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Health-Related Outputs Needed from Clilmate Models

Additional submitted attachment is included below.

Dr. Schmidt-Poolman December 30, 2019
EPIC Climate Change Program
California Energy Commission
1516 Ninth St.
Sacramento, CA 95814

Subject: Comments on CEC Workshop on Climate Scenarios and Analyses GFO, Docket # 19-ERDD-01

Dear Dr. Schmidt-Poolman:

Thank you for hosting the workshop on improvements to California climate models (and hopefully subsequent Cal Adapt improvements) to meet user needs. The Commission's efforts in this area will be critical in moving quickly towards a sustainable and healthy California, and in meeting the GHG reduction goals in the AB 32 Scoping Plan.

Below are some details to follow-up on my oral comments at the December 2019 workshop, regarding Scope and Additional Considerations. I am also attaching my 2015 comments to the CEC on related issues concerning modeling needs for sustainable, resilient building design and operation.

1. Priority Projections:
   Hourly data on humidity and wind, as part of complete hourly weather files, are needed to assess and mitigate current and future climate effects on the performance of buildings, the electrical grid, and other infrastructure. Examples of the importance of warm, moist air masses and stagnant wind conditions have been documented in studies of synoptic weather types, heat waves, and ozone air pollution episodes.

   In addition, hourly data on Urban Heat Island (UHI) impacts are needed. These can significantly amplify the effects of climate change. Examples of recent studies are available for such impacts on indoor heat exposures during power outages (Sailor et al. 2019), during hot weather (Chester and Burillo, 2015, p. 21), and on outdoor temperatures (Yang et al. 2019; Yun et al. 2019). Localized mapping of UHIs in California has monitored and modeled by Taha et al. for the CEC. The current CEC funded project is Intra-urban Enhancements to Probabilistic Climate Forecasting for the Electric System [EPC-15-070]. So perhaps this UHI mapping could be integrated with the climate modeling.

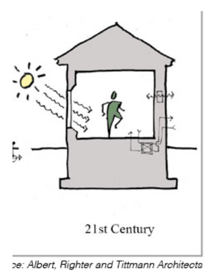
2. Weather Files to Capture Extreme Conditions:
   Extreme weather conditions are not captured well in weather files currently used for

building standards, but such conditions are becoming much more frequent, intense, and longer. Building designers and building code programs are assessing the vulnerability of buildings and other infrastructure to extreme heat, UHI, wind driven rain, and precipitation (see slides below). Better alternatives to TMY weather files, such as Design Summer Year or Extreme Meteorological Year files, have been studied and used in some cases (Grossenbacher et al., uSIM 2018). Simpler approaches have also been tried, e.g. “stress tests” using historical heat and cold wave data. Better weather files and user guidance, and demonstration projects to address extreme conditions are needed. This is an urgent need for addressing our climate emergency now, not in 3-5 years.

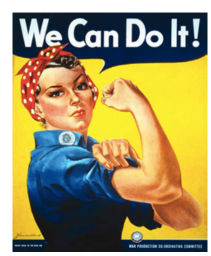
SLIDES (2): Current overheating guidelines and standards

Source: T. Phillips, 12/3/19, updated from ACEEE/CHEE Dec. 2018.
Note: NRC Canada has developed future weather files (Gaur et al. 2019).

Overheating Standards and Guidelines: *International*

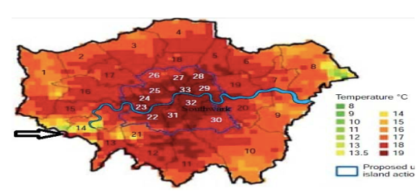


- **Passive House Program:** **≤ 10% (h/y) > 25 C, and moisture limit** [1]



- **CIBSE TM 59 Overheating Design Guide (UK): 1-3 % (h/y) overheating limits by room type; future climate scenarios recommended.** [2,3]

- **CIBSE TM 49 Urban Heat Island Design Guide (UK and London Plan): Overheating risk assessment for urban heat zones.** [4]



Average outdoor air temperature in London during August 2013

1. Passive House Institute, 2016. Criteria for the Passive House, EnerPHit and PHI Low Energy Building Standard.
2. CIBSE, 2017: TM 59, Design methodology for the assessment of overheating in homes.
3. Diamond, S., May 22, 2017. TM 59 webinar. Inking Associates.
4. CIBSE, 2014. TM49 Design Summer Years for London. See also: ARCC Network, 2017. Designing for Future Climate.

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Overheating Standards and Guidelines:
*North America: Input Needed **

- ✓ Build It Green (2017): GreenPoint Rated 7.0 (CA Homes) [1]
- ✓ LEED/RELi (2018 update) Pilot Credit: Resilient Design 2.0 [2]
- ✓ British Columbia Building Energy Step Code 2019. [3]

- ✷ Collaborative for High Performance Schools Criteria: Climate Adaptation & Resilience added (2019 National) [4] — *State Criteria; 2020*
- ✷ California Title 24 Building Energy Efficiency Standards [4] — *Future wather files TBD*
- ✷ Cal-Adapt climate tools update (CA) [6] — *Dec. 2019 workshop*
- ✷ California PUC to address strategies and guidance for climate adaptation for electric and natural gas utilities [4,7] — *IN PROGRESS; PGE starting future weather file work*

⌘ Big Boom in research papers on overheating.

1. Build It Green, 2017. Version 7.0 Update, Executive Summary.
2. Wilson, A., 2018. The LEED credits are back up.
3. ACT, Dec. 2018. BC's Energy Step Code. Low Carbon Resilience: Best Practices for Professionals – Final Report. Simon Fraser University.
4. CHPS 2018 draft update and webinar.
5. J. Huang, White Box Technologies. Personal communication, October 17, 2019.
6. Cal-Adapt. https://cal-adapt.org/blog/2018/webinar-december/. Recurring event.
7. Filings at the CPUC, May 2018. www.cpuc.ca.gov/.../CPUC_Website/.../Filings%20newsletter%202018-05.pdf. Get updates.

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3. Coordinate With Other Key Users in Health Sector:
   State agencies such as CDPH and OES should provide early input on data needs to mitigate climate change impacts, both short- and long-term, on vulnerable populations in assisted living facilities and health care facilities, and to adapt other key public health and safety infrastructure and planning programs.

4. Cascading Impacts Scenarios:
   The combined effects of extreme conditions and systems failures, such as power outages, wildfires, floods, droughts, increased EV charging, and increased decarbonization of buildings, are becoming more likely. I did not comment at the workshop on this issue, but the climate scenarios should help characterize the "perfect storm" cases that are likely to become more common. Examples of such analyses have been done for Phoenix and other cities (Clark et al. 2019; Bondank et al., 2018; and related papers and presentations).

Thank you for the opportunity to provide input on this research program.

Sincerely,

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Attachment: 2015 comments on EPIC Climate Scenario research

Dr. Guido Franco
EPIC Climate Change Program
California Energy Commission
1516 Ninth St.
Sacramento, CA 95814

March 13, 2015

Subject: Comments on CEC EPIC Climate Change Scenario workshop, Feb. 27, 2015

Dear Dr. Franco:

Thank you for hosting the workshop on probabilistic scenarios for climate change in California (http://www.energy.ca.gov/research/notices/index.html#02272015). Climate projections for extreme heat episodes are critical for designing healthy and efficient buildings and infrastructure over the life cycle of the built systems. The Commission's efforts in this area will be very important in moving towards a sustainable and healthy California, and in meeting the GHG reduction goals in the AB 32 Scoping Plan.

In particular, these efforts will be essential in implementing the first recommendation of California's Extreme Heat Adaptation Plan for Public Health (Public Health Workgroup, 2013):

> "1. **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**.
> Lead Agency: Building Standards Commission (i., ii. below), California Energy Commission (iii. below), Governor's Office of Planning and Research (iv. below). Other Agencies and Stakeholders: Air Resources Board, local and regional planning agencies."

Due to the webinar outage and audio problems, I was not able to participate in the workshop. Please consider the following comments and questions:

1. Climate change scenario probabilities are needed to estimate future overheating risks in existing and new buildings. 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.

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. Even in air-conditioned buildings, power outages during heat waves put thousands of buildings at risk of overheating.

2. How will the Commission use the climate change probabilities for assessing building performance and adaptation of buildings to climate change?

   Extreme heat and humidity are not only a concern re: peak power and grid outages, but also a public health concern due to increased heat stress exposure, both indoors and outdoors. Heat waves are the #1 cause of death and hospitalization among weather evens in the U.S. (NRDC, ca. 2012), and such case are greatly underestimated because of various co-morbidities. The large majority of heat-related deaths in the U.S. occur in homes, and about 1/4 of those are in homes without air conditioning.

   Increased stagnation of outdoor air and increased temperatures due to climate change is also projected to increase the frequency of severe outdoor air pollution episodes. Such air pollution episodes would reduce the availability of cooling buildings by natural ventilation.

   Changes in extreme precipitation and wind also pose health concerns in terms of building design and operation. Increases in flooding and wind-driven rain would increase the risk of moisture damage and health hazards from indoor mold and bacterial growth, unless adaptive measures are taken.

3. Your planned modeling work to address relative humidity probabilities will be very useful. 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).

   Hot and humid heat waves ("Moist Tropical" types) are projected to increase in California over this century, according to a study by Sheridan et al. (2011) for the California Air Resources Board. The authors estimated that heat-related deaths, among just the elderly (≥ 65 years old) in California's major urban areas, would increase from about 500 per year to about 3,500 – 8,800 per year by the end of the century. The estimates varied, depending on different climate change models and the assumptions of acclimatization effectiveness. Another projected impact was the increase in warm nights during heat waves, which prevents full recovery from heat exposure and is a known risk factor for heat-related deaths and hospitalizations.

   Increased humidity also increases the cooling load on buildings and, hence, the peak demand on the power grid.

4. Will the project consider different thresholds or definitions for extreme heat episodes?

   For example, Sheridan et al. (2011) and their subsequent studies have used the Spatial Synoptic Classification of weather types to assess the impacts of heat waves in terms of temperature, humidity, and warm nights. This approach has also been used to develop heat-warning systems for cities. It should be considered for planning climate change adaptation in California.

   In addition, a recent study of heat advisory and emergency calls during a heat wave in Houston, Texas found that the vast majority of the calls occur when conditions are below the National Weather Service Heat Index advisory level (Hayden, 2014). This finding suggests that traditional heat stress metrics do not track very well the effects on public health or the need for cooled buildings. The SIMMER project at NCAR recommended looking at physiology-based metrics for heat stress, such as the Uniform Thermal Comfort Index, and other have suggested using the Wet Bulb Globe Temperature.

5. Guidance is needed on how to use climate change probabilities in California. Governmental and private sector groups are already using climate change projections for designing buildings. California should learn from the experience of these leading efforts in optimizing the life cycle performance of low carbon buildings and infrastructure.

   For example, the United Kingdom has developed probabilistic projections for climate change in the UK through the Prometheus Project (Eames et al., 2010; UKCIP, 2013). These probabilistic projections have been used to assess, design, build, and retrofit buildings and communities in the UK, in projects with a total worth over 3 billion pounds (University of Exeter, 2014). These projections are also being used to design the low carbon building standards for the UK.

   In addition, HVAC and building designers in North America now offer software to assess building performance under different climate change scenarios (Building Green, 2013 and 2014).

   Has the project team or the Commission's building energy efficiency programs contacted these groups for recommendations on best practice?

6. For the public health and building sectors, climate change probabilities are needed for not only maximum temperatures and humidity, but also: a) complete weather files to simulate building performance across the day and seasons; b) power outage probabilities; c) wildfire probabilities; and d) air quality standard exceedances probabilities.

   The first two items above are needed to estimate the risks of extreme heat episodes, including their frequency, intensity, and duration. Diffenbaugh and Ashfaq (2009) and Diffenbaugh et al. (2011) have modeled extreme heat in California through 2100 and have projected that these three heat wave characteristics will increase significantly by the 2030s. Weather data are also needed to assess the risks of wind-driven rain.

Probabilities for wildfires and air pollution episodes are needed because they will not only have a major impact on local air pollution and its health impacts, but also the ability of building occupants to open windows for night cooling during an air pollution and/or wildfire episode.

A list of useful climate change variables has been developed by UKCIP (2013).

7. Localized climate change projections, i.e., those with high spatial resolution, are needed. Air conditioning is often lacking or not used in buildings in the coastal areas of California and in low-income populations. Residents in these groups are at the highest risk during heat waves, as evidenced by California's 2006 heat wave. Some studies have found that persons in rural locations can be more vulnerable heat-related health impacts in some cases. In addition, locations in near proximity in California can have much different microclimates due to ocean and mountain influences.

   Thus, localized climate change projections, especially if they can be combined with local information on building stock and it’s thermal properties, would allow California to identify the building types and populations most vulnerable to heat waves. This has been done in some other locations to help identify the best strategies for building weatherization efforts and for locating cooling centers.

8. Projections of probabilities for disruption of our power grid due to population growth and climate change, via increased temperature, humidity, and wildfires, are needed to help reduce the incidence and duration of power outages.

   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.

9. Do your climate models include feedback effects of increased use of air-conditioning? Increased usage of air-conditioning during heat waves may be a

short-term fix, but it exacerbates the problem. It increases the urban heat island effect on temperature and air pollution by creating more outdoor heat sources, and it increases the emissions of GHGs from electricity production. Current climate change models do not incorporate these negative feedback loops from increased use of air-conditioning, from what I have heard from climate change experts.

10. The Commission's Building Energy Efficiency programs may be interested in the eTherm software from the University of Exeter, which greatly reduces building performance simulation time (University of Exeter, 2014). This software allows additional metrics and design options to be assessed in a reasonable amount of time.

I hope these comments will help California leverage the efforts of your project toward adapting to the public health impacts of climate change and toward improving the resilience of our built environment and health systems. Please feel free to contact me if you have questions or need further information.

Sincerely,

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References: on following pages.

REFERENCES

Building Green, 2013. Designing for the Next Century's Weather. Environmental Building News, September 30. https://www2.buildinggreen.com/article/designing-next-centurys-weather.

Building Green, 2014. Tuning Today's Building Designs to Tomorrow's Climate. Environmental Building News, August 3. https://www2.buildinggreen.com/article/tuning-today-s-building-designs-tomorrow-s-climate.
See also: E. Katzenstein, April 30, 2014. Climate Data Trajectories. LMN Architects. http://lmnarchitects.com/tech-studio/parametrics/climate-data-trajectories/.

Diffenbaugh and Ashfaq, 2010. Intensification of hot extremes in the United States. Geophys. Res. Lett., 37, L15701, doi:10.1029/2010GL043888. http://onlinelibrary.wiley.com/doi/10.1029/2010GL043888/abstract.

Diffenbaugh et al., 2011. Transient regional climate change: analysis of the summer climate response in a high-resolution, century-scale, ensemble experiment over the continental United States. J Geophys Res. 2011 Dec 27;116(D24). doi: 10.1029/2011JD016458. http://www.ncbi.nlm.nih.gov/pubmed/24307747. See Free Text link.

Eames et al., 2010. On the creation of future probabilistic design weather years from UKCP09. Building Services Engineering Research and Technology May 2011, 32: 127-142, first published on October 20, 2010. doi:10.1177/0143624410379934. http://bse.sagepub.com/content/32/2/127.short?rss=1&ssource=mfr.
See also Other Articles Citing This Paper link).
See also: University of Exeter, Prometheus Project on future-proofing building design.

Eason, 2014. Blackout Tracker, 2014 Annual Report. http://powerquality.eaton.com/blackouttracker/default.asp?wtredirect=www.eaton.com/blackouttracker.

Gershunov et al., 2013. "Future Climate: Projected Extremes." In Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment, edited by G. Garfin, A. Jardine, R. Merideth, M. Black, and S. LeRoy, 126–147. A report by the Southwest Climate Alliance. Washington, DC: Island Press. http://cnap.ucsd.edu/pdffiles/ACCSWUS_Ch7.pdf.

Hayden, M., February 21, 2014. Reducing urban vulnerability to extreme heat: an integrated approach. San Antonio, TX. http://www.solarsanantonio.org/wp-content/uploads/2014/01/hayden_1015am_022114.pdf.

Mastrandrea et al., 2009. Current and Future Impacts of Extreme Events in California. California Climate Change Center. CEC PIER Report.

http://www.energy.ca.gov/2009publications/CEC-500-2009-026/CEC-500-2009-026-F.PDF.
See also: journal version at http://link.springer.com/article/10.1007%2Fs10584-011-0311-6 - page-1.

NRDC, ca. 2012. "Extreme Heat: More Intense Hot Days and Heat Waves." Natural Resources Defense Council. http://www.nrdc.org/health/climate/heat.asp.

Public Health Workgroup, October 2013. Preparing California for Extreme Heat: Guidance and Recommendations. AB 32 California Climate Action Team. http://www.climatechange.ca.gov/climate_action_team/reports/Preparing_California_for_Extreme_Heat.pdf.

Roaf et al., 2015. Counting the costs of comfort. Building Research & Information, Vol. 43, Iss. 3, 2015. http://www.tandfonline.com/doi/full/10.1080/09613218.2014.998948#abstract (open access).

Sathaye et al., 2011. Estimating Risk to California Energy Infrastructure from Projected Climate Change. Lawrence Berkeley National Laboratory. Prepared for the California Energy Commission. Publication number: CEC-500-2011-XXX. http://www.osti.gov/scitech/servlets/purl/1026811/.
Summary in press release at http://newscenter.lbl.gov/2012/12/18/impact-of-climate-change-on-california-electricity-infrastructure-could-be-costly/.

Sheridan et al., 2011. A Spatial Synoptic Classification approach to projected heat vulnerability in California under future climate change scenarios. Final report, presentation, and journal articles at http://www.arb.ca.gov/research/single-project.php?row_id=64809. Prepared for California Air Resources Board.
See also: links to other journal publications at http://sheridan.geog.kent.edu/publications.html.

University of Exeter, 2014. EPSRC Fellowship (eTherm model). 2014 Annual Report. http://centres.exeter.ac.uk/cee/publications/annual/14.pdf, pp. 18-19.
See also: Wood et al., 2014. Proof and Concept for the Bayesian Analysis of Computer Code Output for Building Energy Modeling. Proceedings of the Building Simulation and Optimisation Conference 2014, Paper ID 103. http://www.bso14.org/BSO14_Papers/BSO14_Paper_103.pdf.
See also: eTherm, http://emps.exeter.ac.uk/research/energy-environment/cee/research/etherm/.

University of Exeter, 2015. Prometheus Project: The Use of Probabilistic Climate Change Data to Future-proof Design Decisions in the Building Sector. Project Proposal, http://emps.exeter.ac.uk/research/energy-environment/cee/research/prometheus/projectproposal/.
See also: links to Publications and Downloads.

See also: Future Proofing Building Design,
http://www.exeter.ac.uk/ref2014/impact/physicalsciences/buildingdesign/.

UKCIP, 2013. "UKCIP: supporting adaptation." Case studies, tools, projects, and resources for climate change adaptation of buildings and infrastructure.
http://archive.ukcip.org.uk/.
See also: Tools / Checklist of Climate Variables,
http://archive.ukcip.org.uk/wizard/wizard/3-2/checklist-climate-variables/.