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Mitsubishi Electric Comments on CASE Team 2022 Updates to Title-24 Envelope, HVAC and ACM

Additional submitted attachment is included below.

Comments on CASE Team 2022 Updates to Title-24
Regarding: Building Envelope, HVAC and ACM Trade-Offs

Submitted on behalf of Mitsubishi Electric by Bruce Severance, November 30, 2019

Dear Commissioner McAllister, CEC staff and CASE Team research staff,

Mitsubishi Electric is a major manufacturer of air-source and geothermal heat pump technology with offices and employees throughout the US. In June 2019, Mitsubishi Electric published "Environmental Sustainability Vision 2050" to clarify the company's stance on addressing long-term environmental issues. This corporate vision asserts that "The Mitsubishi Electric Group shall utilize diverse technological assets throughout wide-ranging business areas to solve various environmental issues, including climate change…" We consider ourselves partners in this effort. The following comments offer feedback on a range of energy code and ACM issues, most of which have been raised by recent CASE Team discussions and we are grateful the opportunity to comment on 2022 code topics.

Recognition of Passive House Standards and PHPP Software as Superior to Title-24 and CBECC

During the Nov. 12 CASE Team conference call it was asked if compliance with Passive House standards should be considered sufficient to also meet Title-24, or if additionally, Passive House (PH) projects should be required to meet all Title-24 minimum requirements. The exceptions for low-SHGC glazing was raised as an example of where the requirements diverge. It is clear from the numerous cases of high-performance homes built in widely ranging climate zones that Passive House standards hinge on the synergies between key design elements. Superimposing minimum Title-24 requirements would in fact compromise the overall efficiency and performance of passive house projects. Solar heat gain coefficient in glazing is a prime example. Passive House design requires attention to interrelated factors including insulated thermal mass, building orientation, overhang length, ratio of wall to glazing on the south side and use of a mix of SHGC glazing such that <u>high</u> solar heat gain glazing protected by overhangs, is used on the south side of a building to allow solar radiation to warm interior surfaces and insulated thermal mass in winter and not in summer. The insulated mass acts like a thermal battery, storing low temperature heat energy for days and stabilizing interior temperatures. Often low SHGC glazing is used on east and west facing windows to avoid unwanted heat gain. Requiring that all glazing meet Title-24 standards for low-SHGC would reduce the overall performance of PH projects. If PH standards are met, this should be a sufficient condition to meet Title-24. Rather than require projects to meet both standards, CBECC should be modified over time to accommodate all PH design variables, including radiant heat gains on interior surfaces and allowing full slab insulation to be modeled, which is not allowed under the 2019 version of CBECC.

The California Energy Code Should Require Envelope Leakage Standards

Although Passive House standards are to be commended, the .6ACH50 leakage standard is probably not cost effective in moderate climates and should perhaps only be adopted in more extreme California climates (CZs 12, 13, 15, 16). A leakage standard of 2ACH50 would be more than adequate for more temperate California climates and does not involve more than about 8-12 hours of labor and minimal material cost on the average home. Envelope leakage is a high-impact variable with a high cost-benefit. Even if the 2ACH50 standard were phased in over time, there should be a minimum of 2.5 to 3ACH50 instituted in 2022 with mandatory blower door tests on every home, and gradually becoming more stringent. This is perhaps one of the most cost effective measures in new construction.

The Importance of Re-Insulating After and Not Before HVAC Replacement and Electrification
The November 12th CASE Team presentation by Alea German of Frontier Energy raised some critical issues that may not be at first obvious to many well-intended regulators, but would be more obvious to any of those who have worked in the energy upgrade field: It is unproductive and ill-timed to require that an accessible attic be insulated with R-38 blown or batt insulation at the time that a new cool-roof is installed. <u>There are key synergies in the whole house approach to energy upgrades that dictate that a significant body of attic work be performed before attic insulation</u> is installed, among these: air sealing, attic framing such as access hatch insulation dams and gangs, attic ventilation, electrical repairs and electrification-ready circuits, and most importantly ducting repairs.

Using Rick Chitwood's HVAC optimization methods, most HVAC systems can be downsized to about a third of the usual capacity with about 60% to 70% energy savings and significant implications for future grid capacity requirements and avoided grid infrastructure costs. The average residential duct system leaks about 30% primarily due to the failure of traditional duct tapes. This leakage is a double energy loss, because fan power is expended to actively drive BTUs out of the building envelope. Additionally, <u>about 2-tons of cooling (or 24kBTU heating) can be lost through low duct R-values in hot or cold attics, and deeply burying ducts in insulation allows smaller HVAC equipment to be installed.</u> These improvements must be performed as a "package" in order for the energy savings to be realized. Insulating attics at time of roof replacement creates sunk costs and the only way to downsize HVAC equipment which yields the highest energy savings and maximizes the cost-benefit of electrification is to re-insulate immediately after HVAC system replacement. This synergistic, whole-house approach has multiple benefits: better comfort, better indoor air quality, high energy savings relative to investment cost, and reduced peak loads on the grid and avoided grid management costs which eventually would be paid by the resident.

Above Deck Insulation on Vaulted Ceilings at Time of Re-Roof Makes Sense
Requiring installation of above-deck (exterior) R-14 rigid insulation foam along with cool roof material at time of roof replacement when attic access is difficult because of a low-pitch roof, flat roof, scissor trusses or vaulted ceilings makes perfect sense and we would support this as the CASE Team suggested. However, this is generally an expensive measure. If above-deck insulation is required at time of re-roof, should it be required regardless of impact on the homeowner's pocketbook? What if the property is a low-income rental property? Typically R-14 extruded polystyrene costs $2.80/sf plus roof decking ($.50/sf), fascia extensions, and labor, the cost is going to reach $8 to $10 per square foot to add this measure. Although it makes a world of difference in terms of comfort and energy savings, this is a cost of over $10,000 for most small homes and it cannot be imposed without a finance program and a clear case for the cost-benefit to the homeowner. Despite this cost and financing concern, this is a measure worthy of consideration. Many homeowners who wished to sign up for programs such as Energy Upgrade California have been told by energy analysts and contractors that they are not good candidates for the program because they had already re-roofed, but did not have above-deck insulation. It seems that an incentive program needs to be designed for this specific scenario to avoid such lost energy savings opportunities.

Ridge or Awing Vents Should Be Mandatory At Time of Roof Replacement
There was no discussion about requiring ridge and awning vents at time of roof replacement which would be a very cost effective means of lowering attic temperatures in high cooling load climates and should be considered as a requirement on homes with attics. Ridge vents should also be considered in conjunction

with above-deck roof insulation at time of re-roofing on homes with vaulted ceilings to minimize vapor drive damage which field studies indicate tends to occur near ridges when vapor drive can penetrate unsealed fixture boxes and light cans. Given the retrofit cost of sealed attics and potential vapor drive and moisture damage issues, the state should not consider sealed attic options on retrofits, and assuring adequate attic ventilation, meeting at least 1sf per 150sf of attic floor area should be met at time of re-roof projects. On homes with attics, this would optimally combine a mix of high and low vents, at ridges and soffits, but could include awning-style vents if these are impractical. Fire safety and resilience should be factored in these attic ventilation requirements as well as in the roofing material and construction details.

Consider Addressing 'Thermal Holes' at Fixtures in Vaulted Ceilings

Because of vapor drive issues that are specific to vaulted ceilings with can lights, if above deck insulation is not required, replacing old-style unsealed can lights with shallower ICAT (insulation contact, air-tight) cans with low temperature LEDs and fully insulated around the fixtures would greatly reduce these "thermal holes" in the assembly that are known to lose disproportionate BTUs.

Energy Retrofit Standards for Existing Buildings Should Be Considered

There is no specific set of code requirements for energy upgrades and given the discussion above, it is clear there are a number of measures that should be triggered when major repairs or room additions are performed. There is now a sufficient body of data from Energy Upgrade California to develop prescriptions of efficiency measures that should be performed given a range of existing site conditions. Rick Chitwood's "Measured Home Performance" and his extensive experience with whole house improvements and HVAC optimization should also be integrated into a cost-effective blend of measures that maximize savings for the homeowner. Failure to integrate these measures as a package misses the opportunity to downsize HVAC equipment by 60%-70% with comparable energy savings. Given the state's decarbonization goals, creation of such a standard would be timely.

Code Should Discourage Ducts in Exterior Wall or Roof Assemblies in New Construction

With a growing trend toward flat roof assemblies in many modern building designs, there should be minimum clearances and insulation values for ducts run in flat roof or vaulted ceiling assemblies. Inadequate insulation and vapor barrier protection could easily produce condensation in the assembly under certain conditions. Additionally, any amount of duct leakage into an unvented roof assembly space will drive water vapor into the assembly, which usually migrates to the highest point and can condense under certain conditions. Such failure modes are more problematic in high humidity climates, but they are nevertheless a concern in dry climates. If ducts are installed in flat or vaulted roof assemblies, they should have less than 2% total duct leakage, be made of metal with minimum R-8 FSK insulation wrap (unless they are accessible and serviceable), and have a minimum of R-38 insulation between the duct wall and the exterior roof deck.

Code Should Explicitly Prohibit Duct Board Products

In an effort to remain product-neutral, the CEC has been hesitant to recommend for or against specific product or eliminate products that do not seem to offer the quality required to meet minimum standards. Duct board products are one of the few product categories that should be made an exception to this rule and they should be categorically prohibited when it is clear that these products are incapable of meeting both higher duct-leakage requirements as well as offer a minimum standard of durability.

All Non-Compliant Duct Tapes Should Require Warning Labels

All duct tapes that are not compliant with UL181 standards should be clearly labeled "Not for use on duct systems" prominently displayed on the packaging. Most hardware stores are positioning these tapes in the plumbing-HVAC aisle without disclaimers and many do not even stock UL181 compliant tapes, so neither stockers nor homeowners and DIYers are aware that the tapes they are purchasing are prone to failure.

Code Should Prohibit Burying Flex Ducts in Wall Assemblies

With CEC research clearly supporting the effectiveness of the 'Chitwood Method' wherein HVAC systems are designed with shorter ducts to throw air from the center of the structure rather than with long ducts running to the perimeter, and with the push to install ducts in conditioned space, there is no reason that flex ducting should be installed in wall cavities and soffits where it is unserviceable. Allowing this would create a unrepairable duct leakage scenarios. Despite improvements in flex duct products over the years, these are going to fail before the walls and envelope fail (100-year life). Flex should only be used in attics where it is accessible and serviceable. It should not be used in crawl spaces unless the crawl space has a concrete floor to prevent rodent intrusion into the duct system. Broken or leaky ducts in a crawl space can be a worst case scenario for indoor air quality. Any amount of moisture in the crawlspace is vaporized and driven into the living space by warm supply air and can lead to rapid mold growth in the living space. Such failure modes need to be thoughtfully considered as we move the code in the direction of higher efficiency and higher indoor air quality.

Interpretation of Section 150.2 (b) 1.G Regarding Allowed System Replacements:

The CASE Team has recommended that on retrofit projects, electric resistance furnaces may be replaced by either gas or heat pump (HP) air handlers, and their proposed changes do not require that baseboard heaters be replaced by HP space heating. The 2019 text of 150.2(b) 1.G reads as follows:

"**G. Altered Space-Conditioning System.** Replacement space-conditioning systems shall be limited to natural gas, liquefied petroleum gas, or the existing fuel type.

EXCEPTION to Section 150.2(b) 1G: When the fuel type of the replaced heating systemwas natural gas or liquefied petroleum gas, the replacement space-conditioning systemmay be a heat pump."

Given the state's decarbonization objectives as mandated by SB350 and clear economic analyses by E3 and others of the RNG and hydrogen fuel alternatives, it is fairly clear that fossil fuel interests do not have reasonable means to supply more than 20% to 25% of the state's projected 2050 clean gas demand. Given these reasonable projections, the only practical strategy for decarbonization of buildings will be to electrify most or all of the residential sector, systematically decommissioning the residential gas infrastructure, and reserving our projected RNG and hydrogen supplies for industrial and fleet transportation applications such as shipping and aviation. Given these reasonable projections, any and all electric resistance furnaces should only be replaced <u>only</u> with air-source heat pump systems and not natural gas or propane furnaces. The above section 150.2 text makes no mention of electric resistance furnaces and this category of outdated heating equipment should be addressed.

The CASE Team should also consider a requirement to replace electric resistance base boards with heat pump technology when the energy savings realized from the upgrade has paybacks of under ten years. If average installed HP system install costs are $13,000, then average projected fuel savings to trigger the requirement would need to be $1500 per year or more (factoring debt service). One low cost scenario would be to require homes with baseboard heating to install a single ductless HP unit in the living or great room, while installing 1-hour limit timers on the heaters in the bedrooms so they automatically shut themselves off and are not left running continuously. Several different criteria could require such a single zone heat pump install, such as a major kitchen or bath remodel or room addition. Similar triggers should be used to replace wood or pellet stoves with heat pump space heating.

Tightening Duct-Sealing Requirements in Section 150.2(b) 1D:
Mitsubishi Electric supports increasing duct insulation minimums to R-8 in milder climates (CZs 1-4, 8-10) and R-12 in more extreme climates (CZs 5-7, 11-16). It is our understanding that R-12 is now available, and the incremental cost would be worth the energy savings. We also support reducing the 40' duct limit to 10' to trigger duct leakage testing and tightening of the entire duct system to an 8% minimum rather than 15% minimum with exceptions made for structures with existing ducts buried in wall and floor assemblies. There are good reasons to tighten these requirements: 1) Duct leakage is a double-loss of efficiency in that we are using fan power to actively drive BTUs out of the envelope; 2) Repairing this condition is always cost effective with ROIs as high as 50% to 100%, and the repairs pay for themselves in no more than two years. Even if all the duct joints in the attic need to be resealed, this is a cost effective means to reap large energy savings at very little cost.

All ER Water Heaters Should Be Upgraded to HPWH's During Replacement
Electric resistance water heaters (ERWH) are notorious energy consumers and there should be similar requirements to replace them with heat pump water heaters (HPWH's) when it comes time to replace them. There are of course, site conditions to consider. Integrated HPWH's that have the condenser sitting atop the tank must either be located in an attached garage from which they draw heat and transfer that heat to the tank, or if in a utility closet, they must be ducted to the outside. Their cost is similar to .96 AFUE on demand gas heaters, both costing about $1100 to $1200 retail, and despite the higher cost compared to ER water heaters (about $450), the $700-dollar premium is likely to be offset by the energy savings amortized over 15 years. There are however, site conditions that may make this retrofit less cost effective or practical and exceptions should be identified. For example, if there are a row of ERWH's in a common utility closet in an apartment building where they are metered separately, it may not be practical to duct them all to the outside, and other replacement options may not be feasible, such as HPWH's with a separate outdoor condenser unit (like Sanden). At very least, under these exceptions, any replacement ERWH should have DR capability to maximize grid harmonization.

Solar Thermal System Cost-Benefits and Associated Incentives
It has been known for many years that solar thermal systems on single family homes are no longer cost effective due to their high installation and maintenance costs. Solar thermal water heating systems have a great deal more system complexity than many realize and they have numerous potential failure modes that make HPWHs plus solar panels to power them a far more cost effective option on single family dwellings. Although central solar thermal systems have still been found to be cost effective in large multi-family projects, they nearly always must be combined with on-demand recirculation systems which add cost and have inherently higher line losses. As new central water heating system options are emerging, it is important to assess the relative cost versus efficiency benefits and be sure CBECC modeling and incentive programs accurately reflect these. For this reason, solar thermal incentives should be

structured to include HP +PV alternatives and should not show bias or preference to only solar thermal technologies.

In-Slab Hydronic Systems Should Require Supporting Data

In-slab hydronic systems are presumed by the code to deserve DICS credit (ducts in conditioned space) when there is no research to prove that these systems don't lose significant BTUs to ground. Although 4' of horizontal under-slab insulation is required in CZ 16, it is not even an option in CBECC to model full slab insulation. When ductless VCHP systems that have no ducts in the attic have been deprived of the DICS credit for years, it is hard to fathom the double standard. There are no studies available to date that actually measure BTUs delivered to conditioned space versus those lost to ground and there seems little justification to overlook this BTU loss. Some have theorized that a zone of soil under the slab warms up and provides and insulating value, but this is theoretical only and BTU loss would vary relative to soil composition and water tables. Most importantly, actively heating slabs precludes the use of an insulated slab as a natural temperature stabilizer and negates the advantages of using an insulated slab as a thermal battery in passive house scenarios. For all of the above reasons, we feel there is no scientific basis to offer DICS credit to hydronic in-slab systems, and such credit should be withdrawn until data verifies and supports the relative efficiency of these systems. We do support DISC credit being given to wall-mounted radiator systems.

A Carbon Tax on Methane Leaks

In 2021 EDF will be launching the MethSat, a satellite that will be able to pinpoint and quantify methane leaks to more accurately assess the environmental impact and "externalities" associated with natural gas and propane. As suggested by the CASE Team, we agree that methane leaks at wells, processing plants and in the distribution infrastructure should be taxed based on the 20-year 86 GWP rate given the immediacy of the climate crisis, and not on the basis of the longer 100-year 25 GWP (CO2 global warming potential equivalence value) of methane. Accounting of such externalities should include the carbon footprint of flaring at well sites and processing.

Although many defenders of combustion-based HVAC systems will point to high GWP refrigerants used in heat pump and refrigeration systems, these in contrast to methane, are being rapidly phased down through international accords with a high degree of support on the part of manufacturers. There is no similar predictable ramp-up of renewable natural gas (RNG) or hydrogen production that parallels this effort, and a methane (carbon) tax would generate funds that could be allocated specifically toward scaling up power to gas hydrogen generation, and incentivizing investment in a hydrogen distribution infrastructure for peaker plants, industrial applications, trucking, shipping and aviation.

Accounting for Climate Externalities

Although TDV and EDR attempt to account for carbon footprint, there is currently no method to account for the cost of climate impacts for California households over the next 25 years. If the projected impact on California households was factored, including increased utility, food, insurance, rent, and medical costs, it would clarify the justification for an escalation in the carbon tax and help fund incentives to decarbonize the building sector.

The Need for Improved EPA 608 Refrigerant Training and Certification

Despite the rapid phase down of high GWP refrigerants, a great deal of equipment already in the field will take decades to replace or upgrade, and there needs to be better, more thorough EPA 608 training on the impacts of improper refrigerant handling, the cost impacts of refrigerant contamination, and stricter refrigerant leakage test requirements on high GWP refrigerants. National and international studies put refrigerant leakage at 2.3% (EDF study) to as high as 3.8% (UK). Especially given the immanent introduction of A2L refrigerants with lower GWP but which are more flammable than more traditional refrigerants, there is a real need to require more in depth quality and safety training on refrigerant handling. To quote a letter from ACCA's Director of Industry and External Relations, Todd Washam to then Acting EPA Secretary Wheeler:

"On September 13, 2018, it was reported that two individuals in Australia died as a result of mishandling refrigerants. In her investigation, Coroner Paresa Spanos stated that the individuals who died were "good with their hands" and had some technical skills because one of them was a motor mechanic. However, the deceased were not "qualified refrigeration mechanics/technicians." They had encountered an HVAC system which had mixed refrigerants, and one of the constituents turned out to be unexpectantly flammable. When inadvertently released into the mechanical room, the mixed refrigerants caused an explosion that was "preventable in the sense that the explosion could have been averted through correct maintenance, correct use and labelling of refrigerants, and correct dismantling and removal processes."

Clearly, proper handling of refrigerants, and avoidance of improperly mixing refrigerant chemistries is critical to both minimize environmental impacts and safety hazards for technicians. EPA 608 training requirements will need to be more stringent, and there are high environmental benefits as we ll as cost benefits to homeowners and building managers.

The Need for an All-Electric Baseline for Non-Res Projects and Modeling

Although there is an all-electric baseline for residential projects and modeling using the ACM and CBECC, there is no corresponding all-electric baseline for commercial projects. There is a perception that this currently tilts the playing field in favor of natural gas systems in CBECC-Com. As the Building Decarbonization Coalition has suggested, the CEC should create a single electric baseline for all energy sources and use energy valuation metrics that appropriately reflect the lower greenhouse gas emissions of all-electric buildings, rather than bifurcating standards for natural gas and electric construction. Continuing to separate performance standards for natural gas and electric heating encourages continued construction of gas-fueled buildings for years to come and these buildings will stand for decades and have lasting greenhouse gas emission impacts. As suggested by economic analyses by E3 and RMI, the continued expansion of the gas infrastructure, particularly in the residential sector, will lead to stranded assets for consumers, and would also lead to higher infrastructure cost burdens falling upon low-income families who rent or who cannot afford to electrify their homes. The Future of Gas Distribution Study (E3) emphasizes that gas-heated buildings are more expensive to build, leave Californians vulnerable to higher energy bills and will cost the state even more in retrofit program overheads in the long-term. Continued investment in maintaining the gas pipeline system will dig the climate crisis hole deeper, resulting in needless cost impacts and externalities effecting all Californians.

Given that law suits are already being filed by the California Restaurant Association against Berkeley, and by the utility workers union against the City of San Luis Obispo with the encouragement of gas industry advocates and Astroturf groups, the CEC and the legislature need to take decisive action to enact clear electrification objectives as well as plans and incentives for gas industry, investment into hydrogen and RNG. The gas industry needs and deserves a sustainable business plan to bring it into the 21st Century.

Support for Two-Phase EDR Process

As suggested by the Building Decarbonization Coalition, we strongly support the two-step energy design rating approach to assess energy and grid impacts, and we recommend that it applies across all building types, residential and non-residential, for consistency. The two-step EDR using Time Dependent Source energy (TDS) and Time Dependent Valuation (TDV) appropriately reflect both the climate and air pollution impacts, and the electricity grid system costs of buildings. Both metrics are important to align with California's climate and housing affordability goals.

TDV Assumptions Must Align with Electrification Objectives

The CEC should update the underlying TDV assumptions to foster more rapid market transformation and building electrification, and a more realistic supply of bio- and synthetic gas. The TDV proposed for the 2022 building code rests on several assumptions that do not factor in the climate imperative and financial advantages of zero emission buildings. These TDV assumptions include: 1) an 80% emission reduction by 2050; 2) a slower rate of building electrification; and 3) a 10% biogas pipeline blend by 2030. The current assumptions appear to be based upon an 80% reduction by 2050 instead of the more recent mandate of carbon neutrality by 2045. The Future of Natural Gas study found that achieving 80% greenhouse gas reductions by decarbonizing the gas grid would cost the state between $5 and $20 billion dollars more than achieving the same reductions through the clean energy electrification of buildings. In order to support these cost savings, the 2022 building code should assume a realistic supply of bio-gas (RNG) given this source currently meets less than 1% of the demand, projected costs are high, and the state has no policy in place to achieve 10 percent biogas supply by 2030.

Proper TDV algorithms and assumptions are of critical importance, and they cannot be allowed to provide cover for further denial of widely accepted climate science and recommendations by the IPCC on remaining below the 1.5 C. target. Above this target, severe economic impacts, including a 90% reduction in agricultural output by 2100, would cause severe economic hardship, scarcity and probable hunger for residents of the state (based on NCA4 Report).

The Projected GWP of RNG

During the Title 24 webinar hosted by the Building Decarbonization Coalition, there was discussion around the Energy Code or another regulation establishing the GWP of RNG or bio-methane to be equal to zero. Although bio-methane is captured or harnessed from agricultural, water treatment or composting processes that are not currently captured, these are still industrial processes that need to capture harmful outgassing and not naturally occurring in most instances. It is therefore not logical to set the GWP value at zero. Whether methane is extracted from the ground, or the byproduct of agricultural or industrial processes, it is still a greenhouse gas with impacts and leakage needs to be contained, or the benefits of RNG are nullified. However, sequestration of CO_2 resulting from burning RNG may be a 'carbon-negative' process which should be incentivized.