Flipping the Net Zero Policy on Its Head: Using Thermal Resilience to Advocate for Community Justice and Net Zero Energy

Getting to Zero Forum – NYC,October 29th, 2021

11:00 AM-12:30 PM

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Amir Rezaei, PhD BEMP

High Performance Building Analyst

CannonDesign

Alex Wilson

President

Resilient Design Institute

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Agenda

- Power Outages and Thermal Stress Background
- National Net Zero Policies and Implementation Gaps
- Passive Thermal Habitability (PTH) Framework
- PTH Framework for Code and Policy
- Summary and Conclusions

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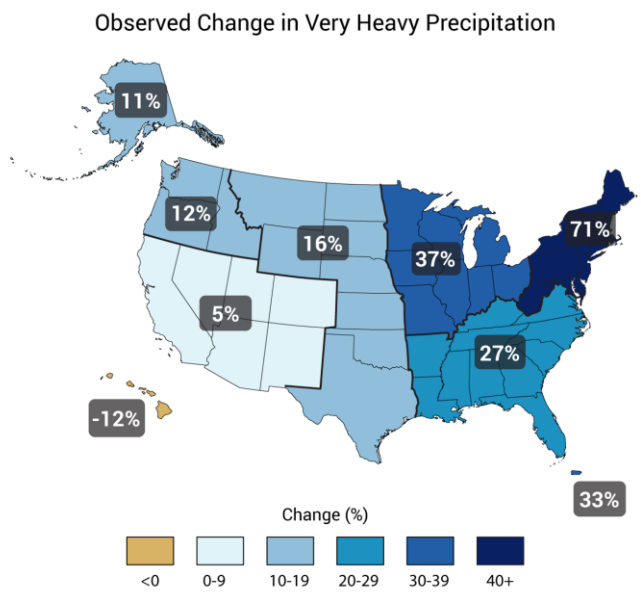
Vulnerability to Power Outages

- Growing risk with climate change
  - Flooding
  - Drought
  - Wildfire
- Non-climate-related risks
  - Earthquakes
  - Terrorism
- Threatens health and safety
- The impacts greatest for the poor



Percent increase in very heavy precipitation 1958-2012 (defined as the heaviest 1% of all events). Source: 2014 National Climate Assessment

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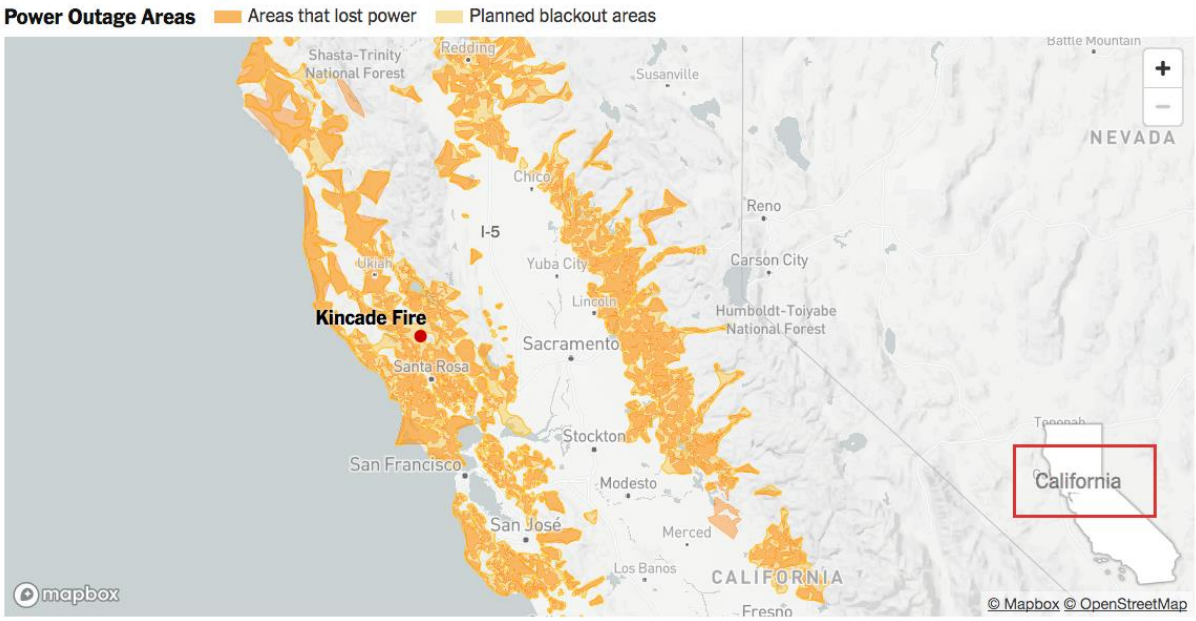

Pre-emptive power outages in the Pacific Gas & Electric territory on October 28, 2019 due to liability concerns about sparking wildfires. Source: Pacific Gas & Electric

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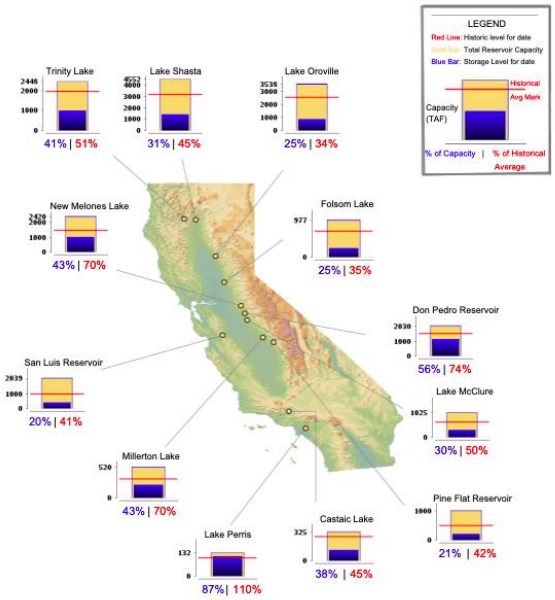
Drought Puts Power Plants at Risk

- Hydropower plants may cease generating power in droughts
- 89% of U.S. power plants are thermo-electric, and most require cooling water
- During extreme drought, some thermo-electric plants will have to reduce power or even shut down



California reservoir capacities on August 2, 2021. Source: California Dept. of Water Resources

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July 2012 power outage in India. The area in dark-red experienced 2-day outage; in light red 1-day. Source: Creative Commons

Power outages outside the United States

- Some parts of the world more vulnerable than the U.S.
- World's largest power outage occurred in India in July 2012
- Relative infrequency of power outages in the U.S. means that we're not as prepared

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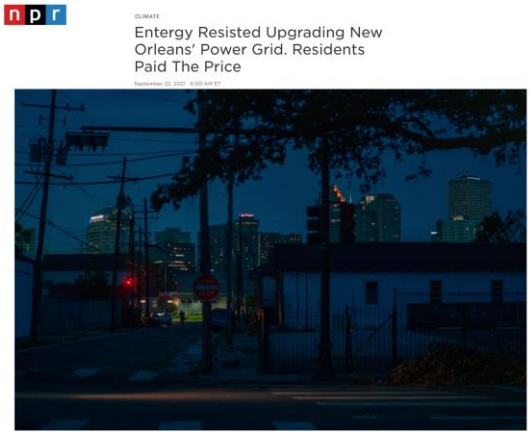
Power Outages Can Have Deadly Consequences

- No matter the cause of the outage, the impacts can be dangerous
- During the summer, risk of extreme heat in buildings
- During winter, risk of hypothermia from low temperatures



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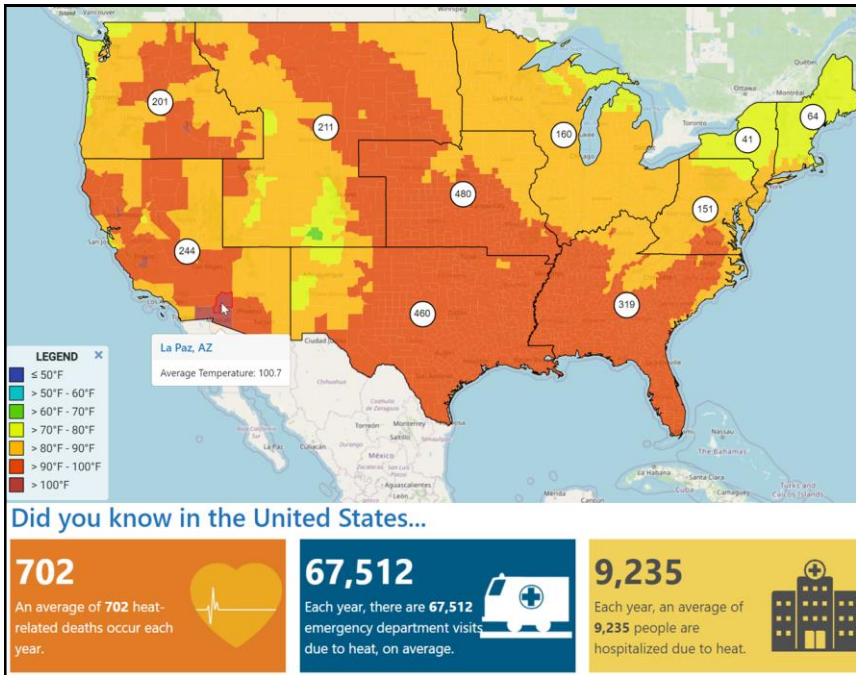

Heat Related ER Visits

https://ephtracking.cdc.gov/Applications/heatTracker/

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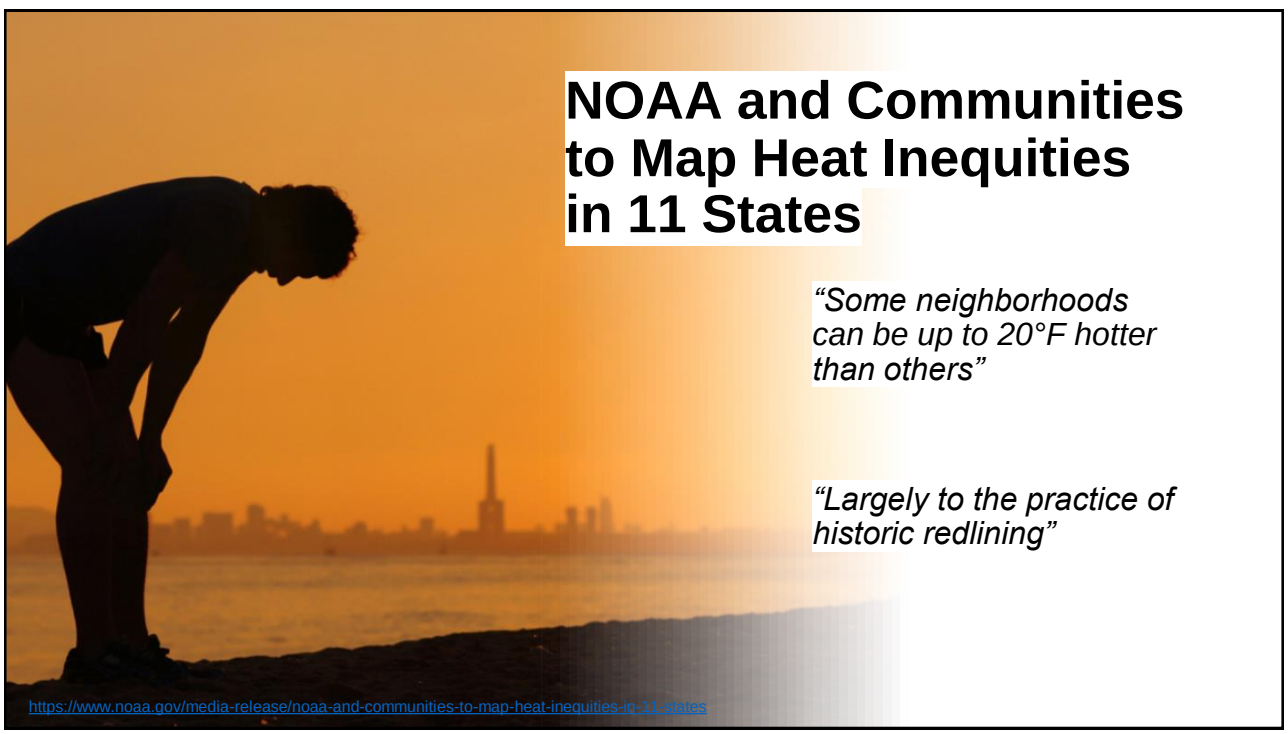

NOAA and Communities to Map Heat Inequities in 11 States

"Some neighborhoods can be up to 20°F hotter than others"

"Largely to the practice of historic redlining"

https://www.noaa.gov/media-release/noaa-and-communities-to-map-heat-inequities-in-11-states

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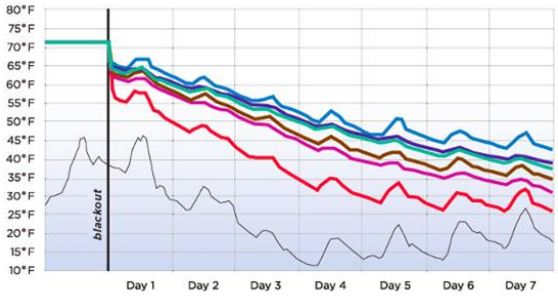
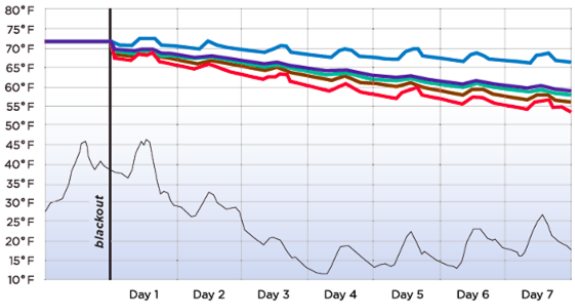
Typical buildings



Energy-efficient buildings



Row House
Brick Low-Rise
Brick High-Rise
All-Glass High-Rise
Single-Family House

Temperature modeling by Atelier Ten for six building types in New York City during a week-long power outage in the winter. Graph on the left showing typical buildings; on the right, energy-efficient buildings. Source: "Baby It's Cold Inside," published by the Urban Green Council.

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More energy-efficient houses keep occupants safer

Thermal image of row houses in Brooklyn, New York. Reds and yellows indicate higher surface temperatures (more heat loss). Very little heat is being lost from the house in the center, which was retrofit to meet Passive House standards. Photo: SGBuild.com

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Another Motivation for Net-Zero-Energy-Performance Codes

- Extremely low-energy buildings keep their occupants safer
- Economically disadvantaged Americans suffer disproportionately during power outages
- We know how to make buildings safer through Passive Thermal Habitability or Passive Survivability
- Building codes could require ultra-low-energy consumption—as a life-safety measure
- The motivation of life-safety may be more palatable politically than legislating based on environmental grounds or dollar savings

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Building Codes Have Typically Emerged from Disasters or Health Problems

- Fire codes created or strengthened following the Great Fire in London in 1666 and the Great Chicago Fire in 1871
- Plumbing codes following Typhoid outbreaks and dysentery resulting from contaminated water supplies
- Seismic codes following the 1755 Lisbon Earthquake in Portugal
- Structural building codes following significant building collapses in Boston and New York City
- Power outages can be disasters depending on when they occur and their duration
- Life-Safety justification for NZ codes can head off perception of energy performance as a “Luxury”

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Thermal Risk Metrics – Occupational Health

"these metrics were created primarily for outdoor conditions; they are not ideal metrics of indoor climatic conditions—but for now, they are what we have to work with"

Wet-Bulb Globe Temperature (WBGT)

Heat Stress Category (WBGT)	Moderate Work		Hard Work	
	Work/Rest Cycle	Water Intake Per Hour	Work/Rest Cycle	Water Intake Per Hour
White ≤76.9°F (≤24.9°C)	60/15 MINUTES	300 ml (1/3 qt)	40/20 MINUTES	500 ml (1/2 qt)
Green 77-81.9°F (25-27.7°C)	60/15 MINUTES	750 ml (3/4 qt)	40/20 MINUTES	1000 ml (1 qt)
Yellow 82-84.9°F (27.8-29.4°C)	40/20 MINUTES	1000 ml (1 qt)	30/30 MINUTES	1000 ml (1 qt)
Red 85-88.9°F (29.5-31.6°C)	30/30 MINUTES	1000 ml (1 qt)	**Exercise is forbidden. Very high risk for heat casualties.**	
Black ≥89°F (≥31.7°C)	**Exercise is forbidden. Very high risk for heat casualties.**			

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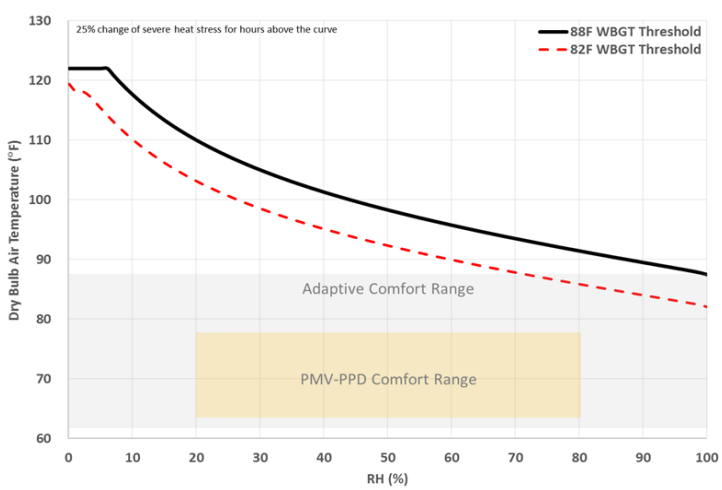
Temperature AND Humidity Matter!

- Comfort versus Habitability
- What Code's got to do with it?



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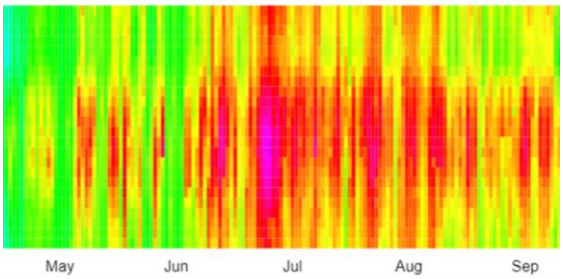
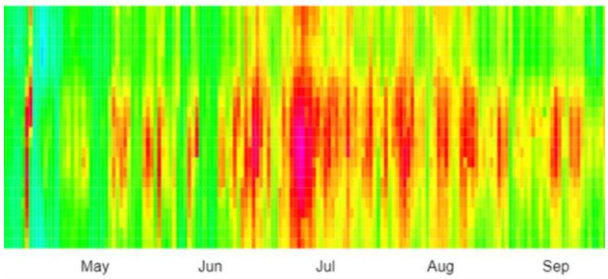


Total number of hours OA Temp above 86°F = 232

Total number of hours OA Temp below 54°F = 4300



Total number of hours OA Temp above 86°F = 80

Total number of hours OA Temp below 54°F = 4880

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Summer	216 °F·SET-Hour above **86 °F (30 °C) SET**
Winter	216 °F·SET-Hour below **54 °F (12 °C) SET**
Natural ventilation	**5 CFM (8.5 m^3/h) per person ≈ 3-5 ACH**
HVAC and Internal Loads Off	
Natural or Designed Shading May be Included	

LEED Pilot Credit: Passive Survivability and Back-up Power During Disruptions

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Gaps for Building Evaluation Based on PTH

How to provide an overall score for a building?

How to account for regional weather differences?

How to account for different human physiology?

How does age, illness and body weight affect passive thermal survivability?

Should building age be a factor?

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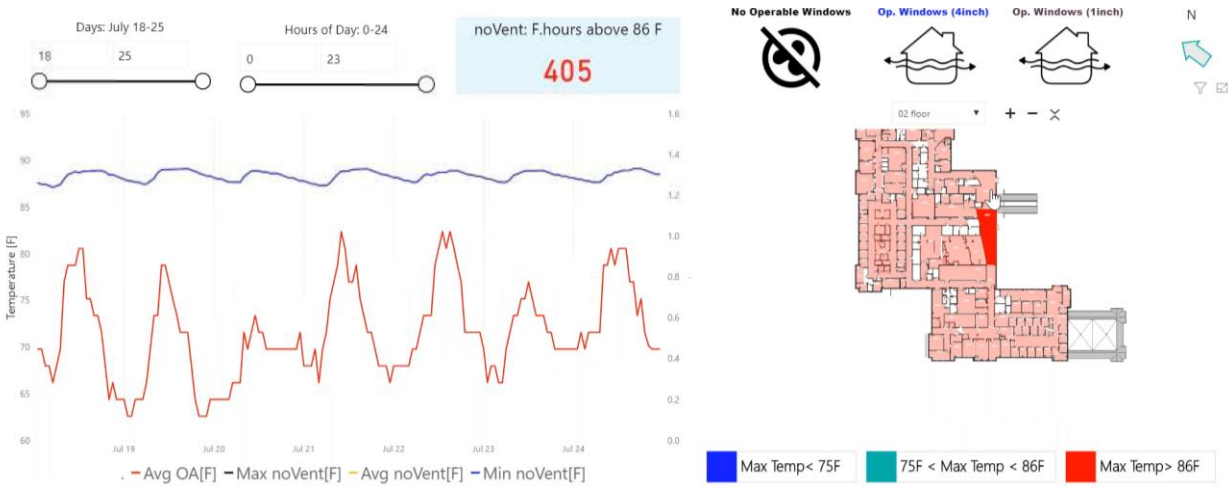
A Whole Building PTH Analysis Framework



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A Whole Building PTH Analysis Framework

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PTH Framework Questions for Code Inclusion

- PTH metrics to code “minimum” values translation!
- Net zero/high performance buildings and PTH
- Code Climate Zone regions
- Active and passive design elements

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Summary and Conclusions

- Ultra-low-energy buildings keep occupants safer during power outages
- Power outages are likely to become more common with more intense storms, drought, and wildfire as a result of climate change
- Impacts of power outages are most severe for the economically disadvantaged
- We can model thermal conditions in buildings
- Based on thermal modeling we can create building codes that mandate ultra low energy consumption

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