say, 0.40 savings fraction by the backup water heating energy for every single hour of the year, instead of multiplying 0.0 during the highest TDV summer hours and 1.0 during dark winter hours (proportional to solar gain).

- This simplification may not matter when using gas backup fuel that has a fairly constant TDV multiplier. However, now that the electric TDV has shifted later in the day and become a worse penalty, we're seeing that a heat-pump water heater with 50% solar savings fraction may still have higher TDV than the Standard gas. This is so fundamentally wrong, and part of the reason is the incorrect averaging of solar thermal, which destroys all the TDV benefit. This applies as well to big multifamily projects. Imagine the missed opportunity for heat-pump central water heating with high SSF, and perhaps all gas service to the building could be removed in some scenarios.
- It would be great to get an hourly solar-thermal model built into the two ACM's for the 2019 code, the way hourly PV has been added to the Res ACM for 2016. Just scale the annual SSF by the PV hourly numbers, to get an hourly SSF.

13. **Why are we fussing the recirculation pump on residential domestic hot water (Cal. Res. Water Heating Engine), and hydronic HVAC pumping, but ignoring recirculation completely on non-residential service water heating systems?** Take an example classroom building, 8 classrooms, two stories, over-sized circulation loop to hit bathrooms spread in the building*, and circulation pump with no controls specified. This system has a waste factor of nearly 50% of the actual useful output, let’s say 1.5 MWh/yr in pipe heat loss & circulation pump. Equivalent to pumping losses in other HVAC fluid systems in the compliance model. Not modeled at all in CBECC-COM, therefore I can’t get a better compliance score by designing it right. Therefore I can’t sell a better service water heating system to a design team that won’t budge unless they see a compliance carrot or stick. [*Plumbing Code requires *Hot Water* to all lavatories, though they probably don’t need it. 80°F would be fine for handwashing, and this temp is below the *Legionella* growth range.]

E. Standards bugs and un-coordinated items

1. **Provide alternative compliance to Solar Thermal requirement** for central multifamily hot water; ST is too fragile, not maintained, field experience shows many/most systems are not working. Very expensive in urban areas under current prices.
    - Allow a solar PV credit for multifamily instead.
    - Heat pump water heaters (HPWH) with solar PV on the roof may function similarly to solar thermal;
    - the HPWH is recovering from morning draws throughout the midday solar window.
2. **Verification of existing features**. Let a licensed architect do the verification of existing features, formerly a HERS verification. This fits with typical process, where HERS is not hired until after plan check, but Architect inspects the house prior to design and selection of energy efficiency measures (EEMs). Architect is already licensed and carries liability and culpability; furthermore, Architect signs "under penalty of perjury" that the Title 24.6 compliance forms are accurate. Does this count for nothing. If she can't tell difference between 2x4, 2x6 and R19 batt etc when verifying existing features, or is willing to lie about it, then we are really in big trouble. If we have given up on architects' ability to discern anything useful, or act with integrity, then let's make this explicit and give their professional organization a chance to respond.
3. **Air leakage testing credit for multifamily**. If I have 2 dwelling units (duplex), I can take compliance credit for air leakage testing. If I add a third, attached dwelling unit, then I cannot? It remains the same building. I need to send the HERS rater to verify IAQ fans for 3 units, but I can't take compliance credit for air leakage testing? If I go to four stories, then I am required to do air leakage testing (compartmentalization) in 2019 code. **We are going in three different policy directions here.** Make air leakage testing prescriptive/mandatory where it needs to be, and a compliance credit where it is not already prescriptive or mandatory, for all building types. High rise res, low rise res, non res. Start by at least harmonizing all dwelling units, regardless of how many other units are in the building, and how tall it is. Match the low-rise-res HERS measures for <2 units.
    - One staff housing unit vs. 14 units ganged together. The 1 unit gets air leakage test credit. The 14-unit building has less heat loss per dwelling, but can't pass code, because no air leakage test credit is available.
4. **NonRes Air Barrier**. Please align across building types (low rise, high rise, non res). Furthermore, please remove the confusing redundancy between 110.7 and 140.3(a)9. The first section requires an air barrier on all buildings everywhere, by definition, and the second creates an overlay Prescriptive requirement for an air barrier for only non-res buildings in CZ 10-16. The latter sets quantitative performance criteria, which cannot be verified without quantitative field testing (blower door); yet no testing requirements are set forth. This Prescriptive

requirement cannot be traded in the Performance method because "air barrier" does not appear in the non-res ACM.

- Recommended: Provide air leakage Performance credit for all building types using blower door testing per national standards, as currently implemented in the Low Rise Res Standards, and Res ACM.
- Where a quantified air barrier is required in CZ10-16, require prescriptive field testing.
- Alternate: Remove the Prescriptive overlay in CZ10-16, including 140.3(a)9, since an Air Barrier is already mandatory for all buildings per 110.7.

5. **Pipe insulation, OMG**

    - **Plumbing code requires insulation on all hot water pipes** (CPC 609.11). **Energy code minimum thickness is 1".** Therefore 1" pipe insulation is required on all hot water pipes. Please refer to table below:

Requirements for Pipe Insulation Thickness, Fluid Temp. Range 105°F-140°F		
Pipe Nominal Size	**Insulation wall-thickness required**	**Governing Code**
0.50 in	1 in	Cal. Energy Code Table 120.3-A
0.75 in	1 in	Cal. Energy Code Table 120.3-A
1.00 in	1.5 in	Cal. Energy Code Table 120.3-A
1.50 in	1.5 in	Cal. Plumbing Code 609.11.2
2.00 in	2 in	Cal. Plumbing Code 609.11.2
>2 in	2 in	Cal. Plumbing Code 609.11.2

    - **Please review all materials and delete language "first 5 feet from the water heater,"** since this has been deprecated by the Plumbing Code.
    - **Pipe insulation**. NonRes Compliance Manual 4.7.1.7, Table 4-22, contradicts the Standards and applies two different requirements to 1" pipe. First column should read "less than 1" rather than "1 and less"
    - **Pipe insulation and QII.** 2016 150.0(j)2.Exc.4 lets builders get away with zero pipe insulation for pipes in interior walls if the building has QII. This conflicts with the 2016 Plumbing Code 609.11.1 which requires that all hot water pipes be insulated.
    - **Home Depot doesn't carry 1" pipe insulation**, nor does local lumberyard, though this is the minimum allowed in T24.6. Stores stock 1/2" and 3/4". Is there any legal use for these thicknesses? Why are they sold at all? I can only find 1" pipe insulation on the shelf locally if I buy colorful "Pool Noodle" kids toys and wrap the pipes with these. They are made by the same insulation company. They ship 1" Pool Noodles to Home Depot but not 1" pipe insulation.

6. **Passive inlets/infiltration for fresh air in High Rise Res.** 2019 [Express Terms] Ref Appendix NA.2.2.3 is ambiguous in the case of high-rise residential.

    - The language "inlet or outlet" would allow testing of an exhaust-fan-and-passive-inlet system at the exhaust fan (the outlet), rather than at the passive inlet (the inlet), although the passive inlet is the only source of outside air.
    - It appears that "inlet or outlet" language was written to allow an outside air system to be tested at the outlet of a supply fan. However, this could be misconstrued to be tested at the inlet of an exhaust fan (which is the outlet of the outdoor air system---where the air goes out), rather than at the source of outside air.
    - It seems in nearly every case, an outside air system should be tested at point where the outside air enters the building. In this choice of language, a loophole was created intentionally or unintentionally.
    - As worded, the section could be taken to mean that with a passive-inlet system, I could show a sufficient airflow taken at the exhaust fan (the outlet of the system---where the air goes out---but the inlet of the exhaust fan), but zero outside airflow entering a passive inlet, and this would pass the test.
    - Please add the clarifying language to NA.2.2.3 that was so helpfully issued in the CEC's 6/22/15 "Letter to Building Industry":

        Where a non-residential, high-rise residential, or hotel/motel building contains a mechanical ventilation system comprised of an exhaust fan and inlet damper system, the acceptance tests for outside airflow measurements for the ventilation system ***are to be obtained at the location of the inlet. This is where the outside air enters the building space****. A measurement at any other location, including the exhaust fan, would not provide valid results because it would measure infiltration air from other parts of the building space as part of the total airflow measurement. It would not accurately measure outside airflow.*

    If the CEC is reversing course and builders do not need to demonstrate acceptable outside air flow through passive inlets, please make this clear.

7. **QII and exterior rigid insulation**:

    - For Standards: If the designers have elected the QII HERS test, and have no cavity insulation (only exterior rigid insul.), is there still an exception requiring no pipe insulation in walls? (2016 150.0(j)2.Exc.4)
    - For Res Appendix and NonRes Appendix: What are requirements for QII for exterior rigid insulation? How is it inspected, and what are installation criteria? Including walls that have no cavity insulation, only exterior rigid? (by design, or because they are solid mass)

8. **Both minimum and exceptional, but doesn't work for exceptional**. The function of Performance compliance is to allow tradeoffs, so that building components can be built below the Prescriptive Standards.

    - However, Performance compliance is commonly used to show %-better than

code, or EDR, **to demonstrate exceptional compliance** for incentive and funding programs, and for technology and policy development, and for future-code cost-effectiveness tests.

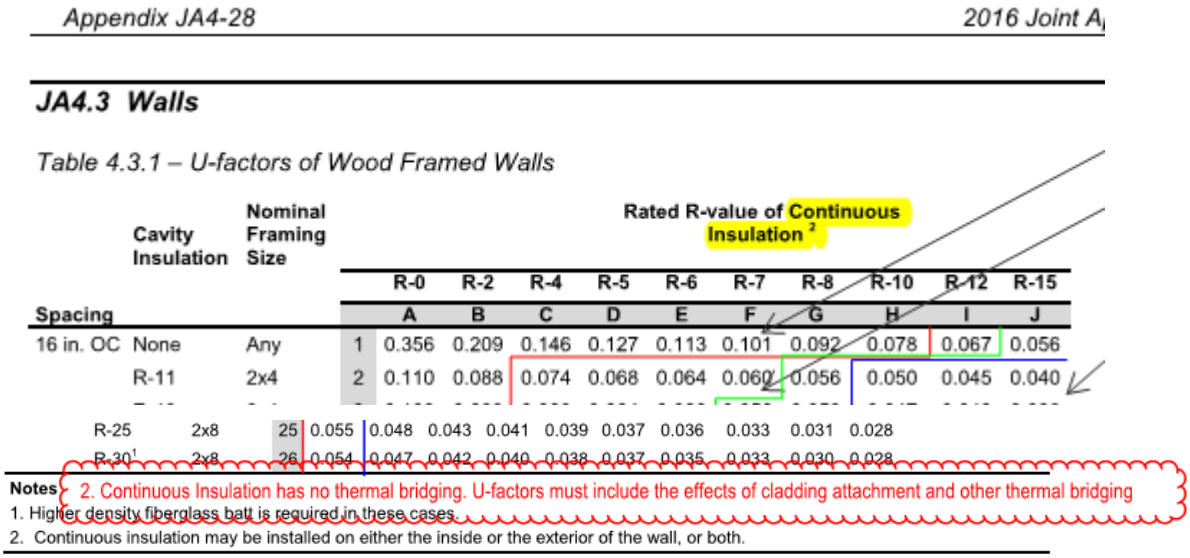
- Many features better-than-code can't be modeled in the ACMs. Basic modeling algorithms such as massless assemblies appear to be incorrect in the ACMs, creating false results.
- Both conditions appear to misdirect the future-looking and above-code work.

9. **Change outside air system language** (§120.1.(b)2.A.ii) near "central fan integrated" to more generically state "fan coil," in order to **capture PTAC & PTHP units and disallow continuous operation of the PTAC fan at low speed.** This is functionally equivalent to running central air handler 24/7 for outside air, with same energy penalties. However, this can be modeled in performance to tradeoff the energy penalty. It appears CEC doesn't want this to be tradeable, because it's prohibited outright by current Standards draft. Please include prohibition on running PTAC 24/7 for outside air, to be thorough.
10. **HEATED FLOOR definition** should include electric mats and hydronic tubing placed on top of slabs, but below finish flooring. Currently this appears to be excluded by the **"...within or under"** language. Once excluded from the definition of "heated floor," then no insulation is required. Unless it's CEC's intention to exclude heating elements placed on top of slabs. We have clients placing radiant heating on top of existing slabs, saying it's not a heated floor because the heating elements are not "within or under," therefore there is no insulation!
11. **Separate the building envelope and rate it alone**. No tradeoffs with machine efficiency. Machine lifetime is 10-20 years; envelope should be good for 80-100 yrs. A water heater is becoming more like a refrigerator. Just buy it, plug it in, it has a compressor, it uses 1500 kWh/yr. (This is less than cable box and garage refrigerator that are assumed in Low Rise ACM?) Similar with heating/cooling machines. If the envelope meets Standards, we don't need to worry about machine efficiency. Already covered by Fed energy standards. Doesn't need to be more complicated.
12. **Renumber the energy code consistently with other parts of Title 24** for clearer referencing. Each paragraph needs a complete number. I shouldn't need to page back 3-4 pages to find a section number indicating where I am in the code. If using a uniform number system would create numbers with too many decimals, e.g. 130.2.1.1.1.2.3.1, then the Energy Code sections are too deep and should be reorganized. Building Code goes about 1203.3.5.2.1 as the maximum decimal. Each paragraph begins with a number. There are no letters. (n)D.5.ii. You're kidding me. If we need to stick with the mixed "(n)D.5.ii" format, then the decimal needs to go at **the head of each and every paragraph**.
13. **Prescriptive envelope gives me loads that are not even considered conditioned space**. It doesn't make sense to discuss passing/not passing when Standard heating load is 15,000 BTH for an entire house (= 8 BTU/hr.sf, <10 BTU/hr.sf definition of CFA). I can't even buy heating equipment this small. And code wants to drive this down further with more insulating walls and windows?

Because we're comparing to a Standard that is relative to the Proposed, we lose sense of the absolute magnitude of the issue, chasing trivial energy savings because 10% of 15,000 is still a number. We're chasing the 10% without looking to see that this is only 1500, too small to chase, lost in the noise. Failing by 5% on the difference of 0.74 kWh/day. This is noise. Ironically, using the extra 0.74 is perfectly OK if I just double the size of the master bathroom, absorbing the 0.74 into more floor area.

- Designer provide: Thermal loads calculations, plus Proposed spec sheets for installed equipment <10 BTU/hr.sf heating and <5 BTU/hr.sf cooling should be enough to satisfy the energy code; no other compliance documents whatsoever; because the building is by definition "unconditioned space," which has no envelope requirements in the Standards.

14. Issue of 30-yr payback. *"We want the home to be an example of something that can last 100 or 200 years. Switch away from the model of 30 year housing and move to something that people can pass down through the generations."* **Consumer appliances like a 15-year water heater should not be tradeable against a 60-year envelope.**
15. Energy Code for buildings is not the place to effect what **appliances** people buy, or influence what time of day they are used. Please focus on 60 yr. building envelope. Building Energy Code should regulate the building, the real property improvement, not the appliances plugged in (appliances include AC, water heater, etc.)
16. **Revise language in Reference Appendix to exclude thermal bridging. That is, JA4 needs to state explicitly that Continuous Insulation (CI) is "unbridged" by definition. Exterior insulation cut by bridges is not CI . Example:**



Appendix JA4-28 *2016 Joint A*

JA4.3 Walls

Table 4.3.1 – U-factors of Wood Framed Walls

Cavity Insulation	Nominal Framing Size		Rated R-value of Continuous Insulation [2]									
			R-0	R-2	R-4	R-5	R-6	R-7	R-8	R-10	R-12	R-15
Spacing			A	B	C	D	E	F	G	H	I	J
16 in. OC None	Any	1	0.356	0.209	0.146	0.127	0.113	0.101	0.092	0.078	0.067	0.056
R-11	2x4	2	0.110	0.088	0.074	0.068	0.064	0.060	0.056	0.050	0.045	0.040
R-25	2x8	25	0.055	0.048	0.043	0.041	0.039	0.037	0.036	0.033	0.031	0.028
R-30[1]	2x8	26	0.054	0.047	0.042	0.040	0.038	0.037	0.035	0.033	0.030	0.028

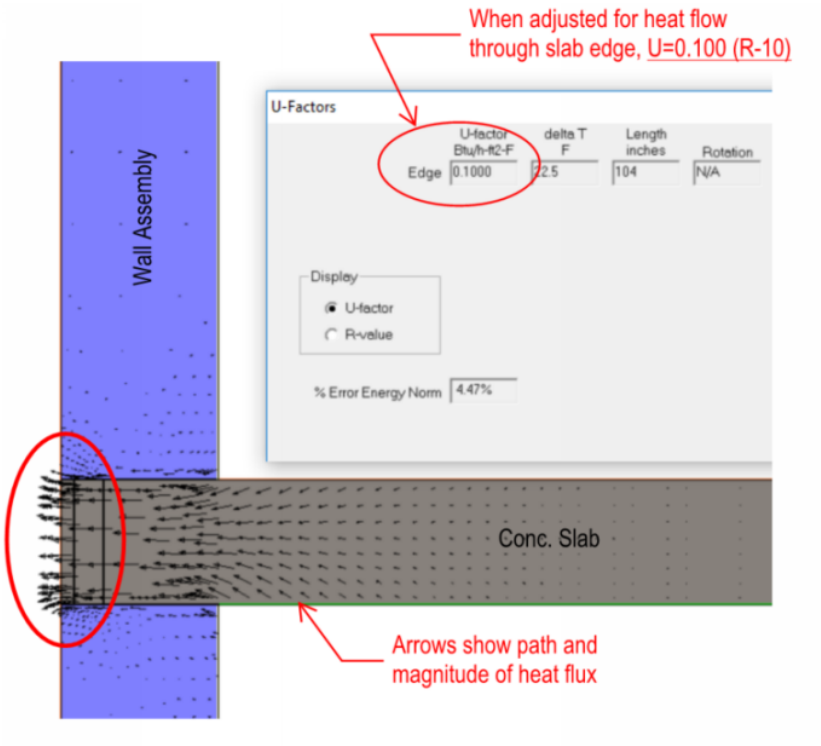
Notes
1. Higher density fiberglass batt is required in these cases.
2. Continuous insulation may be installed on either the inside or the exterior of the wall, or both.

2. Continuous Insulation has no thermal bridging. U-factors must include the effects of cladding attachment and other thermal bridging

I have added a note that reads: "*Continuous Insulation has no thermal bridging. U-factors must include the effects of cladding attachment and other thermal bridging*."

17. Currently ignoring thermal bridging in policy, Prescriptive code, and ACM. **Exposed slab edge and balcony** on high rise res. Results in a -36% derating of wall U-value, as determined by finite element analysis (THERM). Wall U-factor goes from R-12 to R-8, heating energy consumption up +25%. Also **cladding attachments** can similarly degrade U-value. **Provide policy backstop for energy consultants so they can advocate more effectively to architects**, using code as a stick. Wall with bridging by slab edge doesn't meet mandatory minimum U-value "area weighted average".

    - Add a check box to indicate "exposed slab edge" in CBECC-COM, so software can autocalculate thermal bridge losses. It already does this for slab on grade. Calculate elevated slab edge just like slab-on-grade perimeter loss.
    - Get RDH (consultants) to modify one of their detail catalogs into a format that works for CEC and energy consultants, include in Reference Appendix and Compliance Manual.
    - Nonres envelope (and Res using cladding over CI): Make it explicit in the Standards that cladding attachment through continuous insulation (CI) that undermines the continuous insulation due to thermal bridging does in fact reduce the wall's U-value, and the **real bridged U-value must be used for compliance calculations (JA4)**. In some cases the bridged U-value rises above the mandatory insulation requirements, for example Nonres steel frame. Why are we ignoring this? Engineers, architects, and energy consultants ignoring this appears to be rampant. Cladding attachment can de-rate CI by 40-60% easily. **Put a note on Joint Appendix-4 Assembly U-value tables stating that "cladding attachment de-rates the CI indicated here and this table may not be used to estimate U-value if there is thermal bridging through the CI due to cladding attachment."**



18. **Require podium slab insulation for equity and comfort in dwelling units over podiums**. Do floors have a mandatory min. insulation? See 120.7.c.1. Min is 3" gypcrete+conc. or U <= 0.269 (~R4). Cost-effective to insulate slab? At least make it a prescriptive measure (Standard design). Require a podium slab over unconditioned space (unconditioned Garage) to have mandatory minimum R-10/13-ish for comfort and heating load of apartments above. Equity in utility bills (slab dwellers vs. upper floor dwellers).

    *"Thanks for thinking about the tenants, or condo owners, living on that cold concrete podium deck. I have been trying to push the CEC to require concrete residential raised floors to be insulated – for a very long time. IMHO, for **MF occupant equity on energy costs and comfort**, this is much more important than whether the wall insulating sheathing is R-4 or R-5."*

19. **Switching for lighting in Daylight Zones.** Modify language to indicate: If no auto-daylight-dimming is required for systems that meet Exceptions, then separate switching for lights in primary daylit zones is not required.

F. Urban infill dwelling units, Accessory Dwelling Units (ADUs), and the Small-Dwelling-Unit Penalty

The market categories where we are building infill housing, fully 50% of new dwelling units: multifamily and Accessory Dwelling Units (ADU). Furthermore, this dwelling unit type must increase relative to new single-family, to meet urban housing demand, and AB XX smart growth requirements for climate protection.

Current compliance rules create a situation in which **there are few efficiency upgrades are available to the small-dwelling-unit market category to offset built-in compliance penalties**, and small dwelling units are controlled by water heating, not envelope or HVAC.

1. **HVAC & DHW equipment not available in small capacities**.
    - Small capacities are required to match loads for small dwelling units (ACCA Manual S, referenced by CALGreen 4.507.2 and *2015 ASHRAE HVAC Applications*, p.1.2-Equiment Sizing, and 1.4-Distribution)
    - High efficiency equipment (e.g. SEER >20 and HSPF>9) is not available in small capacities (say, <12,000 BTU/hr), or it becomes de-rated in small sizes by policy & compliance rules (see below).
    - Practical low limit of capacity is 6,000 BTU/hr heat or cool. Yet Standard designs have Prescribed insulation levels that frequently result in peak loads ≤6,000 BTU/hr. We are heating HRR apartments using 500W resistance heat (= 1700 BTU/hr heating load). There is no cooling equipment available <1/2 ton. Anything we could install would violate ACCA sizing guidelines 1.25x peak load.
    - If we accept the oversizing, the appropriate unitary equipment might be a PTAC/PTHP, which has poor efficiency, and furthermore is penalized by the ACM, by comparing it to the Federal efficiency requirements for Split Systems; the Standard design runs a Split System for LRR
    - The smallest HPWH on the market is currently 40 gal, First Hour Rating (FHR) ~65 gal. (Similar capacity break for gas equipment.) This leaves fully 1/3 of the FHR chart (CPC Table 501.1) without appropriately sized equipment. Appropriate sizing below 65 gal FHR **limits the designer to only electric resistance water heaters**; this applies to the entire market of dwelling units <2br, 2ba.

TABLE 501.1(1)
FIRST HOUR RATING[1]

Number of Bathrooms	1 to 1.5			2 to 2.5				3 to 3.5			
Number of Bedrooms	1	2	3	2	3	4	5	3	4	5	6
First Hour Rating,[2] Gallons	42	54	54	54	67	67	80	67	80	80	80

For SI units: 1 gallon = 3.785 L

Notes:

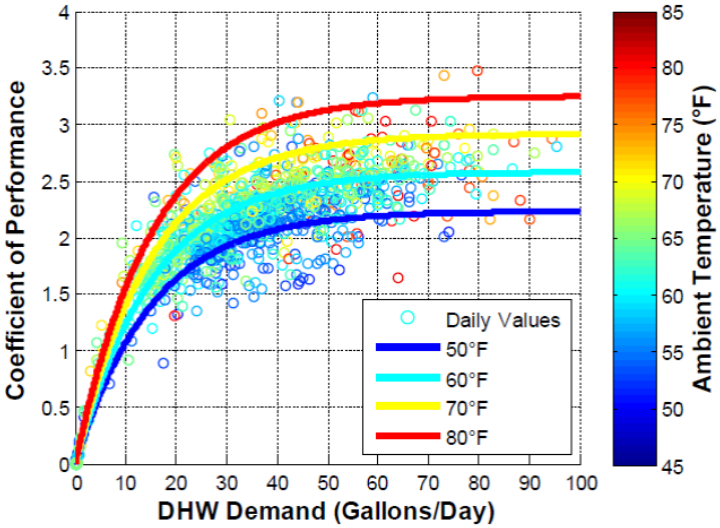
[1] The first hour rating is found on the "Energy Guide" label.

[2] Solar water heaters shall be sized to meet the appropriate first hour rating as shown in the table.

2. **Ductless A/C barrier**. Can't specify higher A/C efficiency (SEER or EER**) in small dwelling units**. **This leaves the Proposed design of small dwelling units with an inevitable cooling penalty**, due to using PTACs & ductless split AC (see Res ACM comments) and due to window geometry/orientation (see below for window orientation issue). For these types of dwelling units, the cooling loads are extremely small in absolute magnitude, and the appropriate small-capacity equipment is universally ductless split- or PTHP/PTAC room heat pumps. Ductless systems. Many are available with high-rated SEER and HSPF, but for split ductless systems, this can't be used for compliance credit. For PTHP systems, Standard design is higher efficiency ducted split. Thus, no ability to input cooling efficiency higher than Standard, to offset window orientation issue.
3. **Window orientation issue**. LRR ACM divides window orientation equally for Standard design. Proposed design for infill, standalone single **small dwelling unit has very constrained orientations**, due to urban lot, say east and west exposure, or just west alone. But the Standard design has equal window area to four cardinal directions.
    - **Windows are generally not allowed on property lines**. Splitting glazing to 4 orientations is a rural-oriented ACM policy that is not realistic for urban lots with zero-lot-line construction. Standard glazing orientation should match Proposed.
    - **Proposed design takes an inevitable cooling penalty** due to window orientation in Performance calculation, which lower-SHGC windows cannot fix (we are running SHGC=0.18 windows, the lowest on market, which still takes a cooling penalty due to window orientation). Higher efficiency A/C cannot be input, due to split ductless barrier described above. **Cooling penalty must be offset in water heating, which is the largest TDV "bucket" in low rise residential**. See water heating emphasis topic below---window orientation issue puts more pressure on water heater, to the neglect of building envelope investment.
    - **We need consistency between 3 and 4 story multifamily buildings.** Make a Proposed multifamily building 1 story taller, to 4 stories, and the Standard design will match the Proposed window area by orientation?
    - **Recommended:** window orientation in Standard should match the % allocation by orientation in Proposed, same as in NonRes ACM. Does this make the "no credit for good design" problem worse? If I put most windows on North/south, the Standard gets the same credit for good orientation. Maybe we live with this, to avoid the urban window orientation penalty.
4. **Water heating emphasis for small dwelling units**. Water heating is the largest TDV "bucket" in low rise LRR dwelling units <600sf and HRR <1200sf. Water heating is a simple choice of which 15-year appliance, independent of the building itself (the 100-year durable asset). Thus in these residential market categories, the Energy Code for BUILDINGS is mostly only regulating the water heating CONSUMER APPLIANCE, to the neglect of every other aspect of the building.
    - Example case: An ADU passes code only on the basis of running the

Performance model with a condensing, tankless fossil gas water heater, EF-0.92. This offsets the window orientation issue (above), and the below-Prescriptive wall insulation. However, when the ADU is built, the builder substitutes a less expensive, non-condensing tankless WH. The builder may also omit any exterior continuous insulation, if any was specified in the Performance compliance at all. Neither change is caught by the local inspector. A HERS rater doing Ducts and IAQ Fan does not look at water heater or wall insulation.

5. **Size matters more than Climate Zone for energy behavior (i.e. TDV dependency on water heating is proportional to number of bedrooms & envelope area, not climate zone)**, yet Standards only vary by climate zone. The cost-effectiveness test will vary by #bedrooms and envelope area, not necessarily by climate zone.
6. **The following chart shows that HPWH COP, or field efficiency of any water heater for that matter, is dominated by storage losses when serving the low daily demand typical of small dwelling units.** Therefore dwelling units with few bedrooms need different water-heating efficiency requirements than do dwelling units with many bedrooms.



7. Figure 5. Efficiency of a 50-gal HPWH operating in heat pump mode

8. **Efficiency requirements need to scale with size of building**. (“Progressive Efficiency”) There could actually be more variation in cost effectiveness by building size than by climate zone. Cost-effectiveness does vary by size of building, yet same measures are required for buildings of all sizes in same climate zone. The Prescriptive design that was decided based on 2000 sf single family prototype is applied to a 300 sf accessory dwelling unit (ADU). Also applied to a 20,000 sf low rise multifamily building. But cost effectiveness doesn't scale up and down the entire size range of buildings. A replacement water heater costs $2000-4000 to install in an urban area, regardless of what size dwelling unit it is attached to. It will be cost effective if serving more bedrooms; it will not be cost effective on the small dwelling with few bedrooms. Energy savings scale with floor area, but equipment

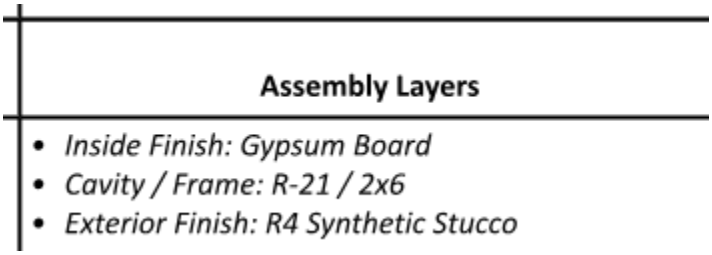
cost is fixed.

9. **Envelope-per-floor area is nonlinear with building size.** Small buildings bear the highest envelope cost relative to habitable or rentable space. Therefore envelope cost-effectiveness is nonlinear with building scale. Ex: prescriptive high performance walls (HPW). Yet the only variation in Standards is by climate zone. For some components there is more variation by size than by climate zone. This is ignored. Therefore 300 sf urban infill ADUs get beaten up for not having HPW and gas tankless DHW, while **5000 sf mansions get an easy ride and need neither of these to pass in Performance**. We get killed on the envelope on a little ADU, but we can get away with an envelope worse than Prescriptive for a large house. A very large house just needs an efficient air conditioner, and this will carry the entire Performance compliance. Every other aspect can be worse than code. This is regressive, not good, imposing relatively higher building costs on those building the smallest, humblest dwellings.
10. **Small house penalty on solar PV**. 220sf Efficiency Dwelling Unit, new construction ADU, required to have 1.3kWpv in CZ3, while adjacent 1250sf Primary Unit required to have 1.9kWpv. The ADU has 70% of the PV cost, but only 17% of the floor/roof area. The 1.3kW array is unlikely to be "cost effective." I wonder if any standalone dwelling <2000 sf will be cost effective to install the solar PV.
11. **Heat pump water heater fails for a small number of bedrooms; What is the non-fossil-fuel option for small dwelling unit water heating?** Number of DHW draws are determined by number of bedrooms; The tank-type heat pump with standby losses is compared to a tankless gas water heater with no standby losses.
    - If there are a lot of draws, then the energy efficiency (EF) factor dominates the compliance. If there a very few draws, then the standby loss dominates.
    - An ADU has very few draws. Therefore it's governed by storage losses. It could have a COP 8 heat pump water heater that never gets used (1 bedroom, few draws) yet it will lose heat from the tank 24/7. While an 82% gas tankless heater that never gets used will never reveal its combustion inefficiency.
    - In this case, it makes sense to use a very small electric resistance tank, or a tankless electric heater, because gas water heating installation including trenching could not likely be cost effective for the owner.
    - The relative efficiency in TDV terms of gas vs. electric resistance prevents code compliance; despite this difference being a very small absolute value, not worth bothering about, and the energy savings in $ utility bill having really no present value, definitely not enough to pay for gas trenching.
12. **LRR Standard Addition water heater with "no gas available" is propane, contradicting Standards.** The CEC released a statement to emphasize that ADUs built as a renovation of an existing structure, whether attached or detached, are to be treated as Additions in the Energy Code, not new construction. If you put this "Addition" into the Performance Calculation, with "No Gas Available" (= "not

connected to building"), then the Standard baseline will contradict the Prescriptive Additions code and it will run a tankless PROPANE water heater. The ADU with electric resistance water heating (per Prescriptive Code, “second water heater”) will not pass code in the Performance model, compared to this tankless propane water heater.

G. Forms and Compliance Reports

1. **Standard Design forms (CBECC-COM**) Checkboxes on "Standard Design NRCC-PRF-01" generated by software should reflect actual Standard design. Checkboxes are blank.
2. **CBECC-COM Fenestration reporting** (NRCC-PRF-1 E) "Exterior fenestration" doesn't appear on report unless it's part of a conditioned zone. This makes QA of the model unnecessarily difficult; the reported fenestration won't match the architect's drawings. Report should say "Conditioned exterior fenestration," or just report total fenestration, or similar.
3. **PRF-1 section N doesn't indicate whether fans are continuous or intermittent**. The terminology varies between CBECC-COM and EnergyPro (and also between ACM?)
4. **Divorce the relationship between "synthetic stucco" and continuous insulation (CI)**. There is no reason to link the finish material with the CI material in the compliance software. While it's true that synthetic stucco is most commonly applied over CI, the reverse is not true. It's also common to install 3-coat cement plaster over CI, as well as fibercement board, and just about every other finish over CI. (Furthermore, the final coat of many 3-coat plaster systems includes synthetic polymers, adding further confusion. Best to stay out of this!) This introduces incorrect information into the forms, such as this screenshot below. The Proposed design has 7/8", 3-coat cement plaster over 1" CI (R-5 XPS insulation), but the form says "R4 Synthetic Stucco" which confuses the architect, builder, plans examiner, and building inspector.



5. **Interface for prescriptive forms**. EnergyPro added a nice interface to complete the prescriptive forms. Why can't CBECC have this forms interface built in; the coding would be so fast & cheap compared to all the Eplus integration (and tech support), which in the end seems to have no greater functionality over DOE-2.
6. **High page count, information not high-value**, and some high-value information is missing. If the intent of the forms had been to condense the drawing content into a reviewable format that would make its code compliance clear to a reviewer, then I think the forms have not met this intent, and are in fact counterproductive. Despite so many forms, plan checkers appear to be not capable of reviewing the content of the work for its conformity to code. What other Part of Title 24 has 24-85 pages of forms to repeat what is already in the contract drawings? We all know that a higher page count means a lower likelihood that any pages will be read at all. As someone who prepares forms, it's clear to me that nobody including the plan checkers understands the forms. Plan checkers only check to see if the floor area listed on

the forms matches the drawings.

7. **Some forms are just lists of other forms**. Indoor and outdoor lighting for a commercial building requires a minimum six different signature pages, each requires the info to be typed from scratch, and each requires a designer's signature. The lighting forms alone, for a typical small commercial building, consume more drawing sheets than the drawings for the building itself. Can we just take the approach of other parts of Title 24, and draw a building that is code compliant, and let the plan checker review it, and field inspector inspect it? I might spend 6 hours doing a set of lighting & electrical forms for a commercial building. I am highly trained and I do this well. Six hours will cost the project $960 just to prepare the paperwork, and I get pushback that my fees are too high.
8. **Landscape vs. Portrait**. We can't have some forms in landscape format and others in portrait format, because these need to be laid out on a drawing sheet, and the mix of orientations doesn't lay out. Please use Portrait format for all forms.
9. **Sign under "penalty of perjury"** thing on forms is probably not legal, because design professionals honestly don't know if they are meeting code. They cannot attest that the design "conforms to code" because they don't know, they have only done their best. Additionally, the forms are going onto a sheet that will already be stamped and signed in the titleblock anyway.
    - Business and Professions Code only holds them to the Standard of Care, which is defined as how other responsible individuals in same area would practice.
    - When a licensed person stamps & signs drawings, this is not a testament that the drawings conform to code, only that they have been prepared under this person's responsible charge. Errors and omissions are inherent in practice, and are expected.
    - Finally, whether the design "conforms to code" cannot be objectively verified, since the local Chief Building Official has the authority to interpret the code.
    - Please remove the language about signing under penalty of perjury.
10. Responsible Person cannot sign "…under penalty of perjury" that the *"system design features identified on this Certificate of Compliance* ***are consistent with the information provided on other applicable compliance documents****,*" because the compliance software cannot model some systems and assemblies, nearly always requires some workaround, such that:
    - The Responsible Person cannot read or interpret the forms, does not know how or what information was input to them
    - The forms include default text such as "PSC Furnace Fan" and "default Split AC" when none such exists in the Proposed design
    - The compliance forms do not accurately represent the proposed design, in big or small ways
    - The gravity of the signature becomes meaningless and disregarded by most practitioners, increasingly so with more experience