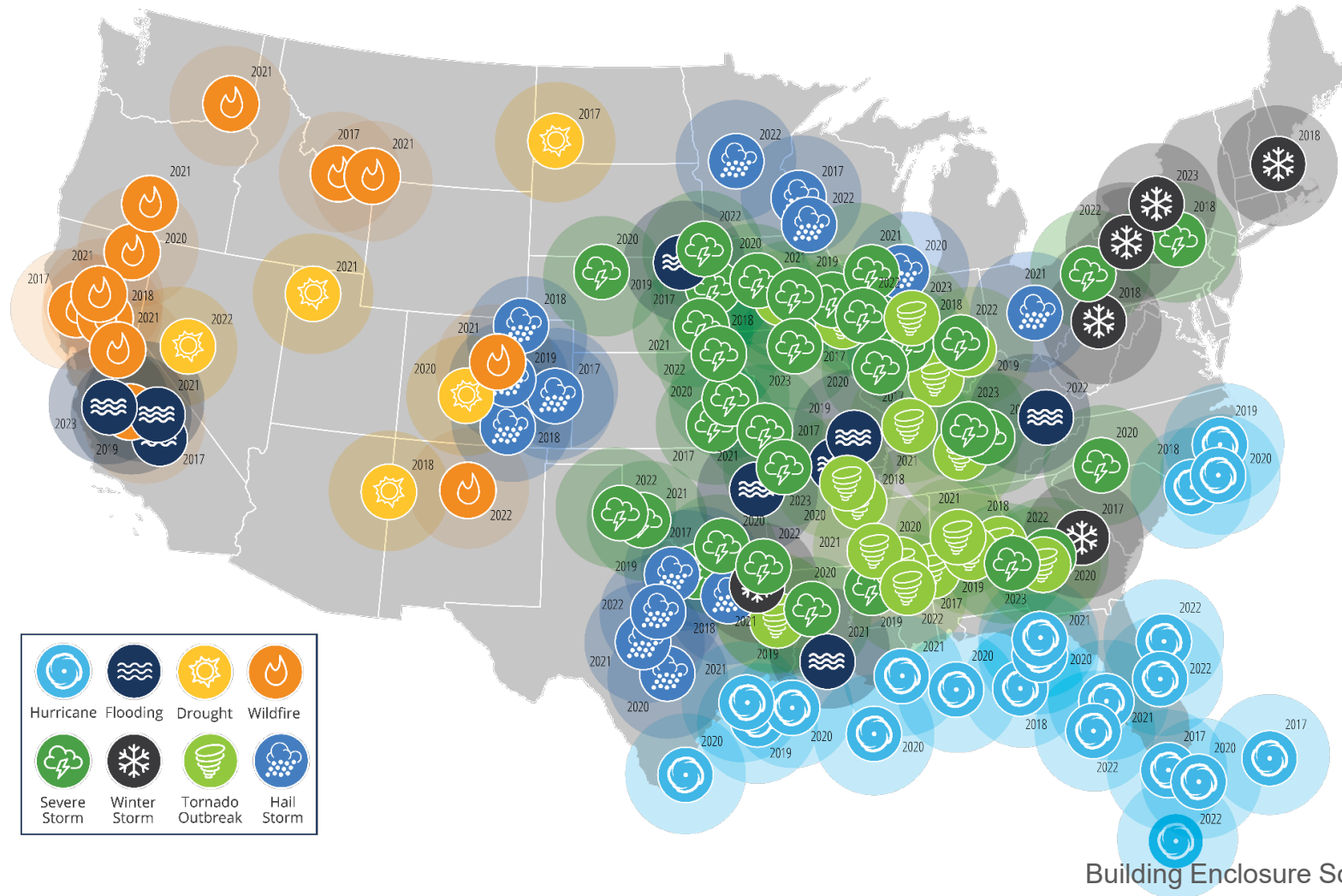




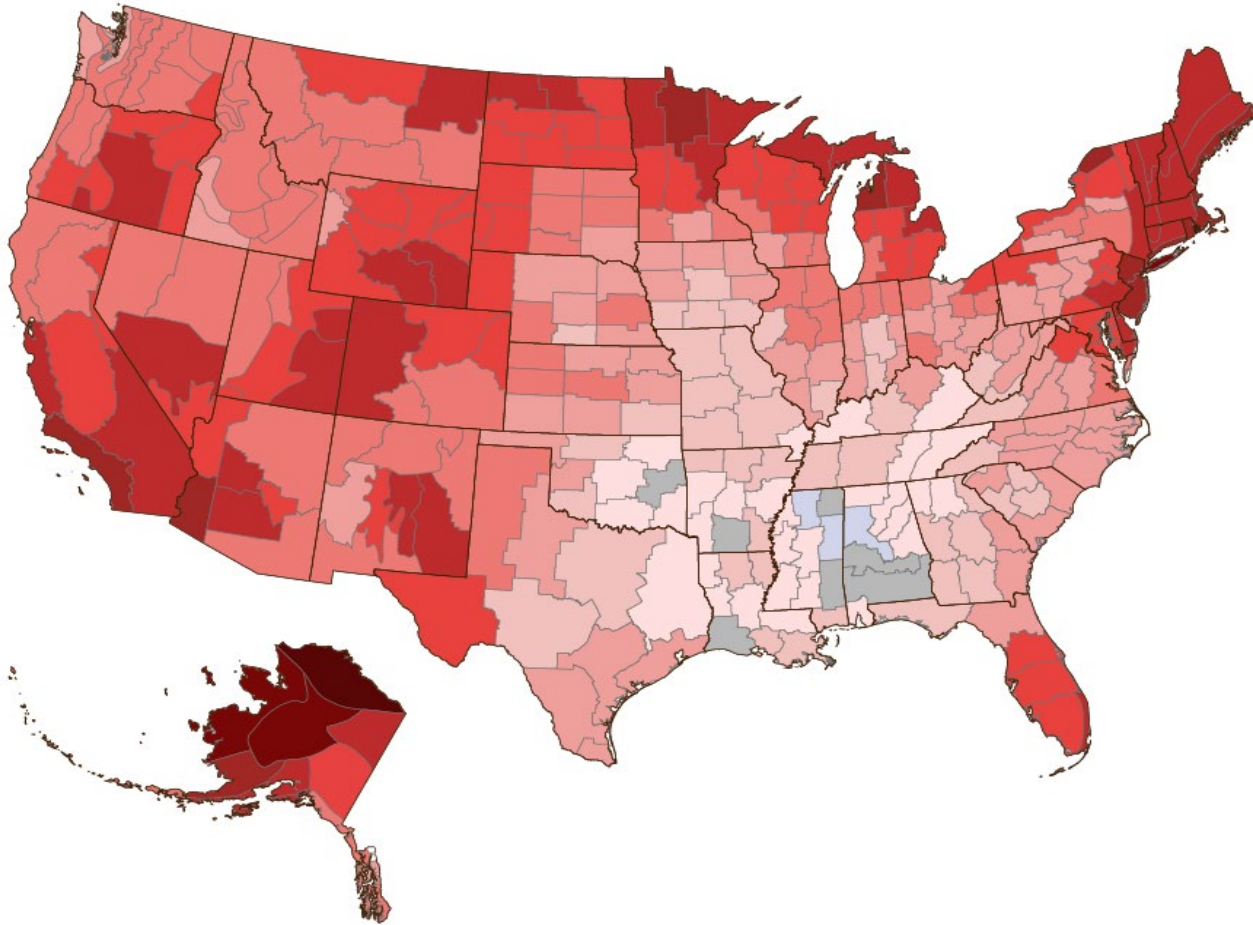
Resilience for Health

Research Scientists' Climate Impact Perspectives on
Building Environment and Materials

Climate disasters in the U.S. >\$1 billion over the last 6+ years (Jan. 2017 to Apr. 2023)



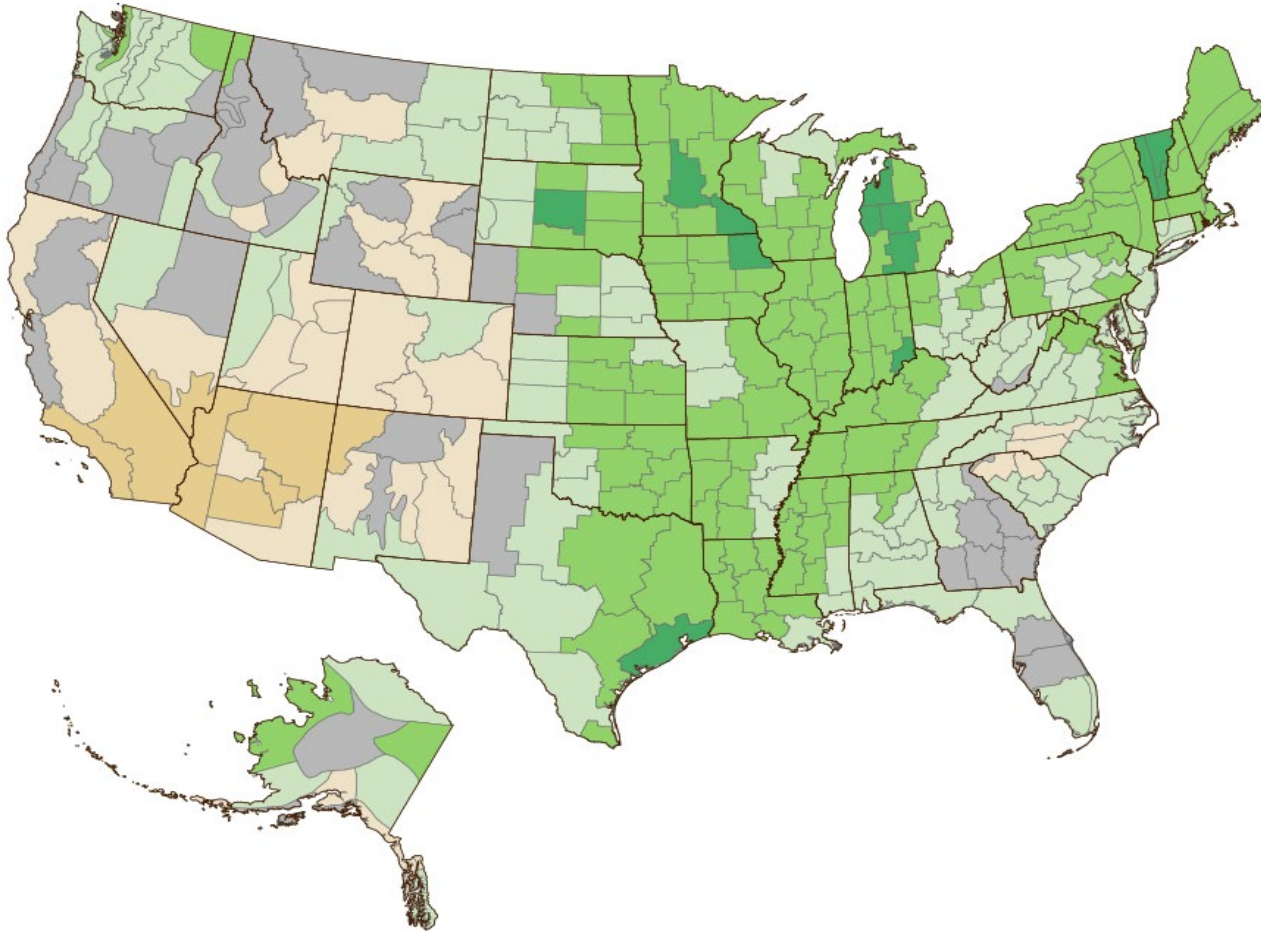
Change in Temperatures (1901-2021)



Elevated air and water temperatures

- Longer growing seasons (earlier spring)
- Prolonged exposure to heat
- Increased ground ozone, mold and growth of pathogens

Change in Precipitation (1901-2021)



Increases in precipitation:

- Storms and hurricanes
 - Flooding/storm surge
 - Increase in nutrient runoff

Decreases in precipitation:

- Drought
 - Increase in dust and pollen
- Wildfires and smoke
 - Increased particulate matter

Impacts on the Built Environment



External Stressors



High Winds



Storms



Fire



Extreme Heat



Snow



Flood

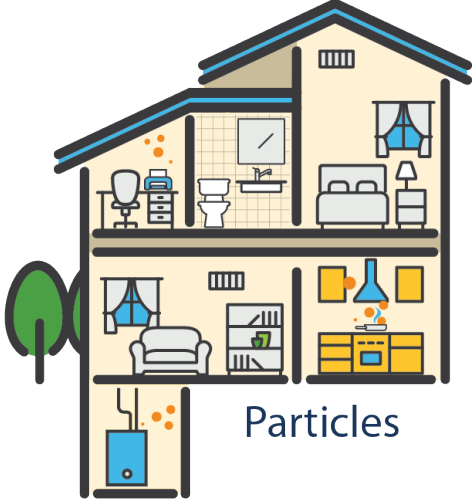
Internal Stressors



Chemicals



Mold



Particles



Temperature

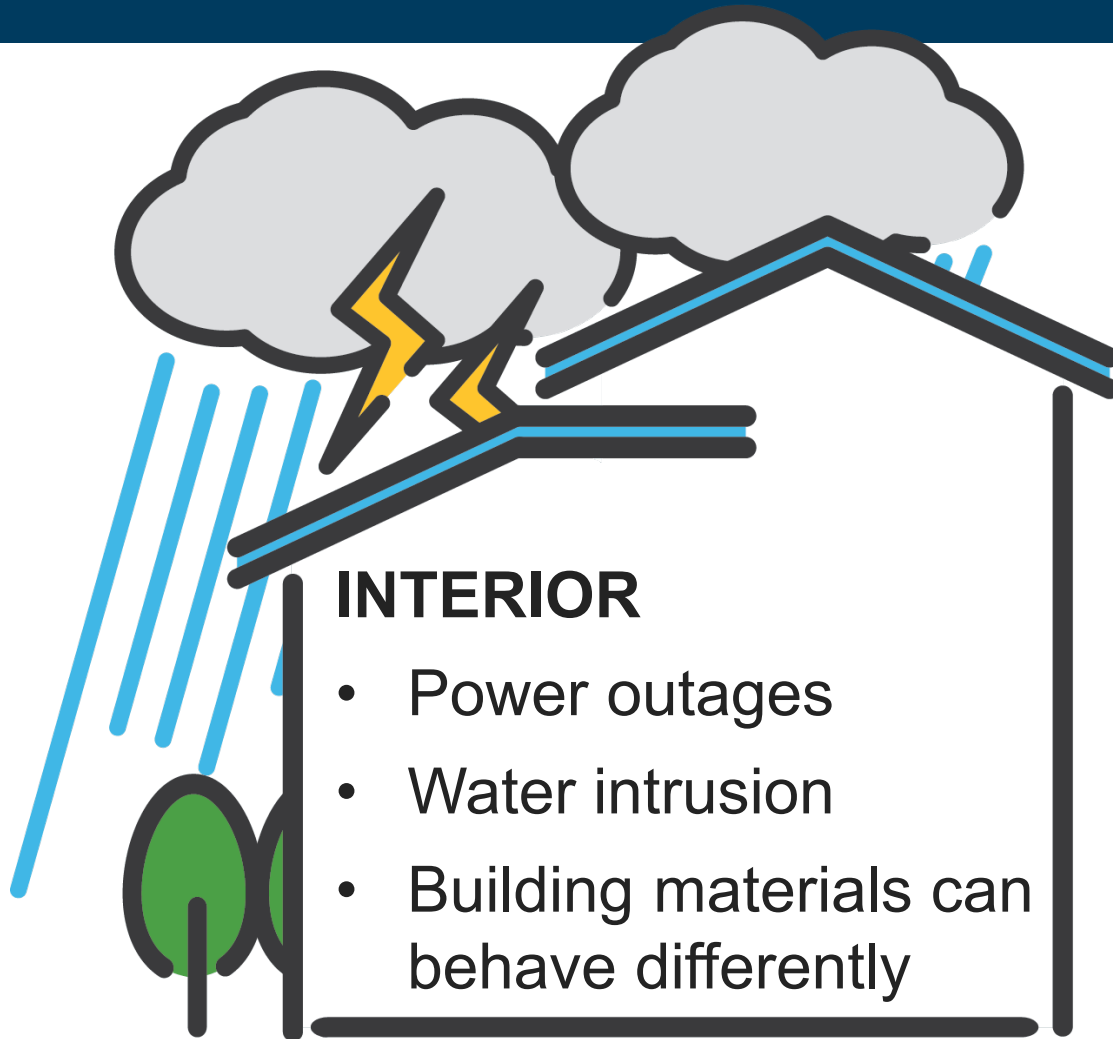


Humidity



Dust & Allergens

What Happens as a Result of Extreme Weather?

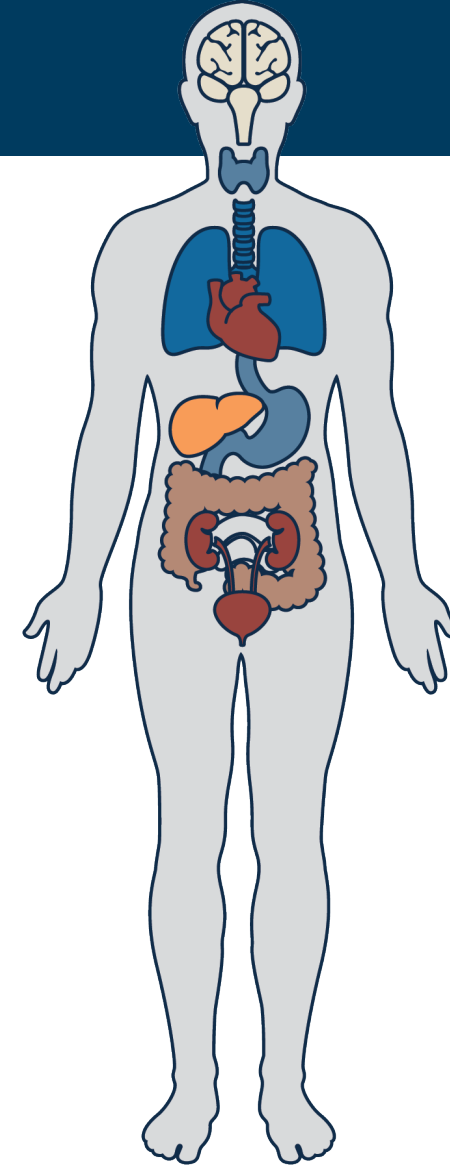


EXTERIOR

- Structural damage
- Requires new materials for repair/replacement
- Debris cleanup creates potentially hazardous waste

Impact on Human Health

- Heat-related illness and death
- Cardiovascular illness
- Asthma and allergy related illnesses
- Water-related and food-related infections
- Drowning and injury
- Stress-related disorders



Vulnerable Populations



Current Sustainable Design Approaches

WEATHERIZATION

(Focus on tightening the building envelope and energy efficient systems)



DECARBONIZATION

(Focus on renewable energy and reducing carbon emissions)



Airtight Buildings + Reduced Ventilation Rates



EVENT:

- 1950s: Synthetic materials in mass production
- 1970s: Oil Embargo, Energy Crisis

OUTCOMES:

- Push to make buildings more airtight for energy efficiency
- Reduced ventilation rates in buildings to 5 cfm/person

Sick Building Syndrome



EVENT:

- Sick Building Syndrome (SBS)
 - EPA Waterside Mall
 - State of Washington Campus

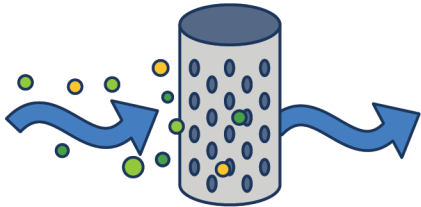
OUTCOMES:

- Development of Environmental Chamber Technology (ECT)
- Understanding that ventilation and source control must happen together

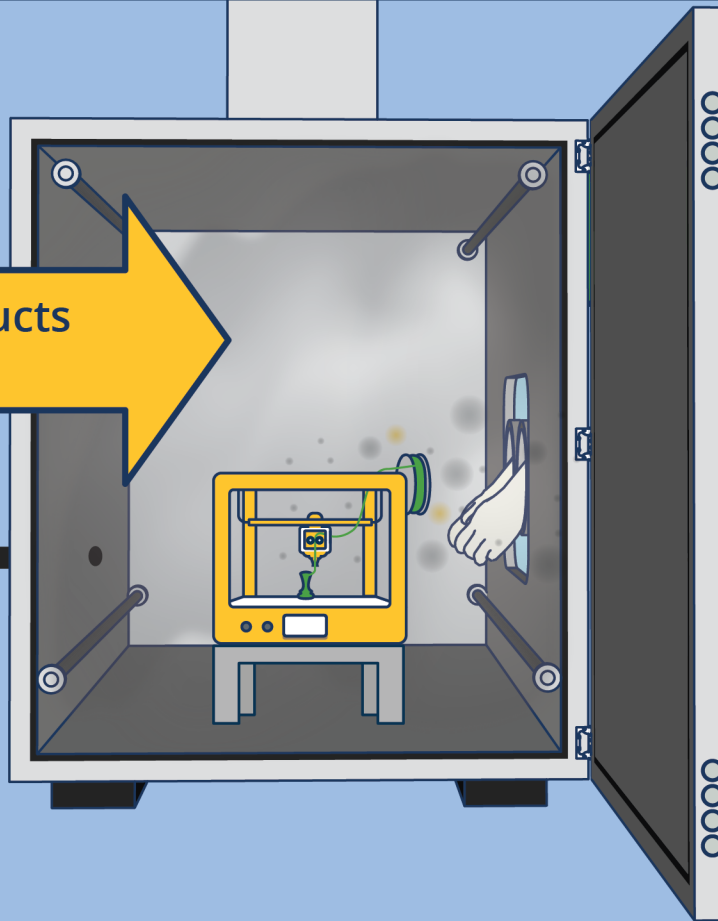
Environmental Chamber Technology

Environmental Chamber Technology:
A stainless steel exposure chamber with realistic air flow, temperature and humidity.

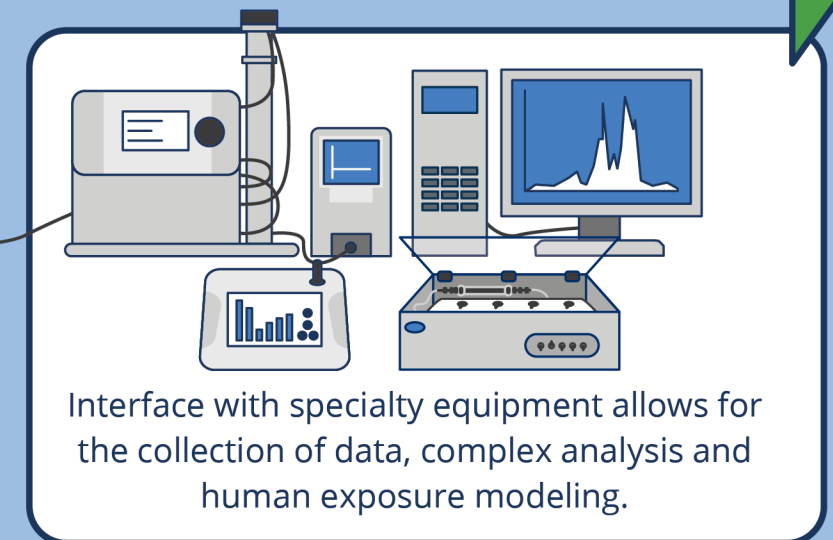
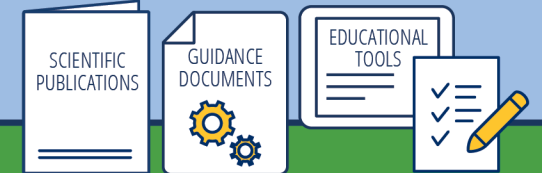
INPUTS: Emerging technologies or products with suspected health hazards



Specialized filtration removes all particles and chemicals from outside air supplied to the chamber to ensure a clean environment.



OUTPUTS:
Actionable Data, Safer Use & Application



New Conditions Create New Material Responses

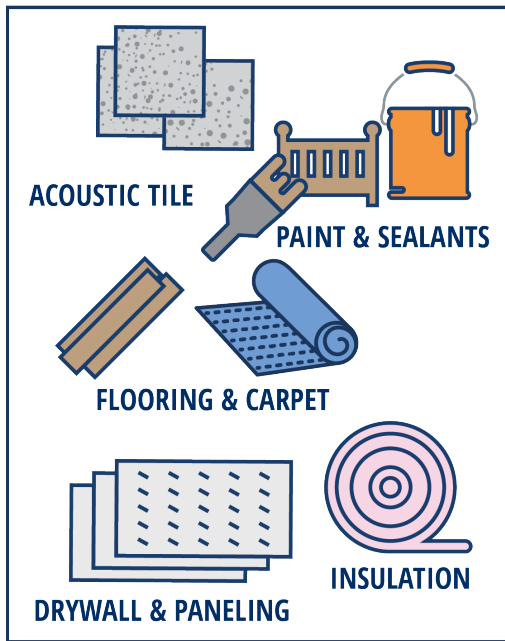
More extreme weather is causing our built environments to experience:

- Prolonged power outages
- Exposure to extreme temperatures
- Water intrusion
- Material damage
- Potential exposure to harsh cleaners/hazardous materials during cleanup
- Internal stressors (chemicals, molds, particles, etc.)



New Data: Extreme Heat Impacts on Materials

Source common building products found in modern homes and test them at both **ambient (23°C)** and **elevated (35°C)** temperatures.



Standardized samples (5cmx5cm)



Microchamber (outside and inside)



Gas chromatography mass spectrometry with thermal desorption

Increase in TVOC and TALD (In Elevated Conditions)

TVOCs	
Material	% Increase
MDF	-12%
Insulation	30%
Drywall	54%
Natural Wood Flooring	89%
Engineered Wood Flooring	405%
Laminate Flooring	334%
Vinyl Flooring (1)	241%
Vinyl Flooring (2)	37%
Carpet Flooring	5%
Crown Molding	291%
Baseboard	103%
Paneling, oil-finish	181%
Paneling, water-finish	10%
Wallpaper Covering	190%
Acoustic Tile	235%

TALDs	
Material	% Increase
MDF	74%
Insulation	29%
Drywall	43%
Natural Wood Flooring	98%
Engineered Wood Flooring	387%
Laminate Flooring	131%
Vinyl Flooring (1)	67%
Vinyl Flooring (2)	-
Carpet Flooring	914%
Crown Molding	186%
Baseboard	114%
Paneling, oil-finish	-78%
Paneling, water-finish	23%
Wallpaper Covering	-
Acoustic Tile	-

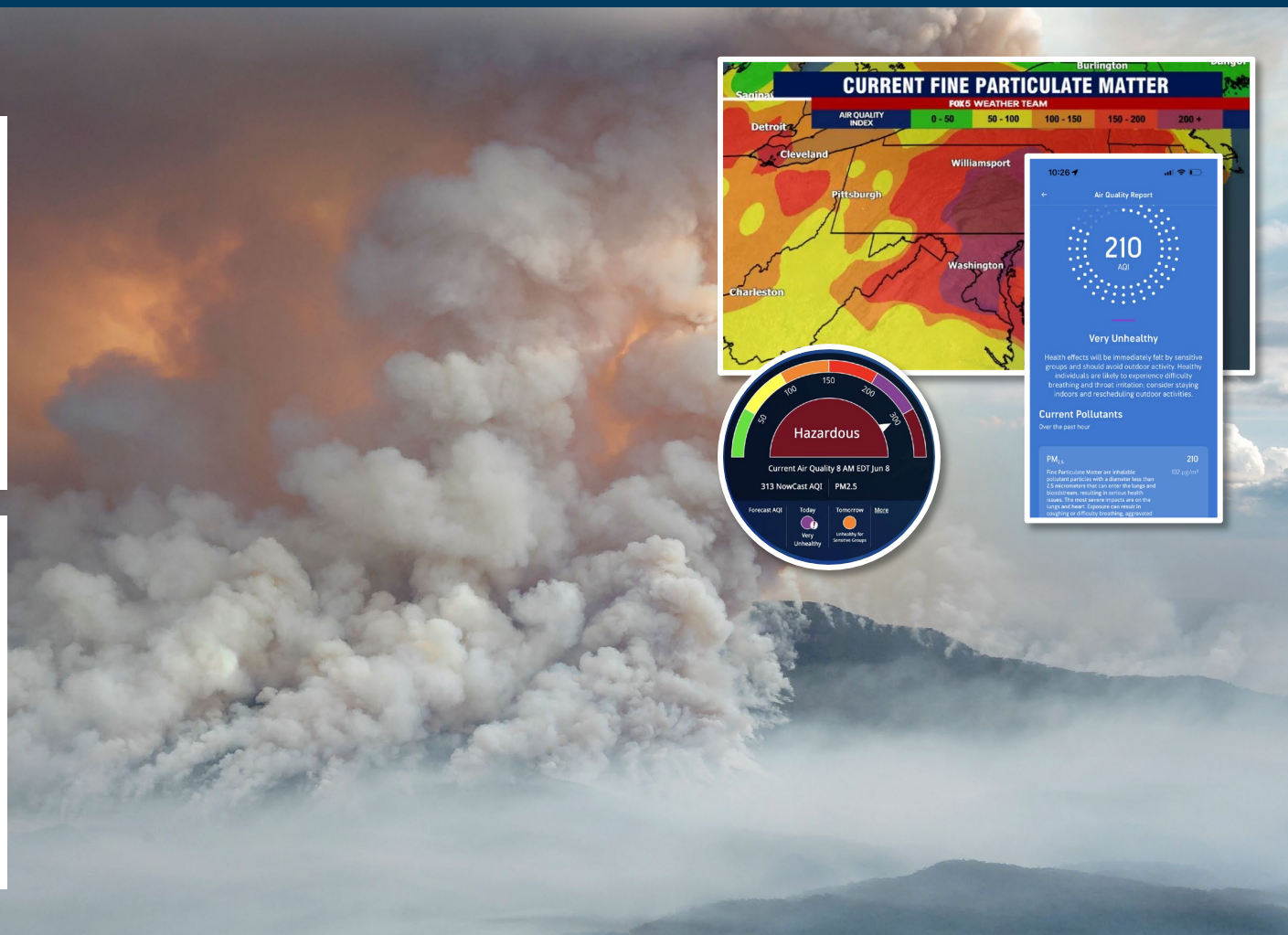
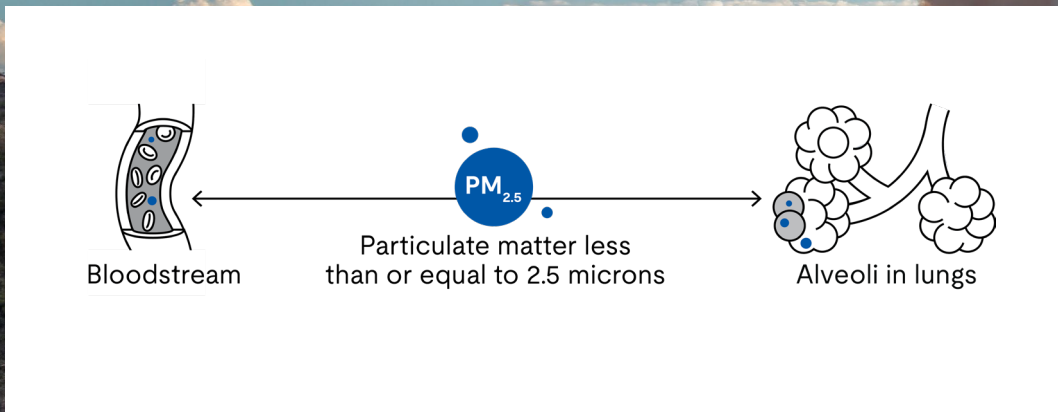
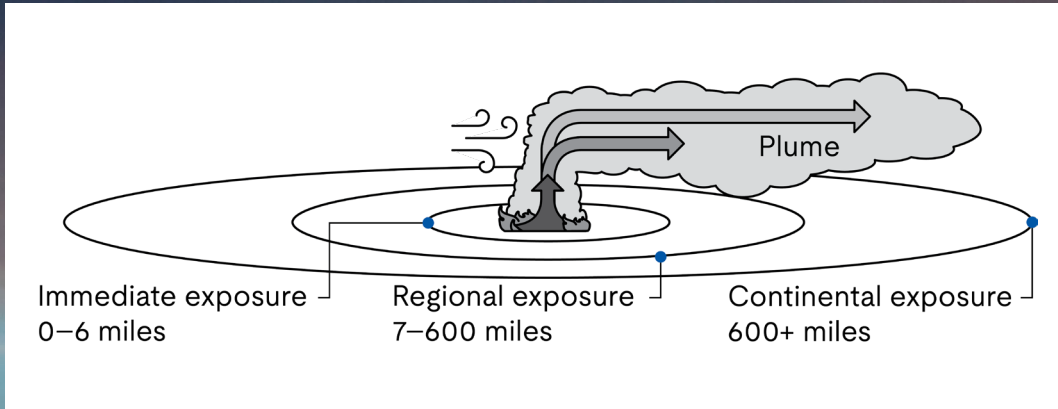
Loading Ratios: Simulated Single Family Residence

Product Type	1st Floor Area	2nd Floor Area	Total Area	L (m ² /m ³)
Interior wallboard paint	347	377	724	1.25
Walls & wallcoverings	235	270	505	0.872
Thermal insulation	170	180	350	0.605
Acoustic insulation	105	234	339	0.586
Wall acoustic insulation	105	149	254	0.439
Ceiling	112	107	219	0.378
Flooring (all types)	108	101	209	0.366
Ceiling/floor thermal insulation	102	109	211	0.364
Wall thermal Insulation	68.1	71.1	139	0.24
Ceiling/floor acoustic insulation	0	85.1	85.1	0.147
Closet doors	14.8	24.8	39.6	0.068
Windows	19.9	12.6	32.5	0.056
Interior doors	12.2	15.7	27.9	0.048
Exterior doors	7.6	0	7.6	0.013

**The Real World Has
A Very Complex
Mixture of Pollutants**



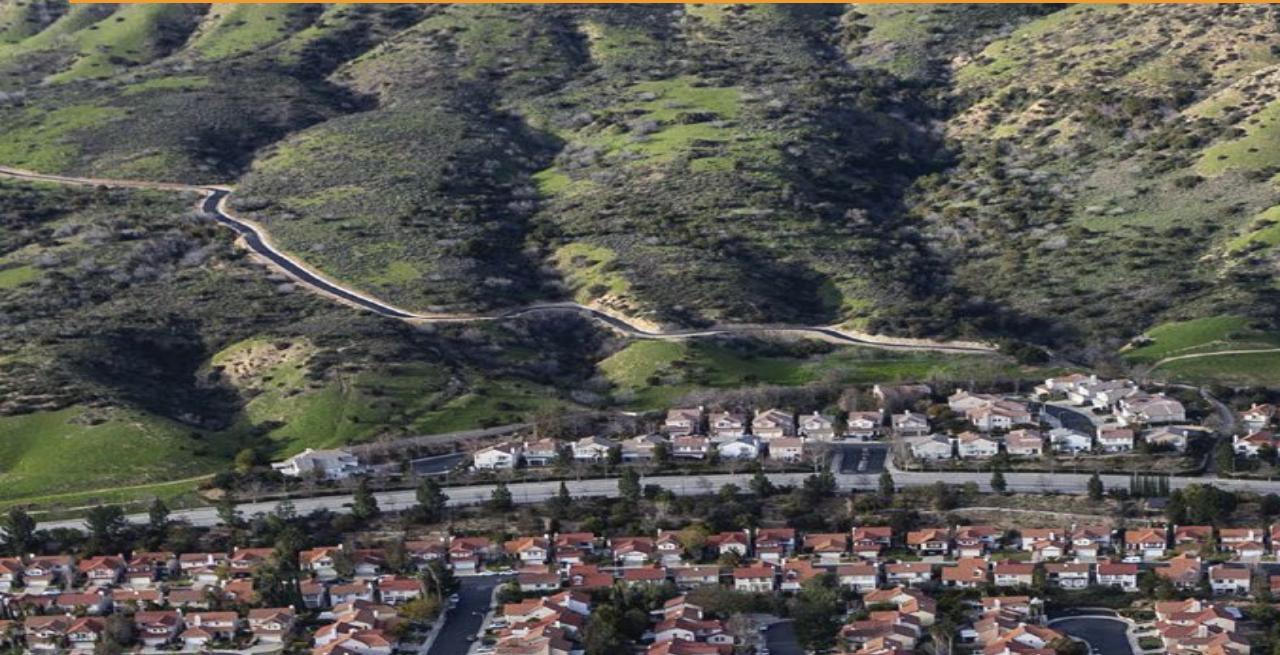
Impacts of Wildfire Smoke on Community Health



WUI Fire Research

Wildland Urban Interface (WUI)

The line, area or zone where structures and other human development meet or intermix with undeveloped wildland or vegetation fuel.



Desired Approaches to Address Climate Change

WEATHERIZATION

(Focus on tightening the building envelope and energy efficient systems)

DECARBONIZATION

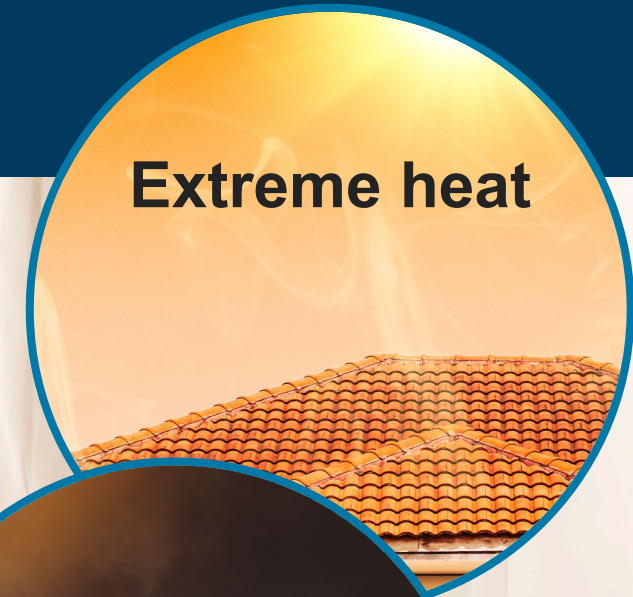
(Focus on renewable energy and reducing carbon emissions)



RESILIENCE FOR HEALTH

(Focus on design measures that factor in the projected climate and support human health)

Designing for the New Normal



We must think beyond the “billion-dollar disasters” to incorporate resilient strategies into everyday life that support human health.

It's time to be proactive...



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Thank You