Cal-THRIVES: A California Toolkit for Heat Resilience in Underserved Environments

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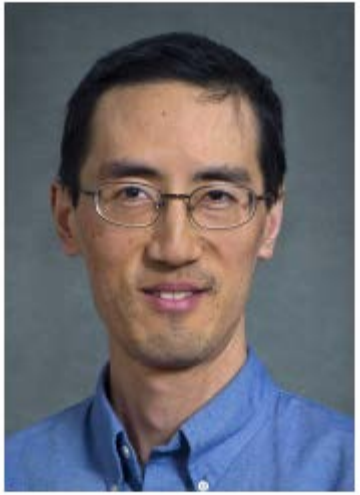
UCCS Event: Protecting Underserved California Homes from Extreme Heat (online) • 24 February 2022



Research Background and Objectives

EXTREME HEAT:

"**Heat now causes more deaths** than hurricanes, tornadoes or floods in most years"

The Guardian, June, 2020

"Most costly climate change impact in CA by 2050" *CA 4th Climate Change Assessment, 2018*

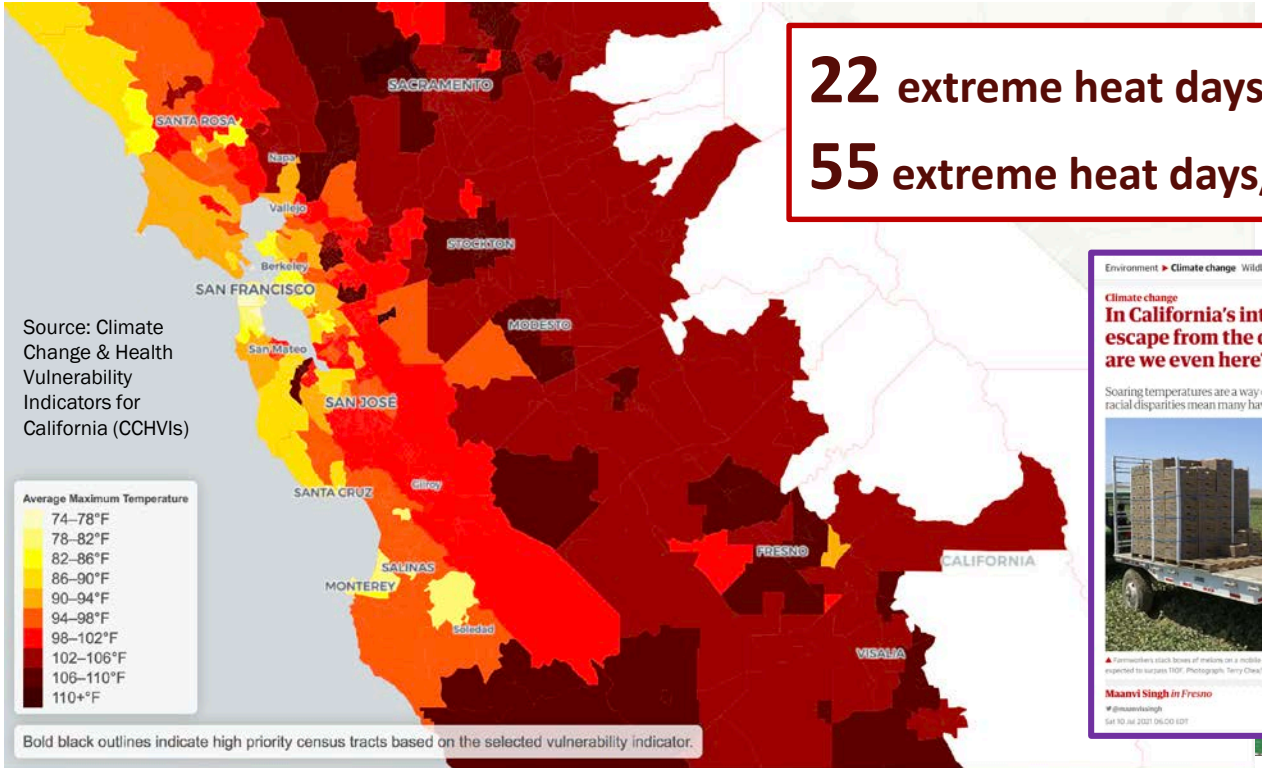
Research objectives:

- Develop methodology to model heat resilience at neighborhood scale
- Quantify resilience benefits of passive and active measures during extreme heat waves in a disadvantaged community
- Develop a set of toolkit items to help disadvantaged community (DAC) residents better cope with extreme heat

Heat is increasingly brutal in California's Central Valley, where low incomes, poor air quality, old homes, and high utility bills disadvantage many residents

California and Fresno are hot

…**and getting hotter**



Source: Climate Change & Health Vulnerability Indicators for California (CCHVIs)

22 extreme heat days/year by 2040 - 2060

55 extreme heat days/year by 2080 - 2099

Environment ▸ Climate change Wildlife Energy Pollution Green light

Climate change

In California's interior, there's no escape from the desperate heat: 'Why are we even here?'

Soaring temperatures are a way of life in the Central Valley, but racial disparities mean many have no access to relief

▲ Farmworkers stack boxes of melons on a mobile platform in Firebaugh, California, where temperatures are expected to surpass 110F. Photograph: Terry Chea/AP

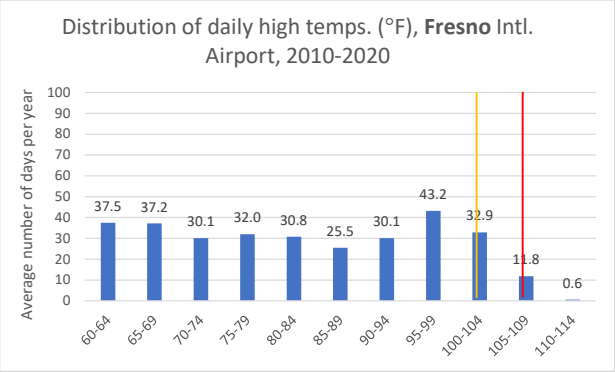
Maanvi Singh *in Fresno*

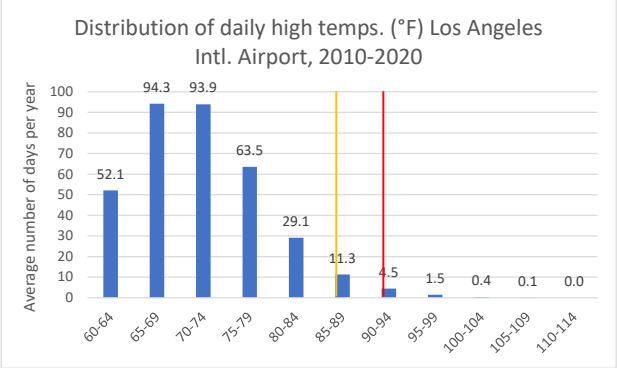
@maanvisingh

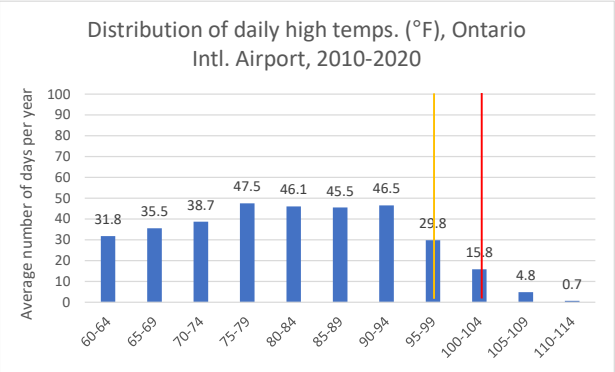
Sat 10 Jul 2021 06.00 EDT

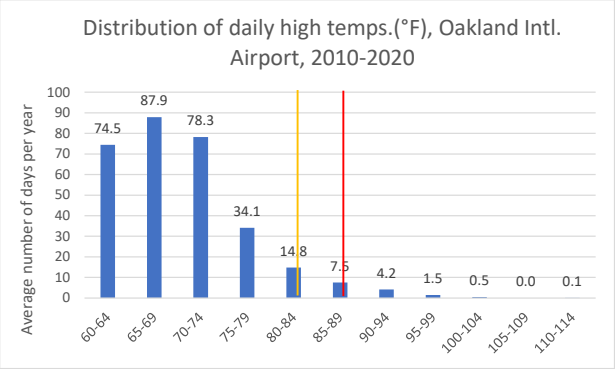
https://www.theguardian.com/us-news/2021/jul/10/california-central-valley-extreme-heat-race

There are **large differences in annual distribution of heat** (chronic vs. acute heat): about twice as many "very hot to extremely hot days" in Fresno and Ontario (CA), for example, than in coastal areas, and 50-100 times more days above 100 °F









	"Extreme heat day" thresh-old (°F, red line); Days/yr.	"Very hot day" (within in 5 °F of extreme heat, orange line)	Annual Days above "very hot day" thresh-old	Annual Days above 100 °F
Fresno	**106.1; 10**	**101.1**	**39**	**45***
Ontario	103.6; 10	98.6	30	22
Los Angeles	90.5; 5	85.5	17	0.4
Oakland	88.4; 10	83.4	18	0.5

***Chronically hot:** Fresno days >100 °F have increased by 21% since 1960-90 to an average of 45 days per year.

The good news is that we **can implement preventative strategies now** to mitigate heat health impacts

The Cal-THRIVES project has developed a toolkit for local and state stakeholders

SHORT TERM

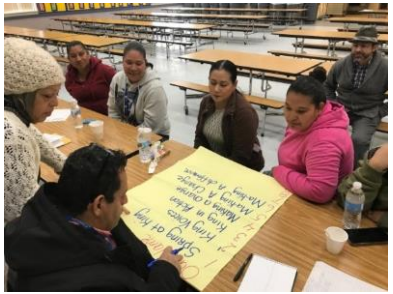
- Increase awareness of heat-related vulnerability
- Identify areas that are vulnerable to extreme heat events

NEAR TERM

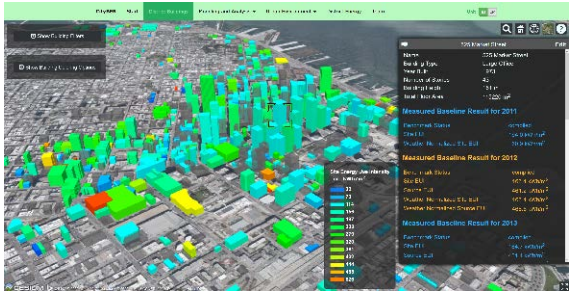
- Remedy the built environment, such as building retrofits & increases to tree canopy
- Enhance community and home cooling programs

Approach: Our heat-resilience toolkit incorporates both **community inputs and science**

Community engagement

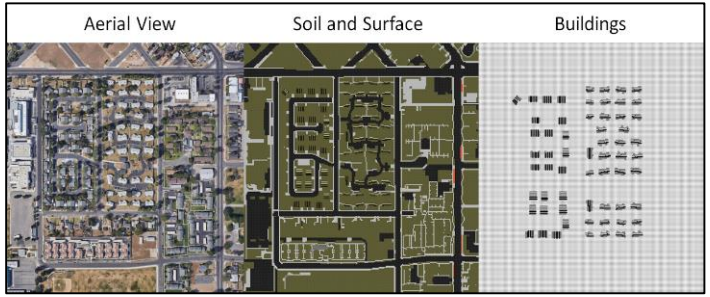


Neighborhood-scale building modeling



Cooling center optimization

Outdoor measure modeling

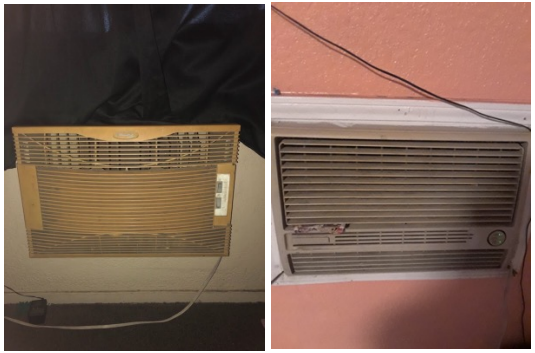


Heat Resilience Toolkit

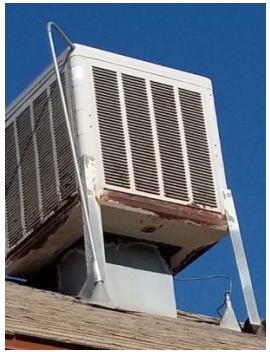
Community cooling guide
Fact sheets
Modeling outputs
Heat vulnerability index tool
Online tutorials (videos, webinars)
Policy/program recommendations

We find **several key vulnerabilities** for residents in disadvantaged communities (DACs) in south Fresno

- Over 70% are uncomfortably hot at home very often during the summer
- Residents on the top floors and those residents in units that lack air conditioning (about 15%) are especially vulnerable



Old, inefficient window ACs

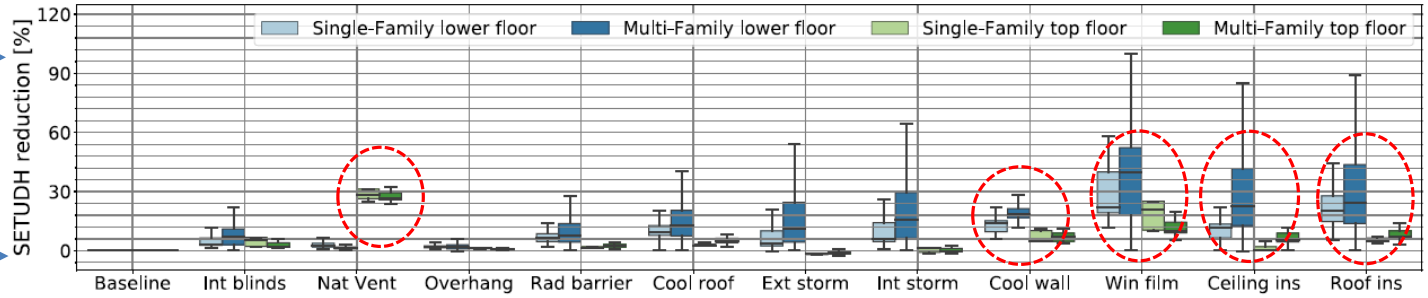


Swamp coolers

Window films, roof/ceiling insulation, and cool walls are the among the most effective passive measures overall; **natural ventilation** on top floors is very helpful

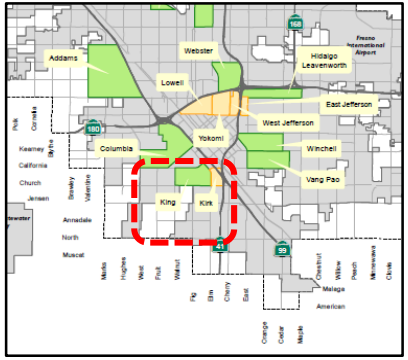
More protection from extreme heat (bigger value)

Less protection from extreme heat (lower value)



(c) King Passive 5-Day SETUDH Relative Reduction Grid Off

Modeled for worst case historical heat wave conditions across five days



King & Kirk neighborhoods in Fresno

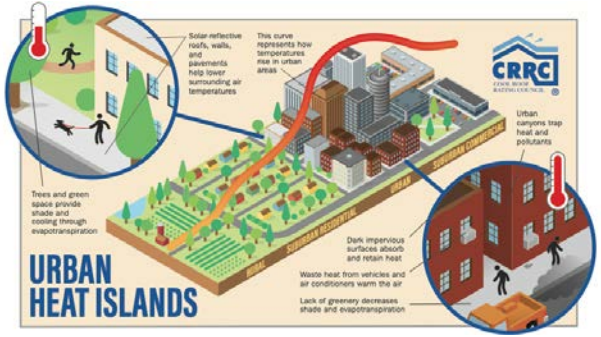
Policy and program recommendations

❶ Heat-island countermeasures provide **failsafe cooling** and can be **5-10X more effective indoors** than outside

Cool roofs

Cool walls

Shade trees



<u>We propose more stringent requirements for cool walls and cool roofs when roofs need replacement and when homes need repainting</u>

R. Levinson - LBNL Heat Island Group Leader

❷ California's building standards should be upgraded to promote extreme-heat solutions based on **human outcomes** (⇩ death, illness, & misery)

CALGreen

California's Title 24 energy & green building standards currently focus on **energy**, **carbon**, and/or **cost savings**

<u>Standards should reward improvements to thermal safety, comfort, & productivity</u>

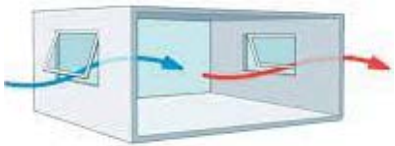
❸ We need to **pilot and demonstrate** these promising passive and active cooling measures to determine what works best for residents

Examples of high impact measures:

Solar-control window films

Cool walls

Natural ventilation

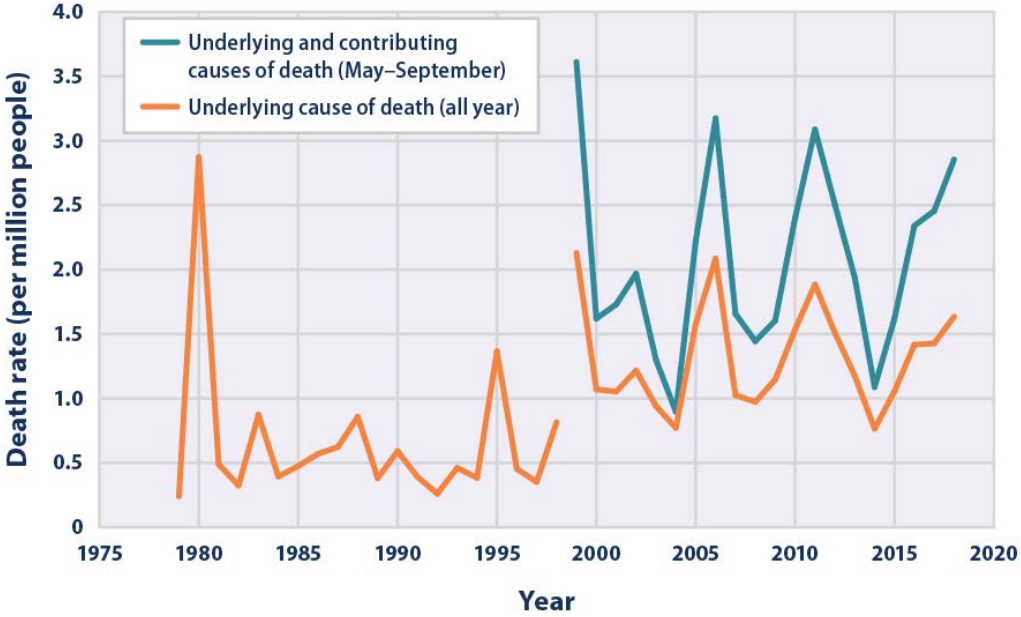


Ceiling fans

Mini-split AC/heat pumps

❹ To guide California's future investments, extreme-heat mitigation programs should dedicate resources to **monitoring outcomes**

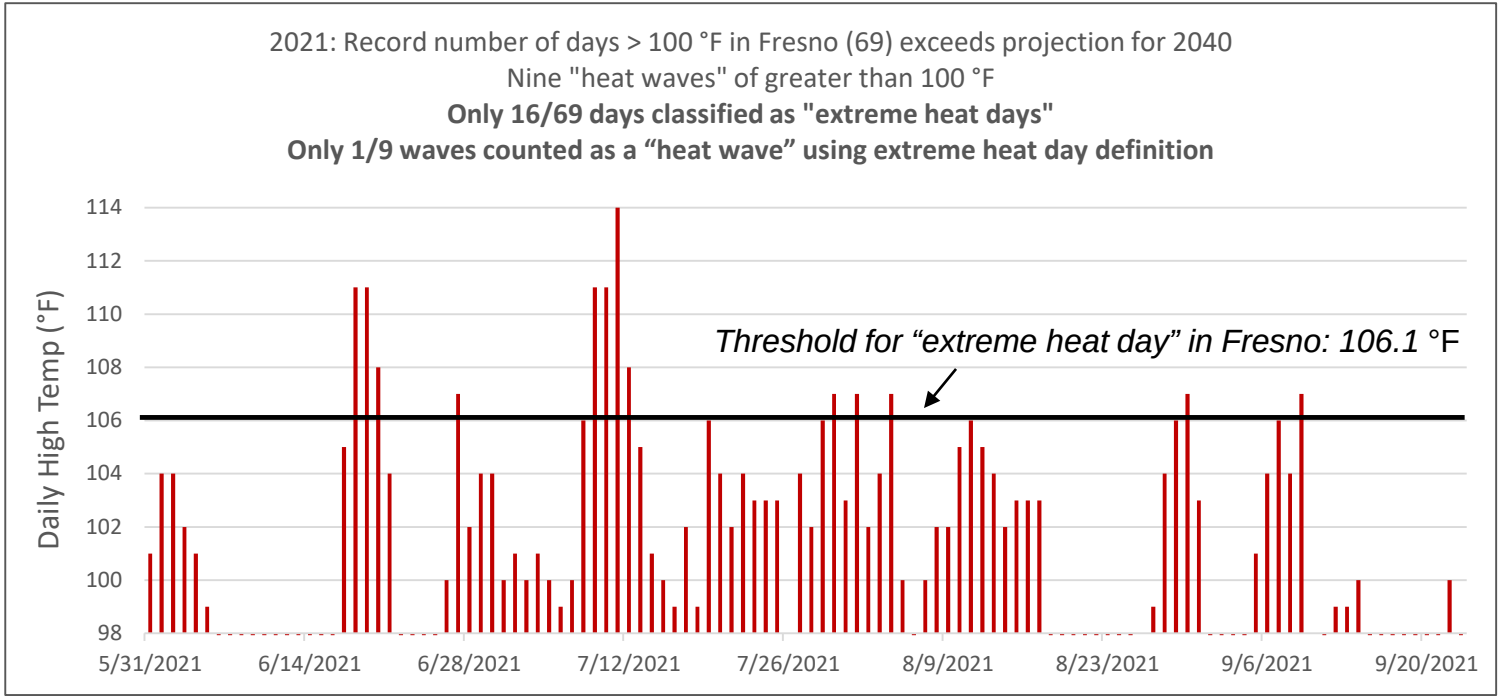
U.S. heat deaths per million people, 1979-2018 (U.S. EPA)



Let's learn what works by measuring

- <u>reductions</u> in temperature, heat stress, illness, hospitalizations, deaths
- <u>improvements</u> to health, comfort, productivity, learning

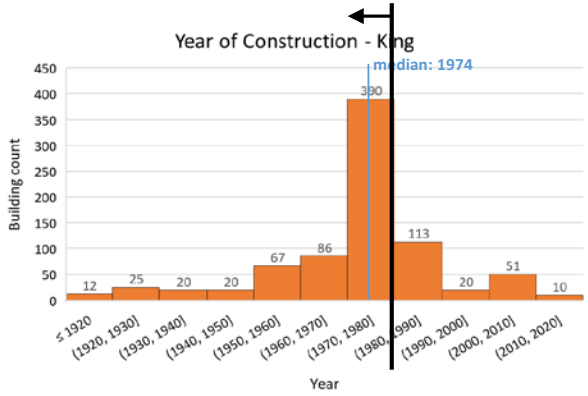
❺ We need more **equitable definitions** of extreme heat and heat waves

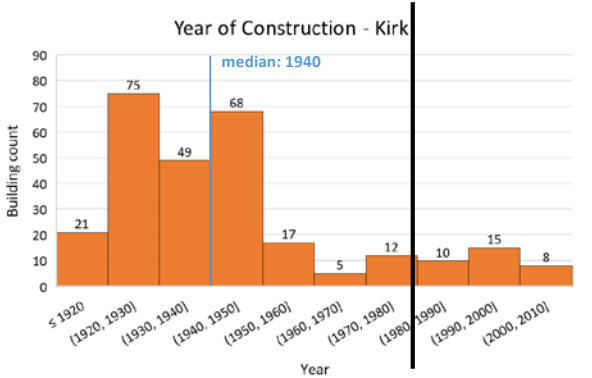


<u>Consider fixed-value definitions for extreme heat and/or extreme heat waves, such as "four or more days above 100 °F," in addition to location-dependent thresholds for extreme heat days</u>

❻ We need mechanisms/ programs to ensure adequate cooling in **existing homes,** especially in **Low Income/DAC** areas with older buildings

Pre-1980 homes





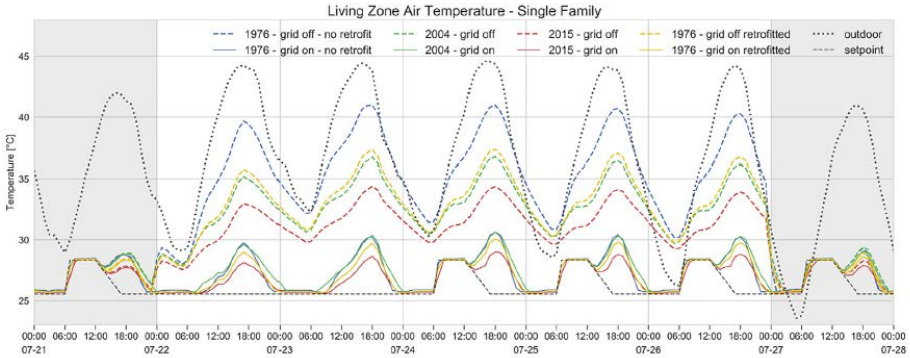
- Most of the homes in southwest Fresno are **older single-family homes** (80% are pre-1980)
- We need to find mechanisms other than new building codes to cool these existing buildings, e.g.:
  - Expanding existing weatherization and low-income assistance programs
  - Requiring adequate cooling on home point-of-sale
  - Requiring cooling equipment inspection during other home inspections

❼ **Expanding weatherization audits** for energy efficiency (EE) to include climate resilience is recommended for identifying homes most in need of heat resilience upgrades

- Climate resilience audits expand the scope of existing EE audits and auditors would need additional training and well-defined protocols for privacy and data collection
- Additional home audit checklist items might include
  - Age of AC system, type of AC
  - Testing AC system operation
  - Collecting some demographic information about residents such as ages of residents and underlying health conditions
  - Noting risk factors for overheating – top floors, south facing windows, inoperable windows, mobility of residents, transportation options of residents
- These should feed into a ‘heat vulnerability index’ score to identify those most in need for interventions such as home cooling upgrade

❽ All homes should have a **minimum cooling standard** or equivalently a max indoor temperature allowed

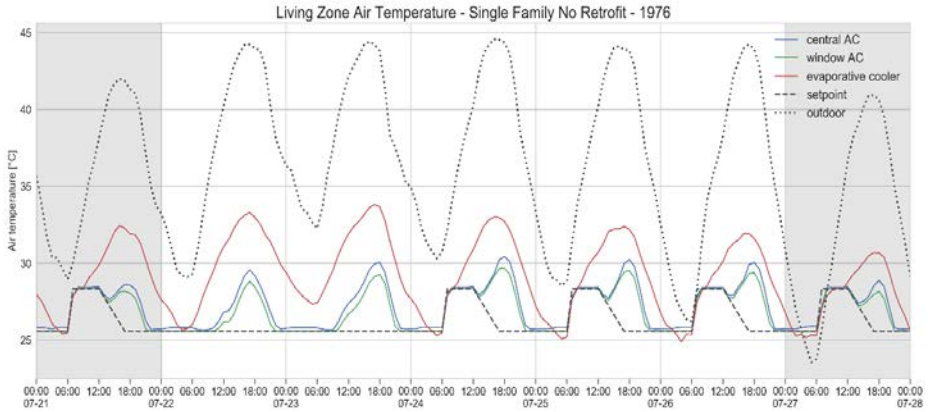
- Our research shows homes without AC get dangerously hot and increasingly so with climate change (95-106 °F, fig. below)
- Minimum cooling standards would avoid dangerous situations and prevent worst case heat exposure to residents
- Some policy options include:
  - New homes: include in Title 24 building code or CAL-GREEN
  - Existing homes: state habitability requirements
  - Existing owner-occupied: require inspection at point of sale, or require inspection during other permitting work
- Specific requirements would be set by a consensus process similar to Title 24 approach



Modeled for worst case historical heat wave conditions across five days

❾ All homes without an AC unit in Fresno should get **at least one AC or heat pump (HP) unit** to safely withstand extreme heat waves

- Many homes in Fresno without an AC unit and only have swamp coolers, which are inadequate for extreme heat (fig. below)
- Homes without an AC in Fresno and other hot climate areas should be prioritized for upgrades to receive an AC or heat pump unit
- Increased use of cooling will increase electricity consumption and additional financial assistance may be needed to avoid residents facing higher utility bills



Modeled for worst case historical heat wave conditions across five days

⑩ More R&D is needed to support resilient, equitable decarbonization

- Non-energy metric development and quantification of impacts to support codes and standards development
- Monitoring of installed measures and their effectiveness
- Development of “comprehensive climate assessments” to consolidate separate audits/assessments
- Decision support tools for larger scale deployment
  - E.g., tool like Home Energy Saver for extreme heat and climate resilient buildings

Thank you

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We also thank the **SGC Climate Change Research Program** for their support and our research partners below: