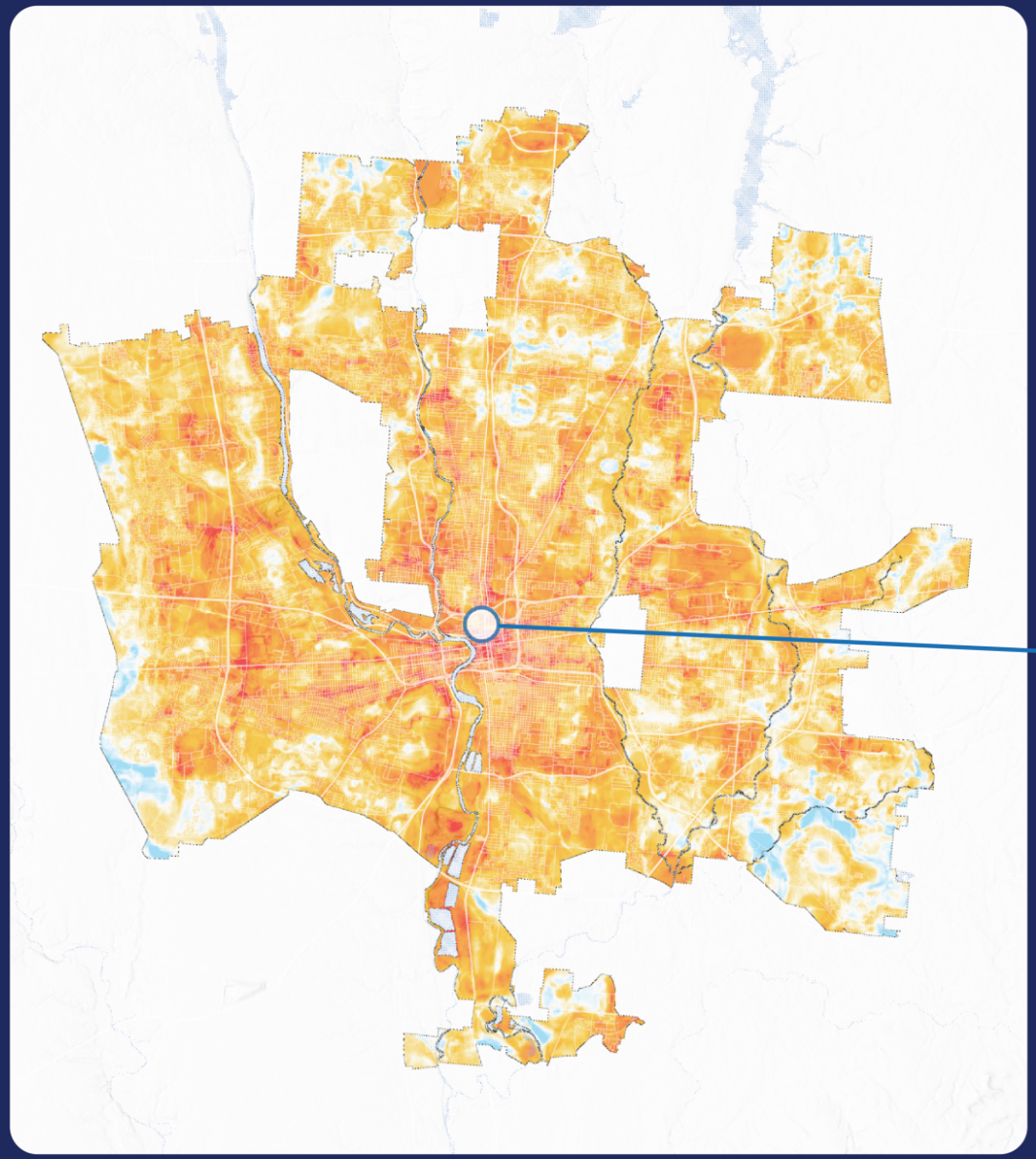
Heat-Energy-Vulnerability Nexus during an Extreme Climate-Induced Event:

Early evidence

March 28th, 2023

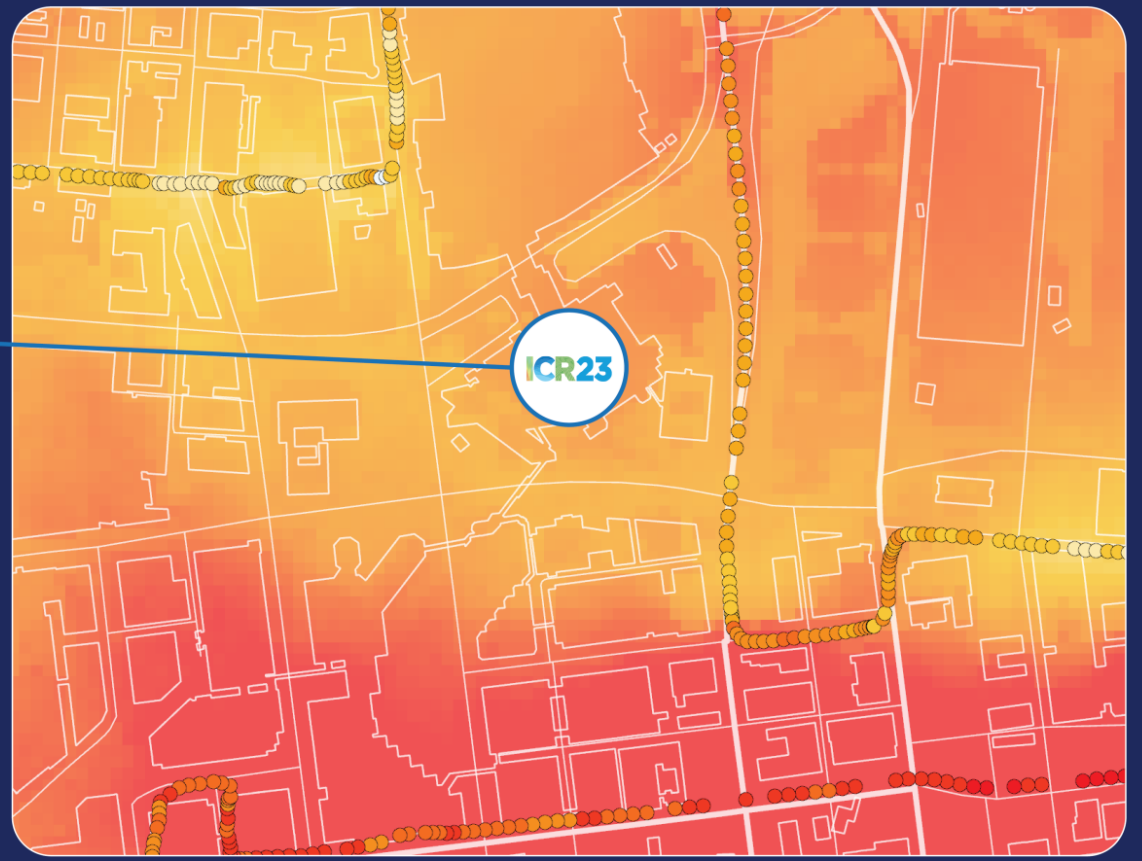
CAPA



12° F
Temperature Differential

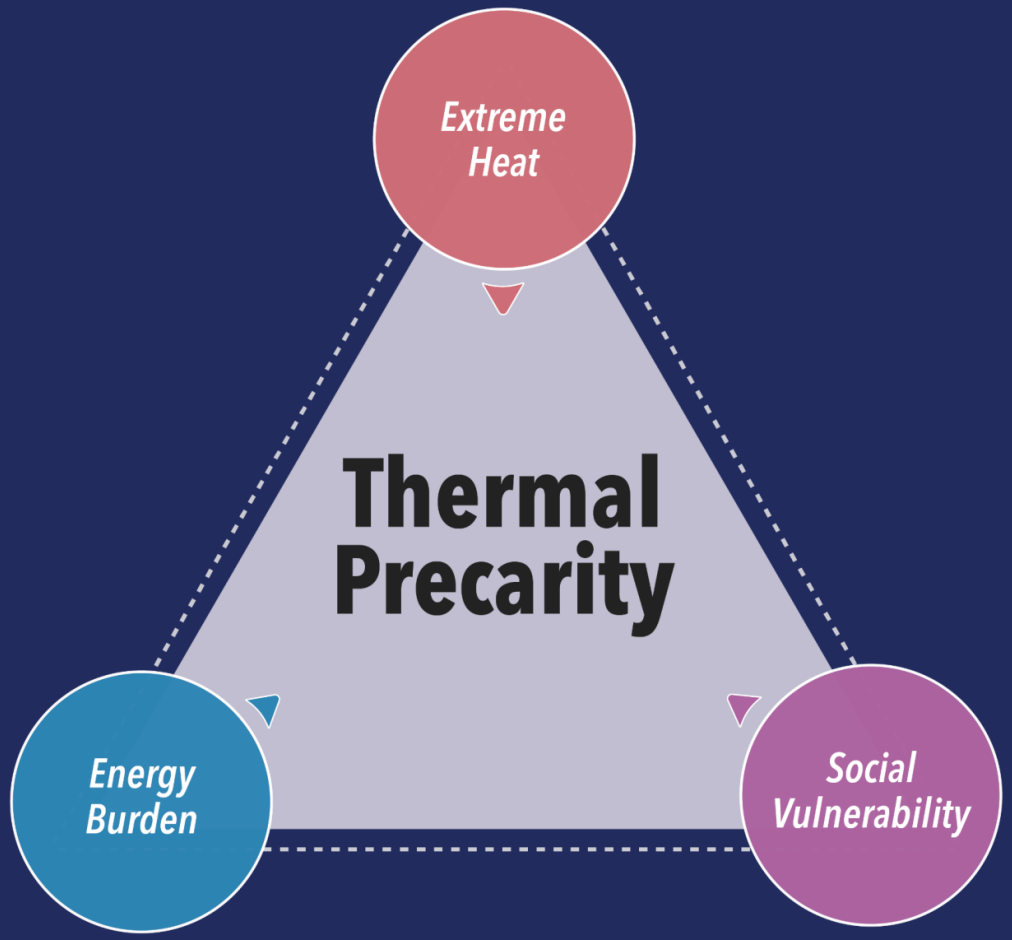
112k
Temperature Measurements

CAPA



Background + Research Questions

- Local utility experiencing unprecedented peak loads during Heat Dome
- Looking for equitable strategy to manage grid capacity
- How do socio-demographic differences change behavioral response throughout an extreme heat event?
- How do spatial differences in the City's built infrastructure lead to differential heat exposures?
- What are the statistical relationships between temperature, energy usage, and heat-related social variables?


Extreme Heat
Thermal Precarity
Energy Burden
Social Vulnerability

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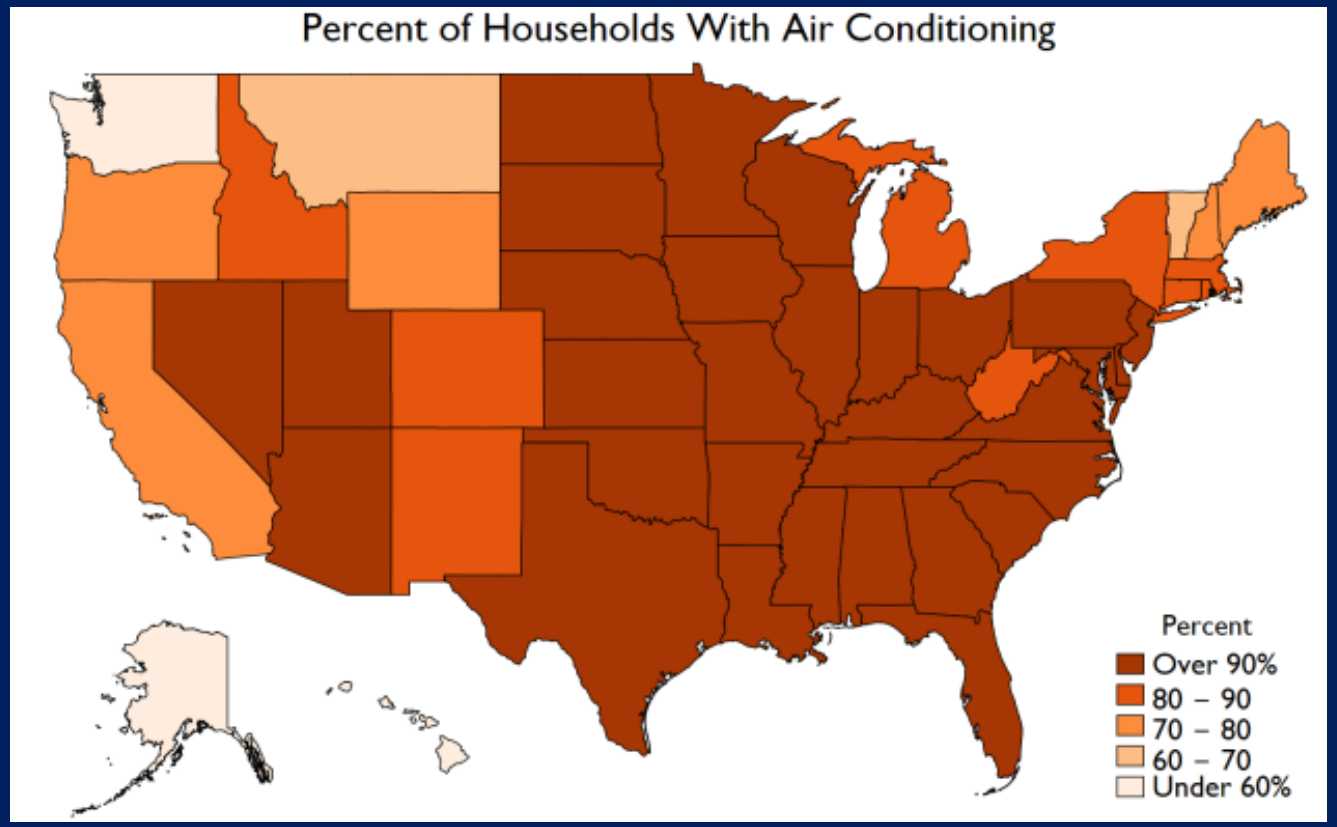
Air Conditioning Adoption

10% increase nationally in 2020



American Housing Survey[4]		
Year	% AC	% Change
2011	41.2	-
2015	69.9	69.7
2019	78.6	12.4

https://www.eia.gov/consumption/residential/data/2020/index.php?view=microdata

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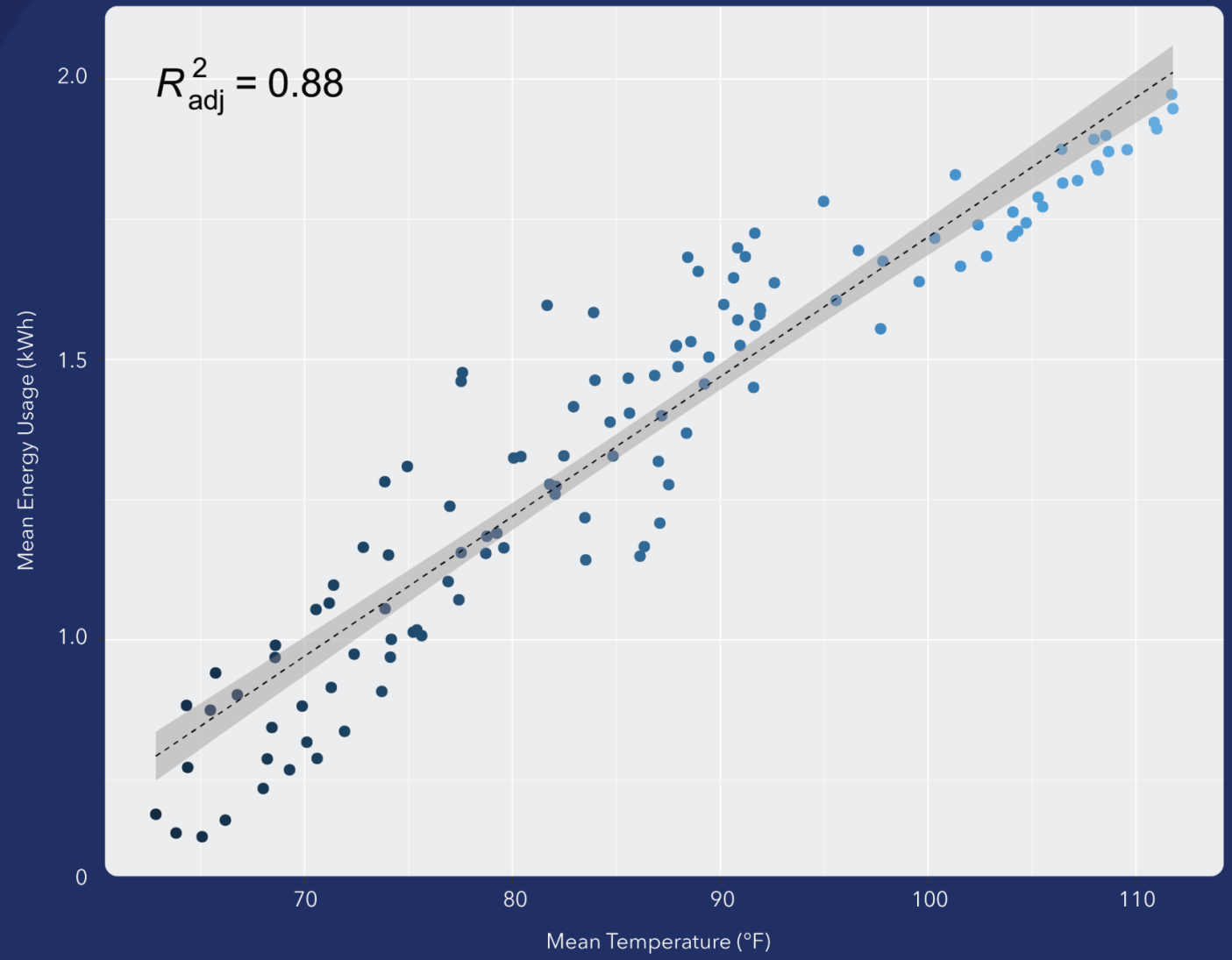
2021 Heat Dome

Mean Temperature vs Mean Energy Usage



117.5° F
Maximum Temperature

100+
Heat-Related Deaths

33
Hours above 100°F in 4 days

49
Hours above 95°F in 5 days

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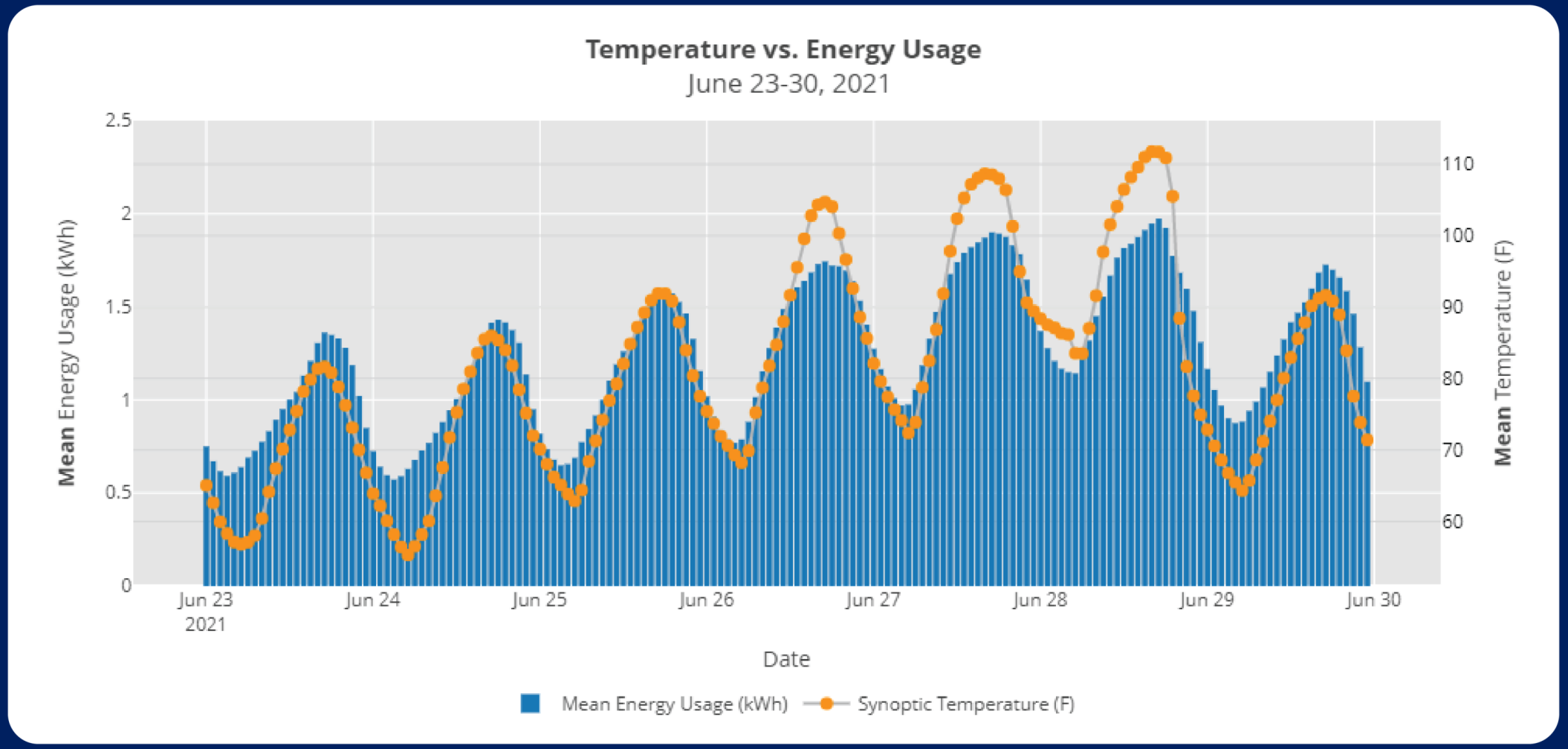
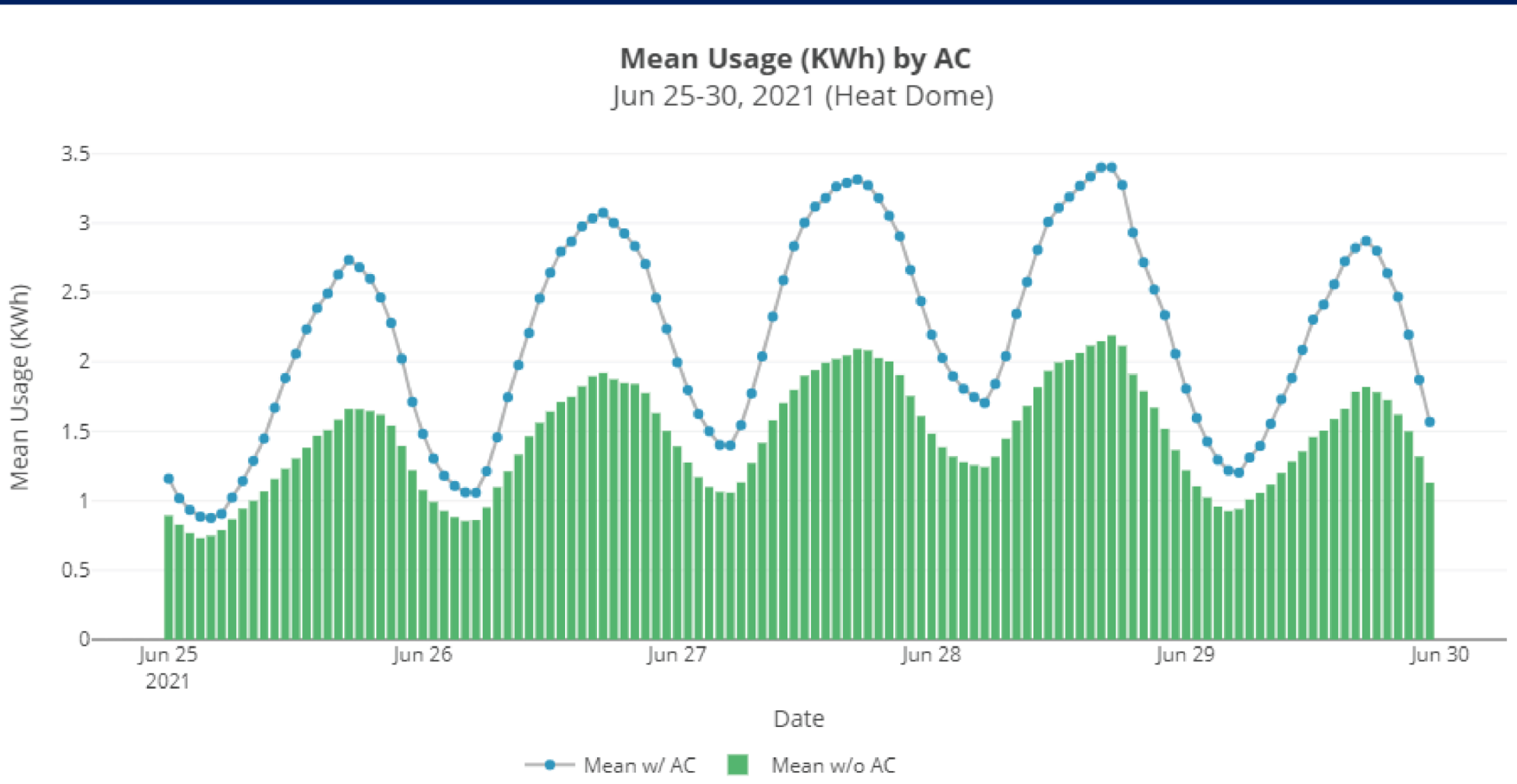
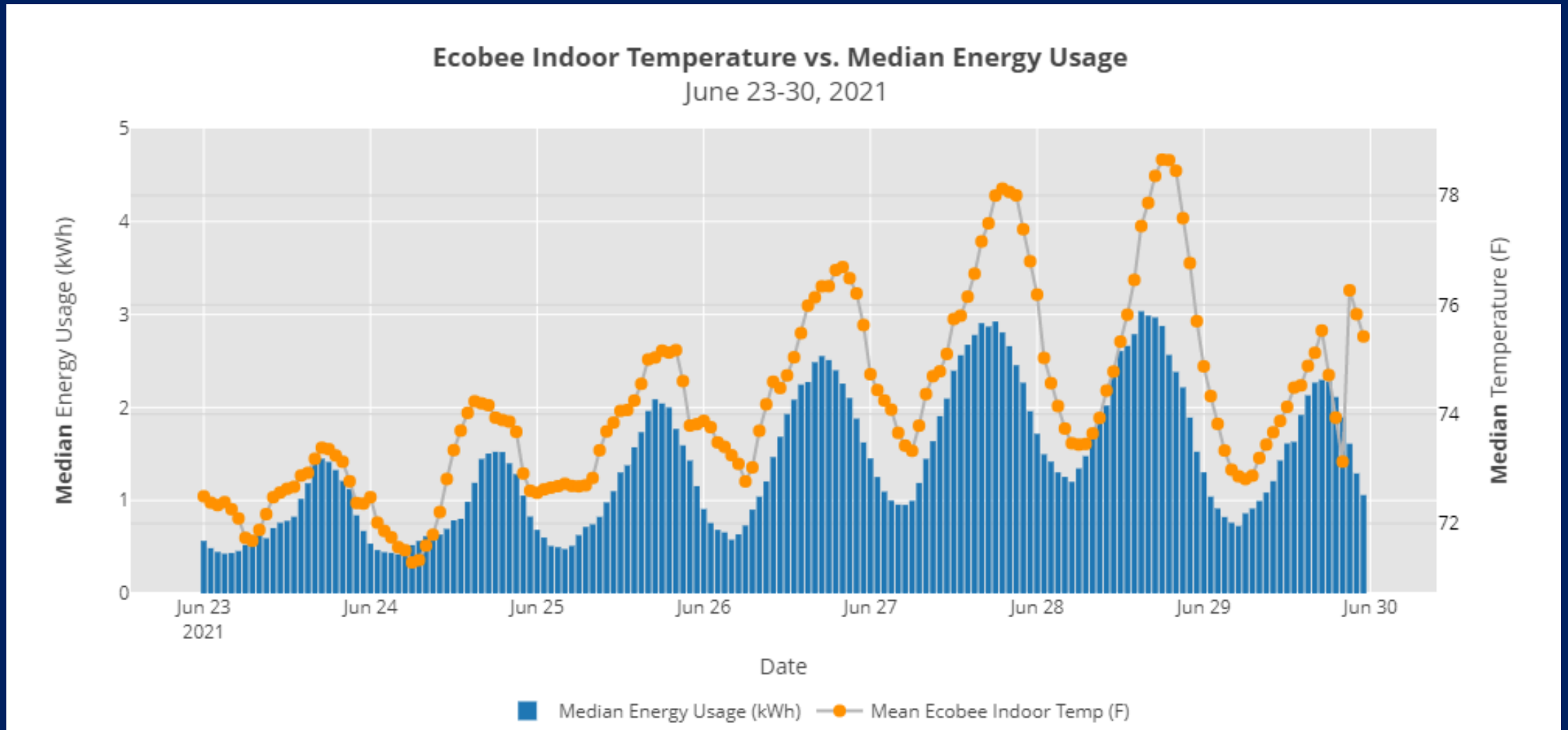
Portland's Climate Future

Date Range	Days > 95 by Emissions Scenario[5]		
	SSP2-4.5	SSP3-7.0	SSP5-8.5
1986-2005	5	5	5
2020-2039	8	10	13
2040-2059	10	14	19
2080-2099	21	38	51

>90

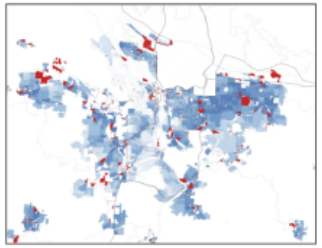

Temperature vs. Energy Usage
June 23-30, 2021
Mean Energy Usage (kWh)
2.5
2
1.5
1
0.5
0
Mean Temperature (F)
110
100
90
80
70
60
Jun 23
2021
Jun 24
Jun 25
Jun 26
Jun 27
Jun 28
Jun 29
Jun 30
Date
Mean Energy Usage (kWh)
Synoptic Temperature (F)


Mean Usage (KWh) by AC
Jun 25-30, 2021 (Heat Dome)
Mean Usage (KWh)
3.5
3
2.5
2
1.5
1
0.5
0
Jun 25
2021
Jun 26
Jun 27
Jun 28
Jun 29
Jun 30
Date
Mean w/ AC
Mean w/o AC

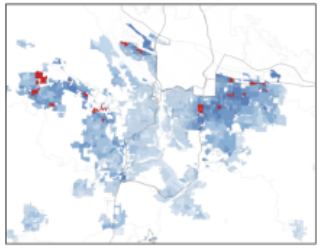

Ecobee Indoor Temperature vs. Median Energy Usage
June 23-30, 2021
Median Energy Usage (kWh)
Median Temperature (F)
0
1
2
3
4
5
72
74
76
78
Jun 23
2021
Jun 24
Jun 25
Jun 26
Jun 27
Jun 28
Jun 29
Jun 30
Date
Median Energy Usage (kWh)
Mean Ecobee Indoor Temp (F)

Heat Vulnerability Measures

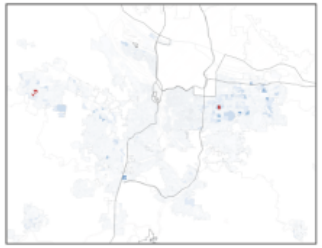
City Level



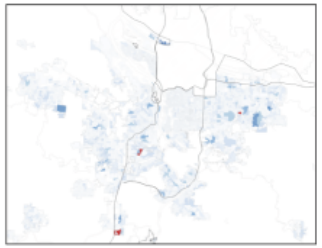
Median Household Income



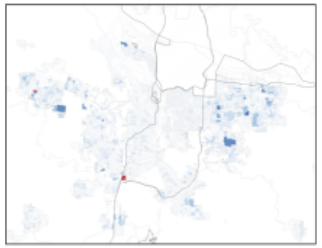
% People of Color



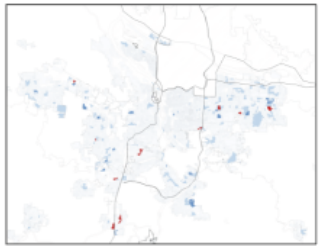
Education < HS



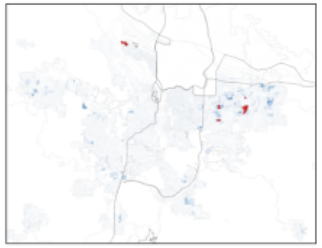
Age 65+



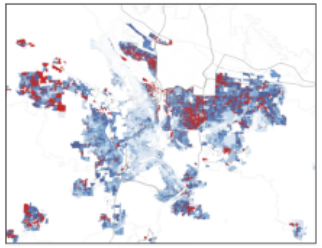
Age <5



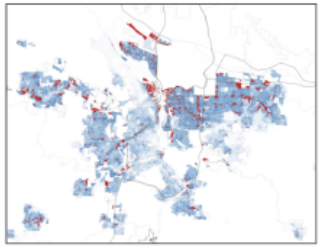
HHs w/ Disability



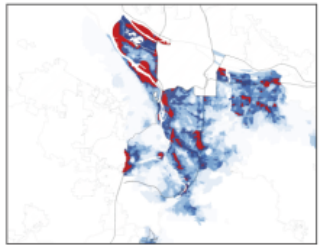
HHs w/ SNAP benefits



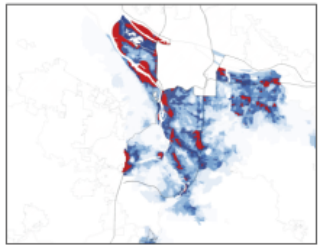
% Canopy Cover



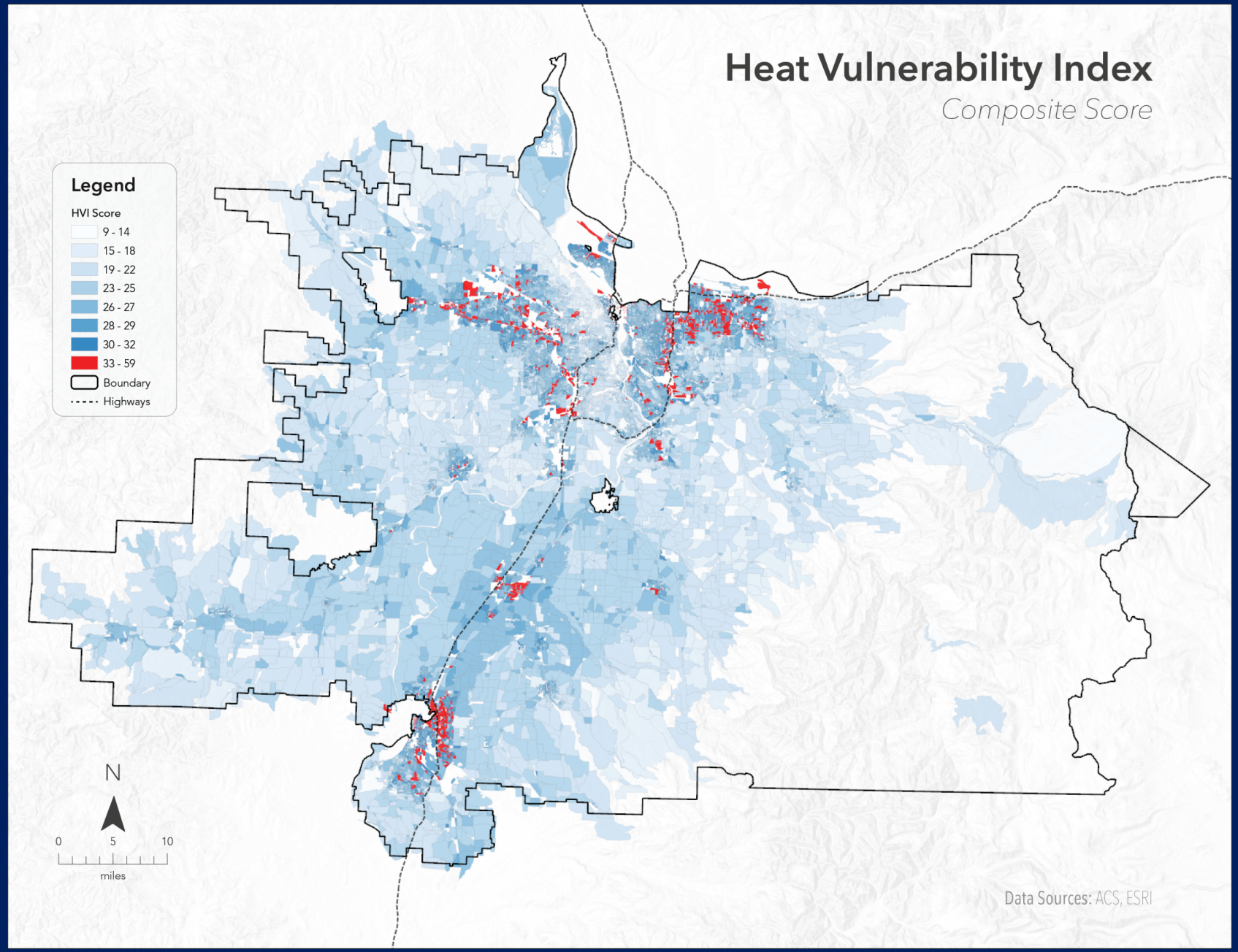
% Impervious Surface

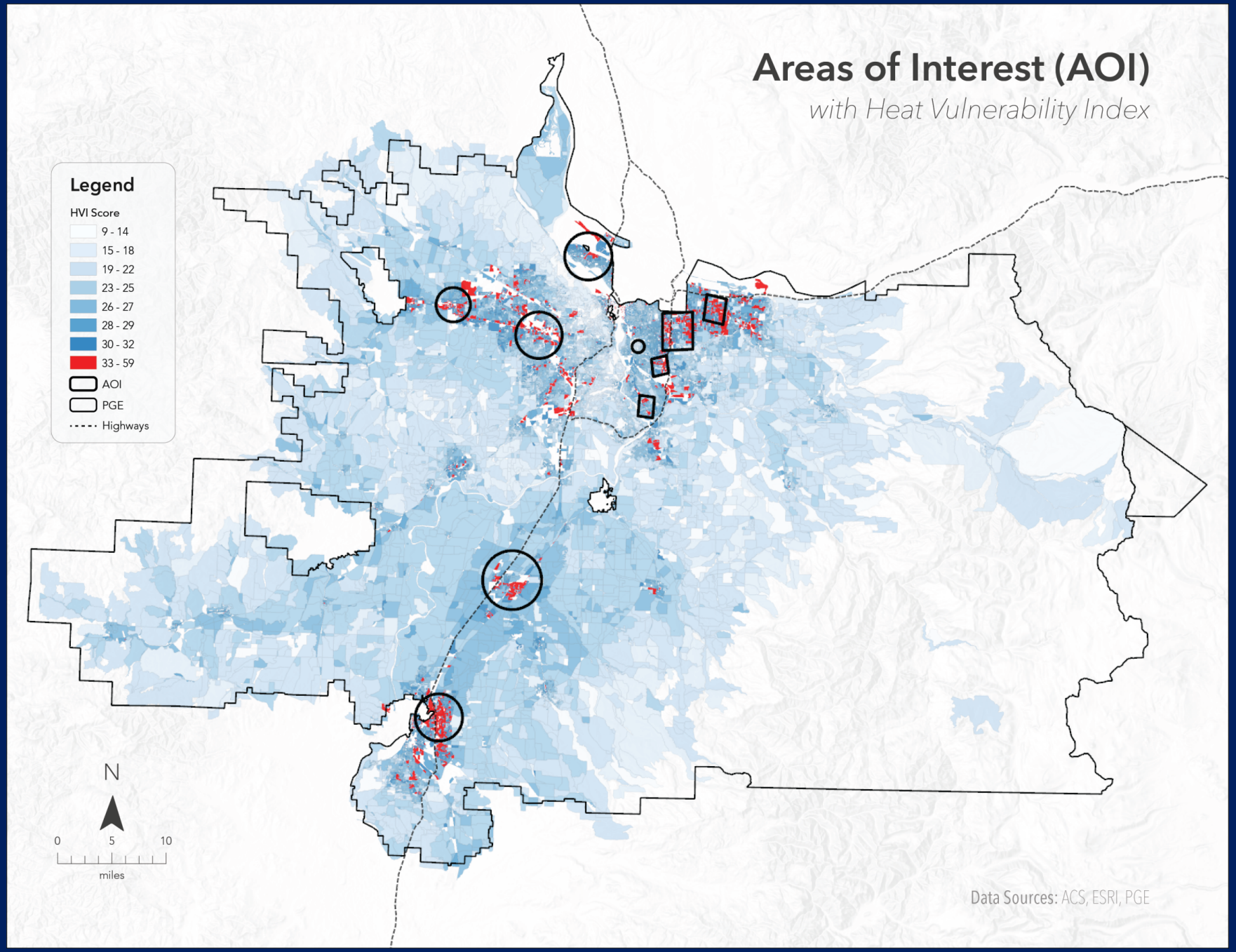


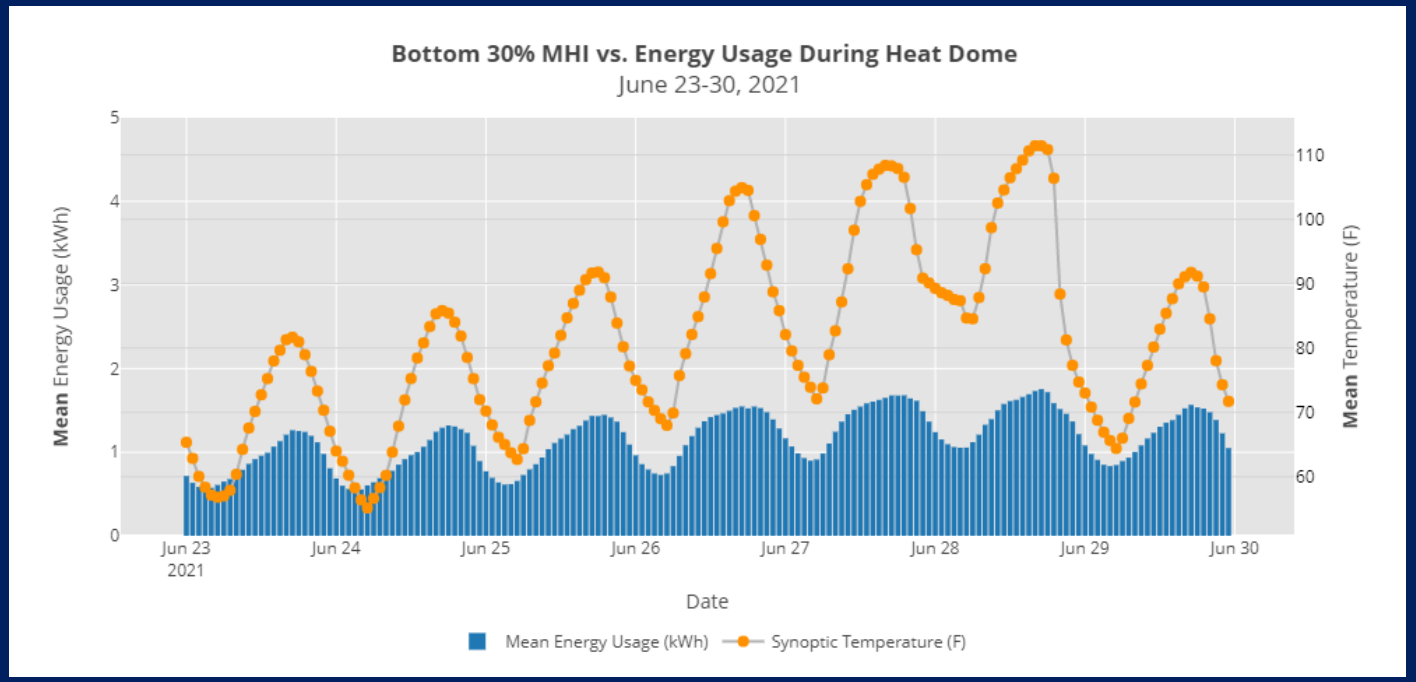
Building SQFT

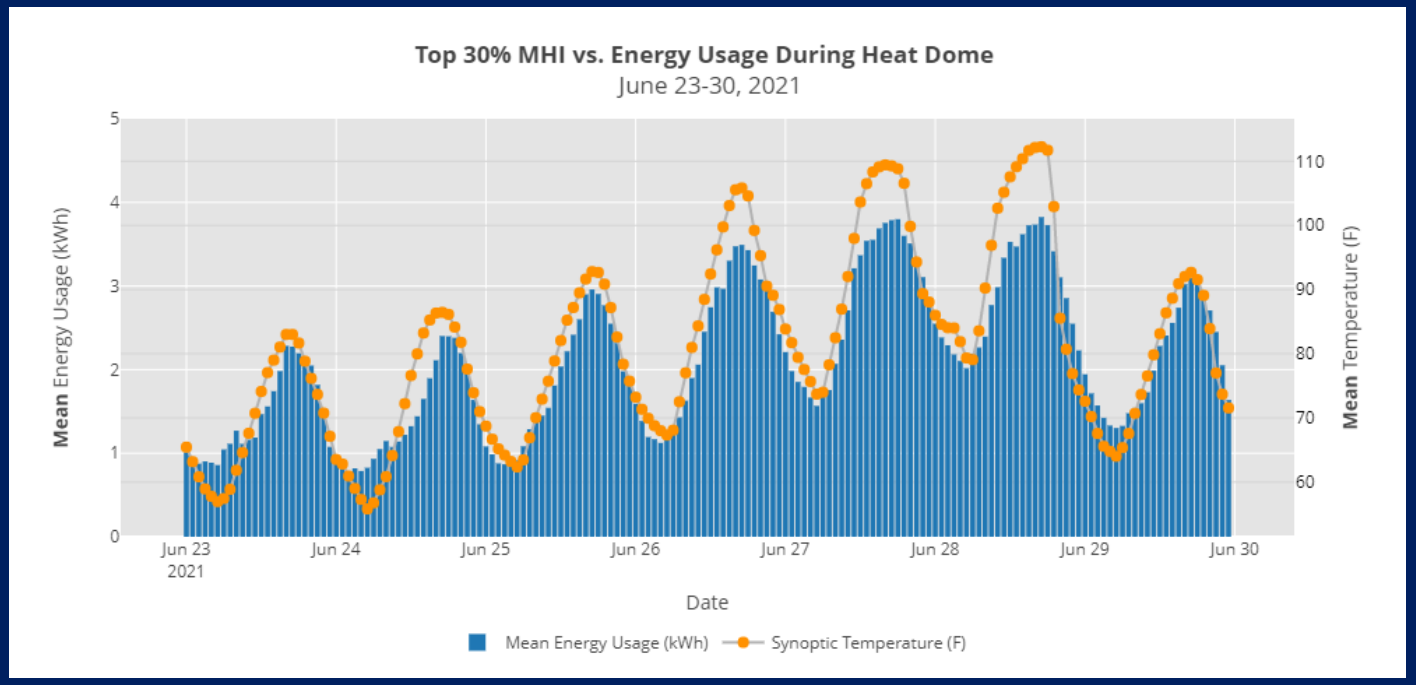


Distributional Heat Score


Heat Vulnerability Index
Composite Score
Legend
HVI Score
9 - 14
15 - 18
19 - 22
23 - 25
26 - 27
28 - 29
30 - 32
33 - 59
Boundary
Highways
N
0
5
10
miles
Data Sources: ACS, ESRI


Areas of Interest (AOI)
with Heat Vulnerability Index
Legend
HVI Score
9 - 14
15 - 18
19 - 22
23 - 25
26 - 27
28 - 29
30 - 32
33 - 59
AOI
PGE
Highways
N
0
5
10
miles
Data Sources: ACS, ESRI, PGE



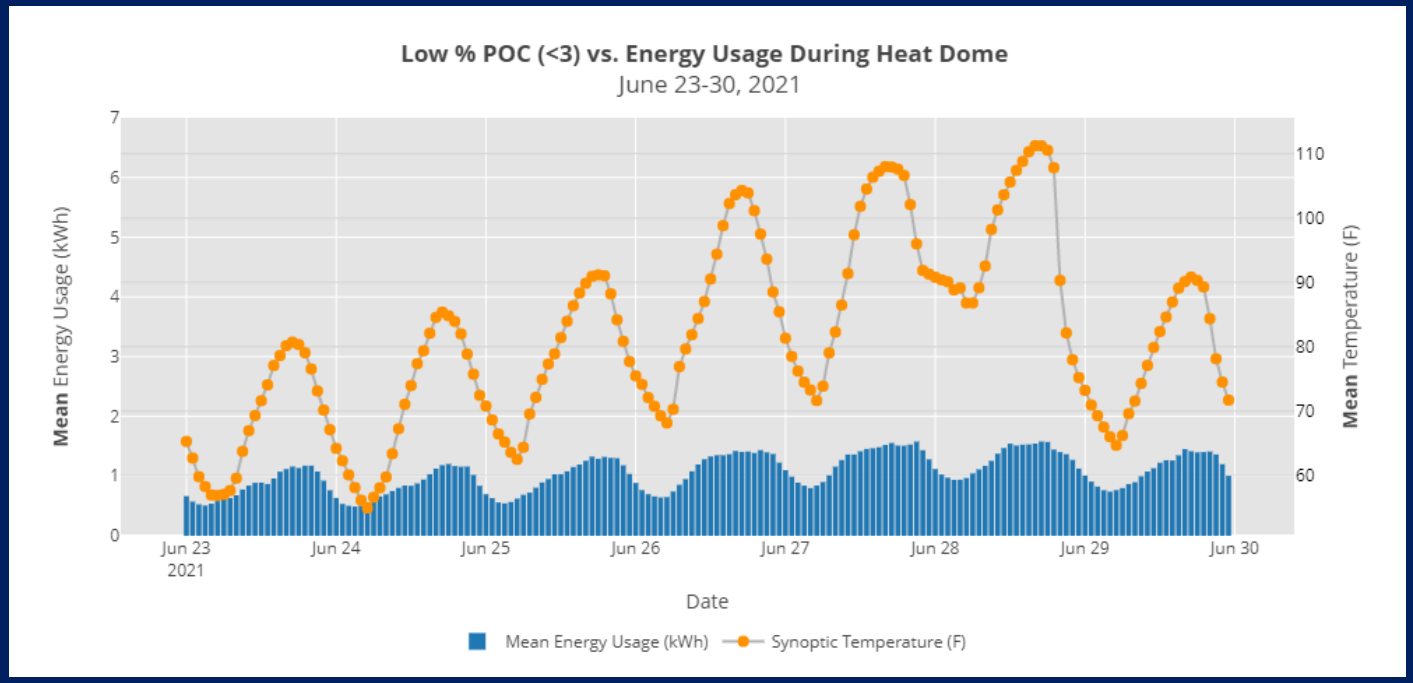


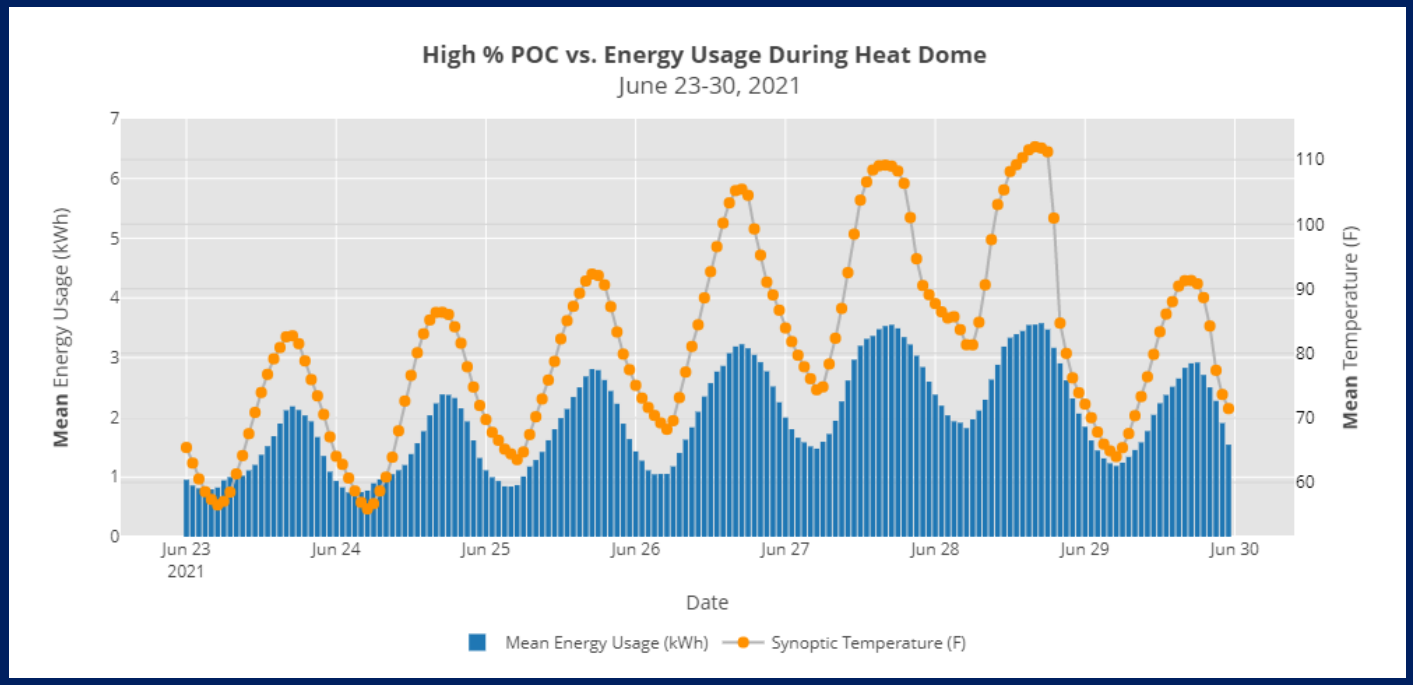
Median Household Income

During the Heat Dome, Census Blocks that have a higher average MHI used more energy.

At peak temperatures and usage, the mean difference was ±

2.2kWh/hr





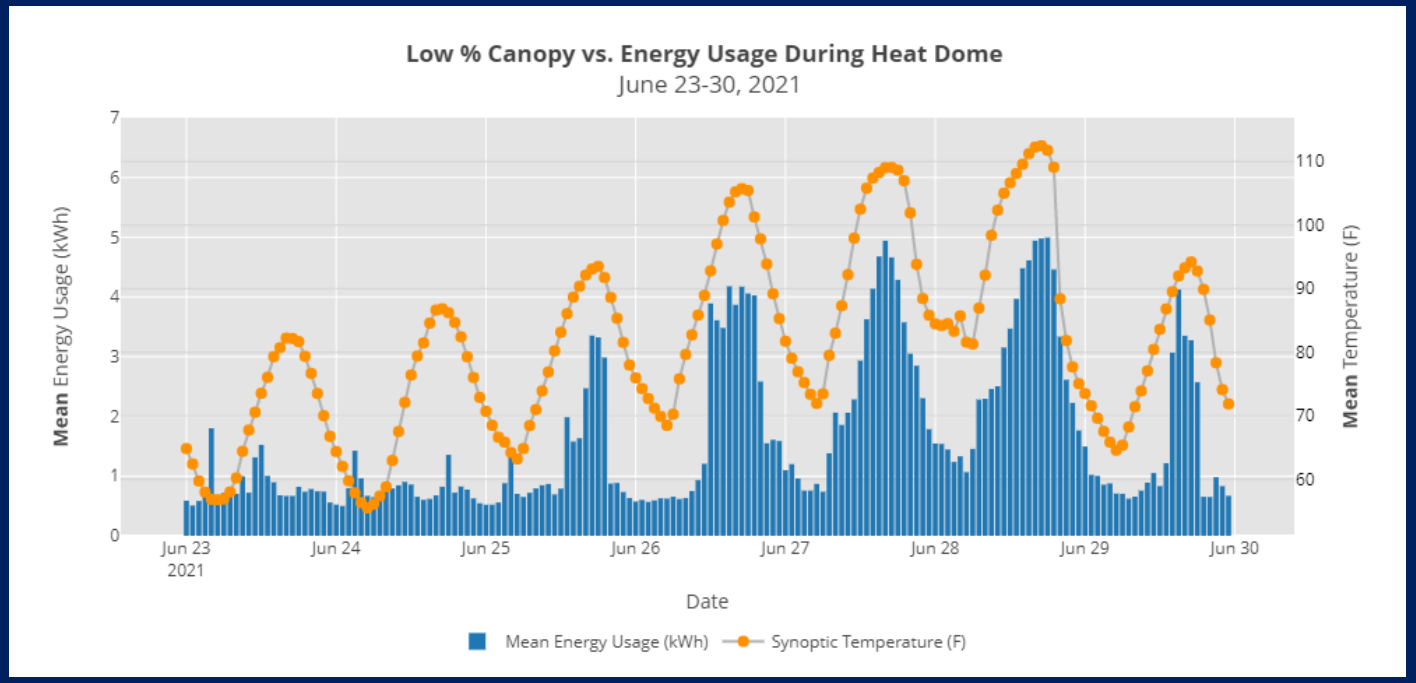
% People of Color

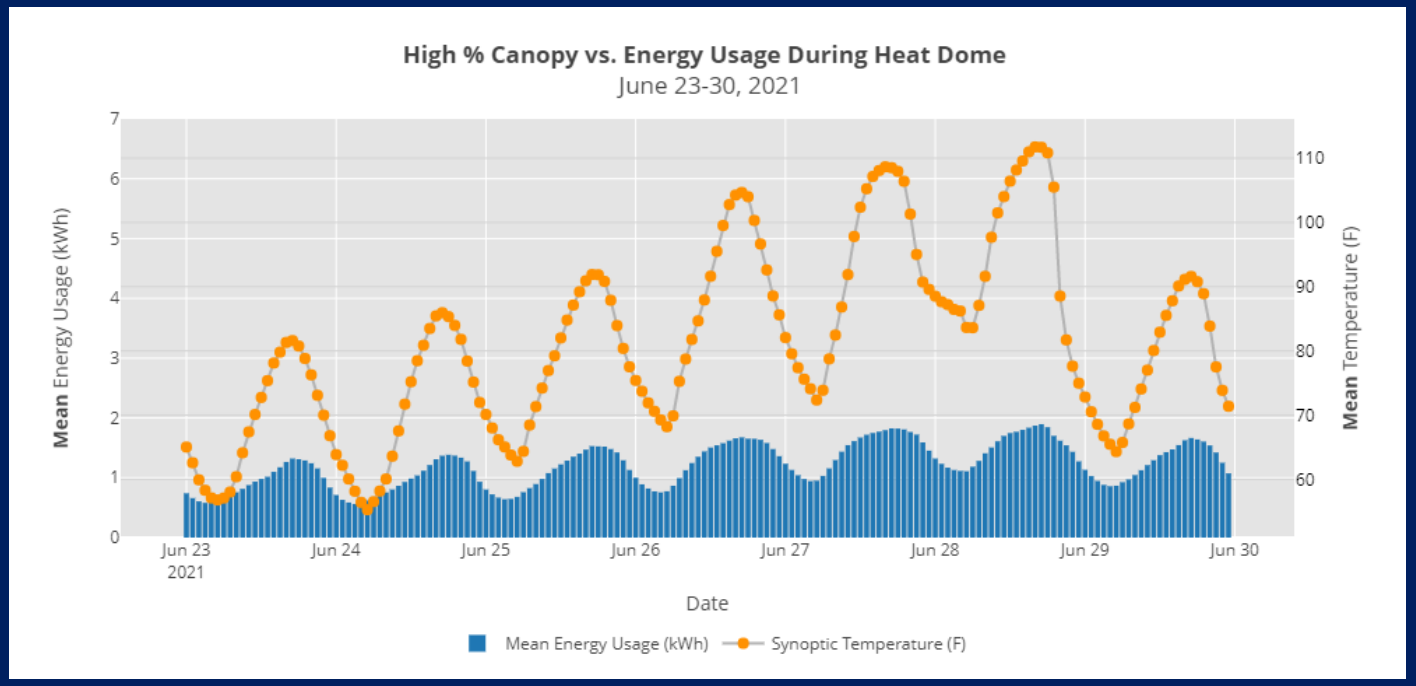
During the Heat Dome, Census Blocks that have a higher percentage of POC used more energy than their low percentage counterparts.

At peak temperatures and usage,

the mean difference was ±

2kWh/hr



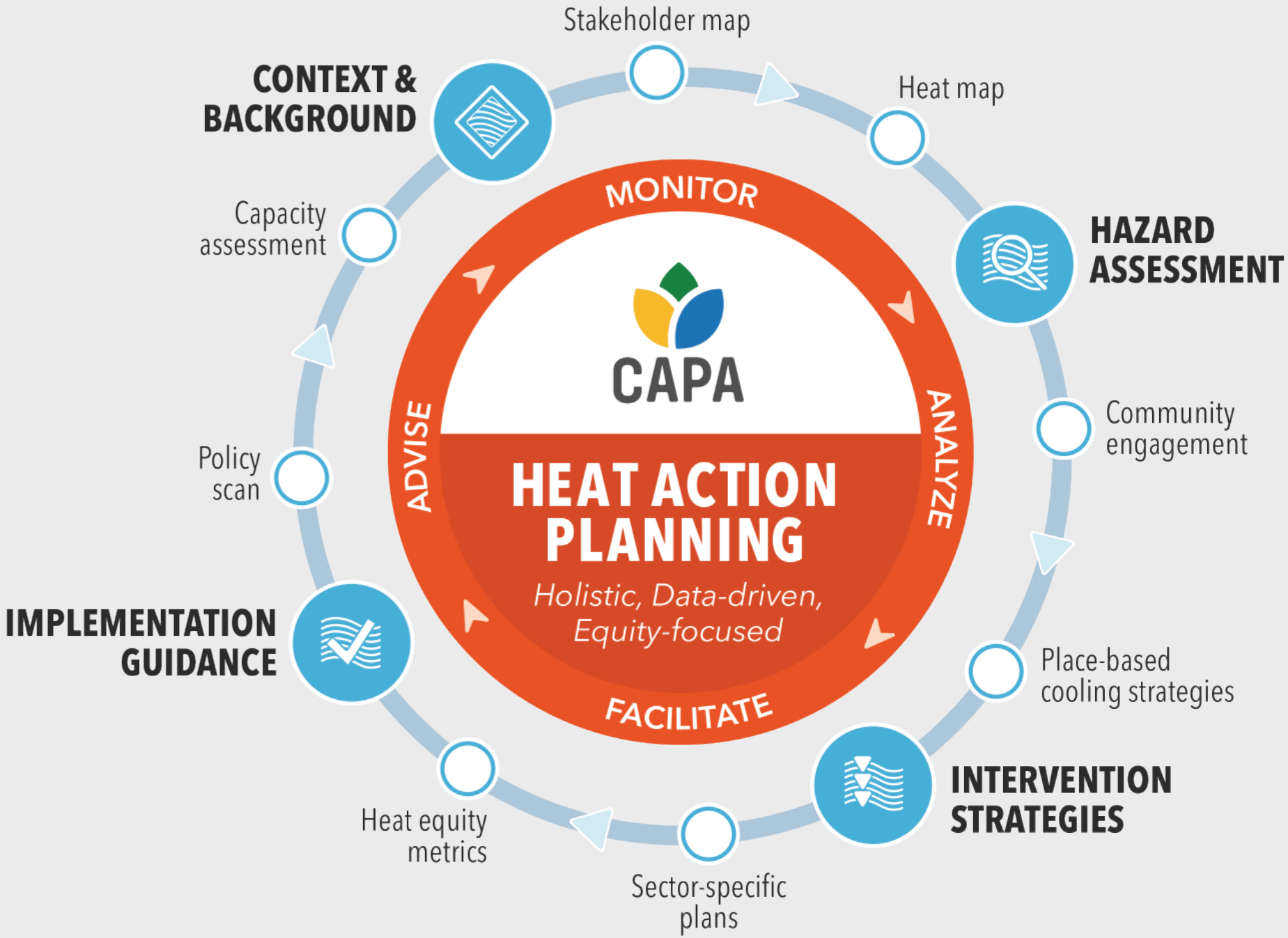


Canopy

During the Heat Dome, Census Blocks that have a higher average % Canopy used less energy.

At peak temperatures and usage, the mean difference was

±3kWh/hr


Stakeholder map
CONTEXT & BACKGROUND
Heat map
Capacity assessment
MONITOR
HAZARD ASSESSMENT
CAPA
ADVISE
ANALYZE
Community engagement
Policy scan
HEAT ACTION PLANNING
Holistic, Data-driven, Equity-focused
IMPLEMENTATION GUIDANCE
Place-based cooling strategies
FACILITATE
INTERVENTION STRATEGIES
Heat equity metrics
Sector-specific plans

Thank You

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