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Climate Adaptation Needs, Thermal Comfort and Resilient Design

Additional submitted attachment is included below.

2019 Title 24 Update, Docket # xxx
and Cal Green Update, Docket # xxx
California Energy Commission
1516 Ninth St.
Sacramento, CA 95814

February 21, 2018

Subject: Future climate adaptation needs in building standard updates

Dear Commission Staff:

Healthy Buildings Research appreciates the opportunity to comment on the proposed updates to Title 24 and CalGreen building standards. We also thank the Commission staff for all of their work towards meeting the ZNE goals for new California buildings.

Pleases consider our comments below on the 45 day draft language for 2019 Title 24 and Cal Green address the need to consider future climate in California. In short, we need aggressively adaptation our buildings for climate change in order to actually meet California's ZNE and carbon reduction goals, to avoid or minimize overheating of buildings, and to reduce grid outages. These actions are necessary to avoid significant impacts on human health and safety, jobs, and economic productivity.

Below are our recommended changes to the standards and the relevant legislative requirements and policy guidance. Supporting information is also provided. We have raised these issues in previous comments at workshops on the 2019 Title 24 standards (May 5 and June 23, 2017 comments; Phillips, 2017), but have not seen any response yet regarding the climate adaptation comments.

RECOMMENDED CHANGES

We recommend the following additions to Sec. 120.1, Requirements for Ventilation and Indoor Air Quality (Title 24 Residential and Nonresidential Standard, and pertinent sections in Cal Green Standards).

1. Assess Life Cycle Performance for Thermal Comfort.

   Analyze and report the number of hours per year that the building will exceed the ASHRAE Standard 55-2017 thermal comfort standard (ASHRAE, 2017) under current and future climate conditions:

   A) Use the most recent 10 years of climate data from the nearest weather station to model thermal comfort performance for both average daily temperatures over 10 years and for the three hottest consecutive days and three coldest consecutive days of the year. If weather data sets with sufficient proximity to the project site area available from the Commission, those data may be used instead, in order to adequately capture significant microclimate effects.

B) Mid-century climate conditions using Maximum and Minimum temperatures and relative humidity for the project location for the 2050 decade or a wider time period if necessary. Use Cal-Adapt (2017) Extreme Heat Tools, RCP 8.5 emission scenario, 2050-2059 period, to incrementally shift the average daily temperature and humidity profile at the hourly level to the future conditions. Alternatively, use weather data from climate models with good time and spatial resolution, such as the 3-hour 50 km grid weather data from the NARCCAP model (NCAR, 2009), but use the 4 climate models that Cal-Adapt recommends for heat wave modeling, with the A2 emission scenario.

C) Late-century climate conditions: repeat B above, using the 2090-99 period instead. Include adjacent decades, if decadal data are not available.

D) Report the results of the thermal comfort assessment, including calculation inputs and number of overheating and underheating hours per year.

2. Assess Thermal Resilience During Extended Power Outage.

   A. Conduct thermal modeling to demonstrate that the building will maintain "livable temperatures" during a power outage lasting seven days, during both peak winter and peak summer conditions. Peak conditions shall be based on the most recent weather data used for the building standards compliance modeling.

   B. Livable conditions are defined as SET temperature between 54°F and 86°F. SET is a temperature metric (standard effective temperature) that factors in relative humidity and mean radiant temperature.

   C. For residential buildings (single-family and multifamily) during a one-week period during the summer peak, the building may not exceed 86°F SET for more than 9 SET °F degree-days (216 °F SET hours). During the winter, a residential building may not drop below 54°F SET for more than 9 SET °F degree-days during a one-week period.

   D. For non-residential buildings, the winter requirements are the same as for residential, but in the summer, a greater deviation above 86°F SET is allowed: 18 °F SET degree-days (432 °F SET degree-hours) during a one-week period.

   E. Optional: designate "habitable zones" in a building and ensure that these spaces, and not the entire building, achieve thermal resilience.

F. Demonstrate that sufficient ventilation is provided to ensure adequate fresh air, through mechanical and/or natural ventilation, for the planned number of occupants.

G. Demonstrate that sufficient back-up power is available to provide sufficient heating and/or cooling during such outage conditions, either through a backup generator or through thermal and/or electrical storage. Back-up power must be sufficient for critically important functions such as fuel fired heating system, cooling fan, low level lighting, cable/modem/router operation, and potable water supply.

3. Provide labeling at the building HVAC maintenance access and information in the building operations manual to notify users that the building has the above resilient design features.

RATIONALE

Background: Overheating of buildings as our climate changes is a major health and comfort concern in existing buildings as well as new buildings (Roaf et al., 2015). Overheating of buildings is also major economic concern in terms of worker and student productivity, and in terms of liability for discomfort and habitability problems in buildings. Several examples of buildings adapted to future climate and increased extreme heat conditions in a cost effective manner are found in the U.S., Australia, and the U.K. (Scheuter et al., 2014; Phillips, 2017).

Overheating of buildings tends to occur more during extended periods of extremely hot or hot plus humid conditions. The risks of overheating are higher in buildings that lack air-conditioning, which is the case for much of California's homes in coastal areas and in older buildings. For example, in the L.A. basin, most of the homes do not have central air conditioning, especially in low income households, and many areas have less 10% of less of the homes have central air conditioning. (Chester, 2015; Nahlik et al., 2017). Even in air-conditioned buildings, power outages during heat waves put thousands of buildings at risk of overheating.

The most deadly heat waves tend to be those with high humidity (Sheridan et al., 2011). Climate change is projected to increase humidity in the southwestern U.S. (Gershunov et al., 2013).

Climate change is expected to increase cooling loads and reduce the availability of natural ventilation for cooling in California's buildings. Diffenbaugh and Ashfaq (2009) and Diffenbaugh et al. (2011) have modeled extreme heat in California through 2100 and have projected that heat wave will increase significantly by the 2030s in terms of intensity, duration, and frequency. The extent of wildfires and particulate matter emissions over multiple days California is also expected to increase drastically, and thereby producing multi-day “smoke waves” that would reduce the availability of natural ventilation and increase the time people spend indoors (Liu et al., 2016).

Climate change is expected to substantially increase the risk of power outages in California, which will exacerbate the health and safety impacts of heat waves and the risks of underheating during cold waves (Bartos et al., 2016; Sathaye et al., 2011). In addition, extreme heat can substantially reduce the efficiency of rooftop air conditioning units. Cal ISO has raised the issue of climate change impacts on grid reliability, e.g., the increased cooling demand from “monsoonal weather systems: and extended heat waves. In addition, fuel switching from fossil fuels to electricity for space conditioning is already occurring in California, and charging of electrical vehicles is expected to increase. This could place further demands on the power grid.

Power outages have been increasing in the U.S. over the last 20 years, mainly due to weather events. Extreme heat reduces the performance of power lines, transformers, and turbines, and can lead to transformer failure. Population growth in the inland areas of California has been increasing the cooling and peak power demand for electricity. California has had the highest number of power outages among all states in 2014, and the number of outages in May-July has been increasing in recent years (Eason, 2014).

Some of California’s worst heat waves have coincided with power outages due to equipment thermal overload or wildfires (Sathaye et al., 2011). The authors also found that, in some parts of the state, the likelihood of fires occurring near important transmission lines is expected to go up by more than 300 percent by the year 2100.

Legislation, Regulations, Standards, and Policies: PRC Sec. 25402(b)(3) requires the Commission to conduct life cycle cost analyses of building performance when developing the building energy standards. The Commission currently uses a 30-year life cycle, but many components of a building, especially the building shell, can last 50-100 years. The International Energy Agency (IEA, 2017) used 60 years for their reference case in life cycle analyses of operational and embedded carbon emissions and energy use.

HSC Sec. 18930 requires the Commission to provide an analysis of how the standards meet the public interest criteria, including health and safety, resource efficiency, and building and building system performance.

Ventilation design standards such as ASHRAE 62 and Title 24 incorporate the ASHRAE 55 thermal comfort standard, which sets temperature and humidity targets for heating and cooling seasons (ASHRAE, 2017). ASHRAE 55 compliance approaches include the reporting of design operative temperature and humidity, heating and cooling design outdoor conditions, total indoor loads, and design exceedance hours (Wikipedia, January 2018). The Passive House Institute (2016) 2016) requires that the thermal comfort performance of certified Passive Houses be modeled for the number of hours outside the temperature targets. Energy Plus and many other energy modeling programs can calculate indoor temperatures and humidities.

California public health policy also points to the need to address climate change impacts on cooling needs for buildings. The Public Health Working Group (2013) of the AB 32 California Climate Action Team recommended that California take the following actions to protect public health and safety:

a) “Review and incorporate changes as appropriate, to state and local regulations, codes and industry practices for buildings, land use and design elements to identify opportunities to accelerate the adoption of cooling strategies for both indoor and outdoor environments” (p. 10, Recommendation 1); and

b) “Evaluate strategies that could provide protection against heat and air pollution to vulnerable populations that are not based on energy intensive air conditioning” (p. 17, Recommendation 4).

In its report on climate change, the indoor environment, and health, the Institute of Medicine (2011) recommended that building codes account for climate change projections and that buildings have fail-safe ventilation methods in the event of power outages or ventilation system breakdown. Several researchers in the previous decade have made similar conclusions.

The U.S. Green Building Council has adopted LEED pilot credits for resilient design (Wilson, 2015 and 2016). The thermal resilience credit requires thermal modeling to demonstrate that the building will maintain “livable temperatures” during a power outage lasting seven days during both peak winter and peak summer conditions. Livable conditions are defined as SET temperature between 54°F and 86°F. Credits for backup power and potable water are also included. HVAC and building designers in North America now offer software to assess building performance under different climate change scenarios (Building Green, 2013 and 2014).

Building design guides for preventing overheating and addressing urban heat island impacts on building performance have been published by CIBSE (2017; 2014) in England. Safe temperature limits for the general population and vulnerable populations such as care facilities and hospitals have been set by CIBSE,

Discussion and Summary: The impacts of proposed building standards on thermal comfort should be assessed and mitigated as necessary. Results of thermal comfort assessment will be essential for public and worker health agencies to identify the buildings most at risk of overheating, thereby allowing health prevention efforts to be focused most effectively. The results should also be provided to building owners and occupants in order to disclose this health related information, similar to the requirement for making ventilation standard compliance information available to workers (Labor Code Sec. 5142).

Recommendation 1 is appropriate for Title 24 standards, given that the modeling process can also provide essential guidance in the need for adapting buildings to climate change in a timely and cost-effective manner. Adaptation measures that are identified only for late century conditions can be planned for by installing any necessary infrastructure and then phasing in the installation over time.

Recommendation 2 is appropriate for Cal Green. It requires more extensive analysis than Recommendation 1, although it is a logical follow-up to analyses done for Recommendation 1. Sufficient incentives should be provided for this measure to encourage its implementation.

At a minimum, the **Title 24 and Cal Green standards should include an Advisory Note** in the appropriate sections in order to advise designers, builders, and operators that future climate conditions are expected to change over the life of the building and should be considered in order to provide a healthy, safe, and comfortable building in an energy efficient and low carbon manner.

Sincerely,

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ATTACHMENT: REFERENCES
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