Building Energy Codes
Delivering Resilience and Life Safety

Joseph W. Sollod, M.S., Innovation Associate

Governments Have Committed

ICC INTERNATIONAL CODE COUNCIL®

USDN urban sustainability directors network

C40 CITIES

2030 DISTRICTS®

CITY ENERGY A JOINT PROJECT of NRDC + IMT

CLIMATE MAYORS

EcoDistricts

Pledge, Compact, Commitment, or Initiative	Number of Participating US Local Governments
Climate Mayors	407
We are Still In	307
Ready for 100	148
Under2MOU	26
Bloomberg American Cities Climate Challenge	25
Rockefeller 100 Resilient Cities	24
2030 Districts	21
DOE Zero Energy Schools Accelerator	14
DOE Energy Accelerator	11
DOE Zero Energy Districts Accelerator	4

2021 IECC Code on a Mission

ICC INTERNATIONAL CODE COUNCIL®

The U.S. Administration has set **zero-energy building goals** of 2030 for new construction and 2050 for all buildings.*

*The U.S. White House, Fact Sheet: 2030 Greenhouse Gas Pollution Reduction Target (April 22, 2021)

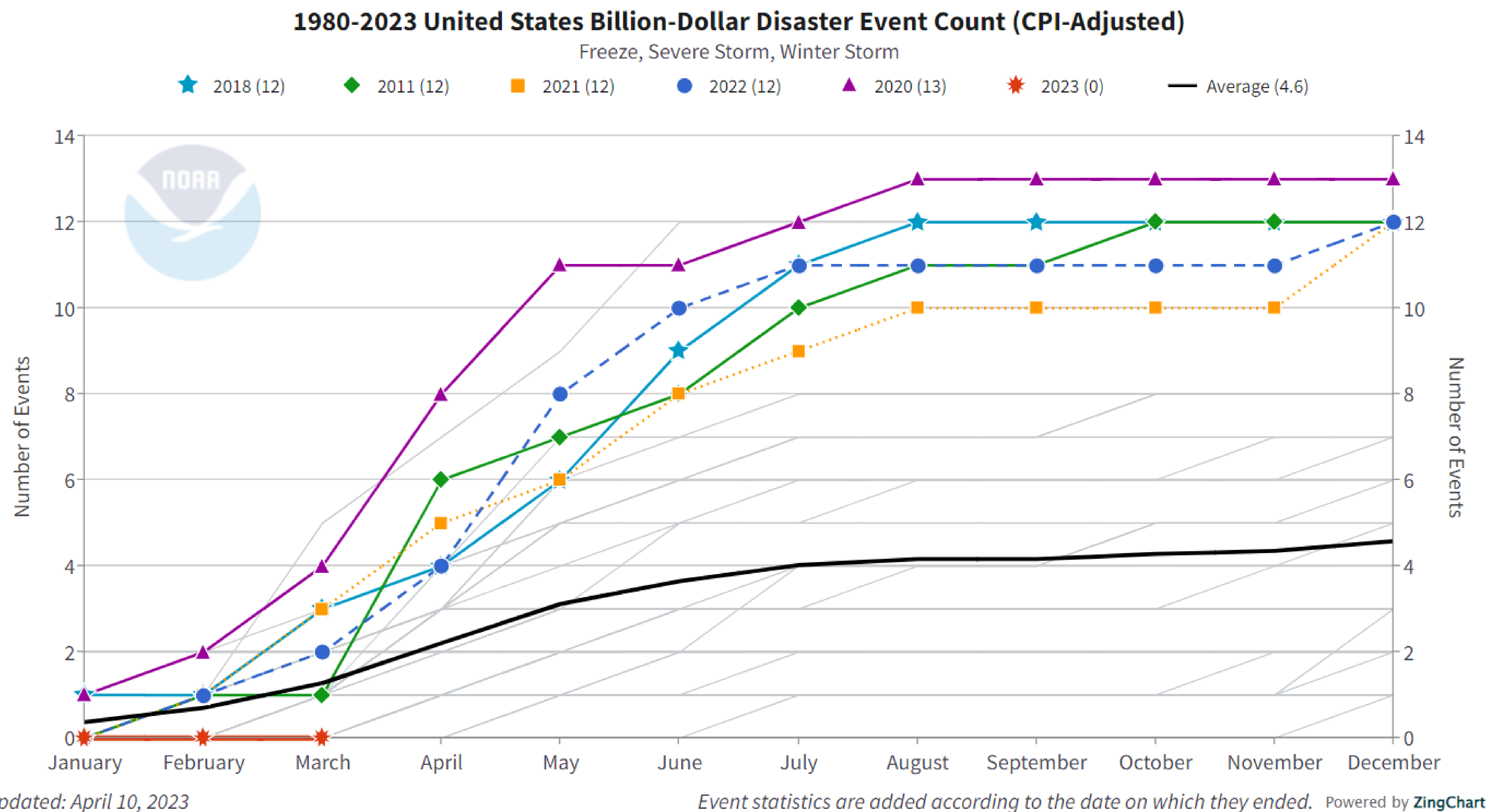
ACCEPTANCE ON BEHALF OF THE UNITED STATES OF AMERICA

I, Joseph R. Biden Jr., President of the United States of America, having seen and considered the Paris Agreement, done at Paris on December 12, 2015, do hereby accept the said Agreement and every article and clause thereof on behalf of the United States of America.

Done at Washington this 20th day of January, 2021.

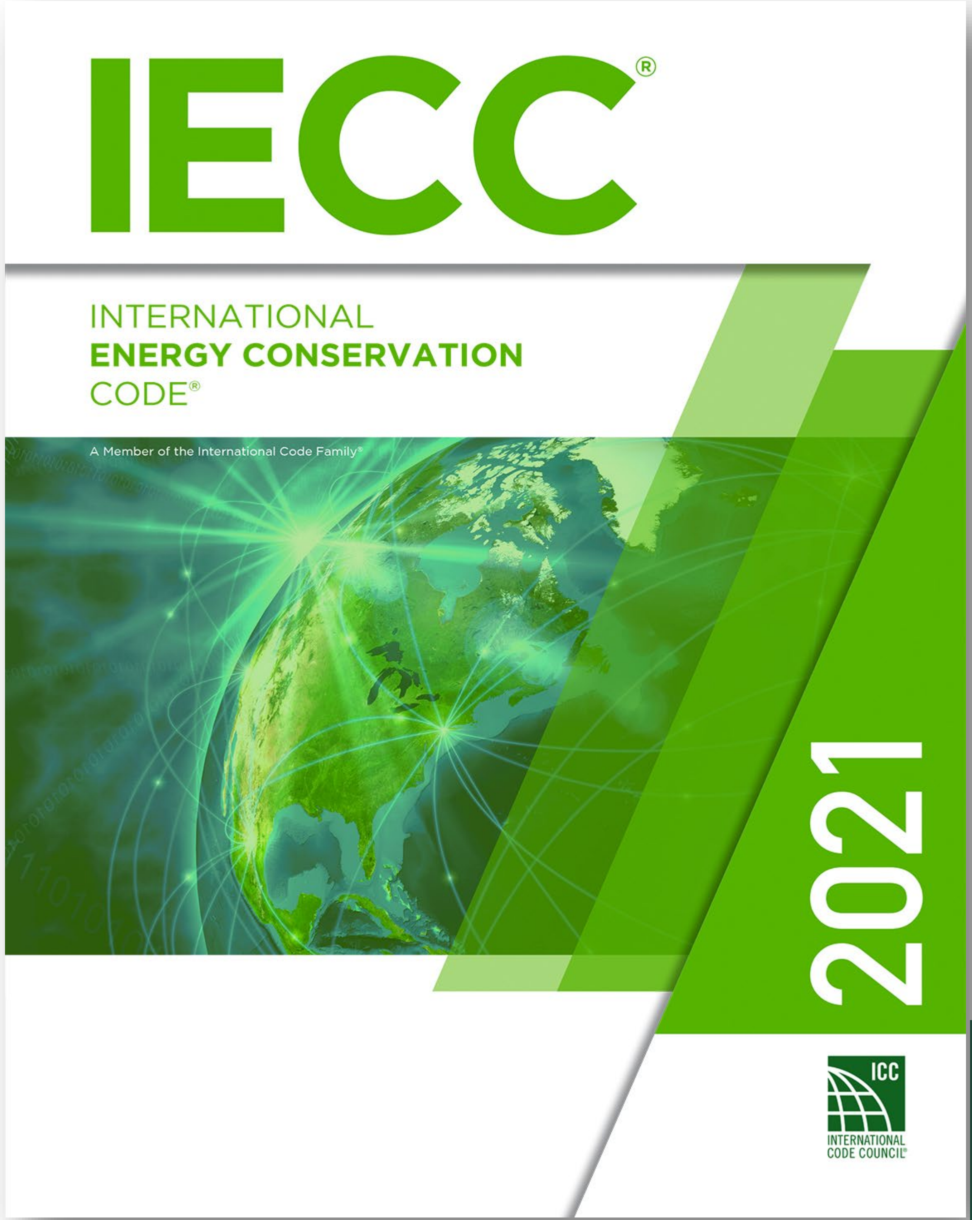
JOSEPH R. BIDEN JR.

Extreme Weather Events are Trending



2021 IECC Code on a Mission

Governments cannot meet their GHG reduction goals without having **building energy codes that align with those goals**.



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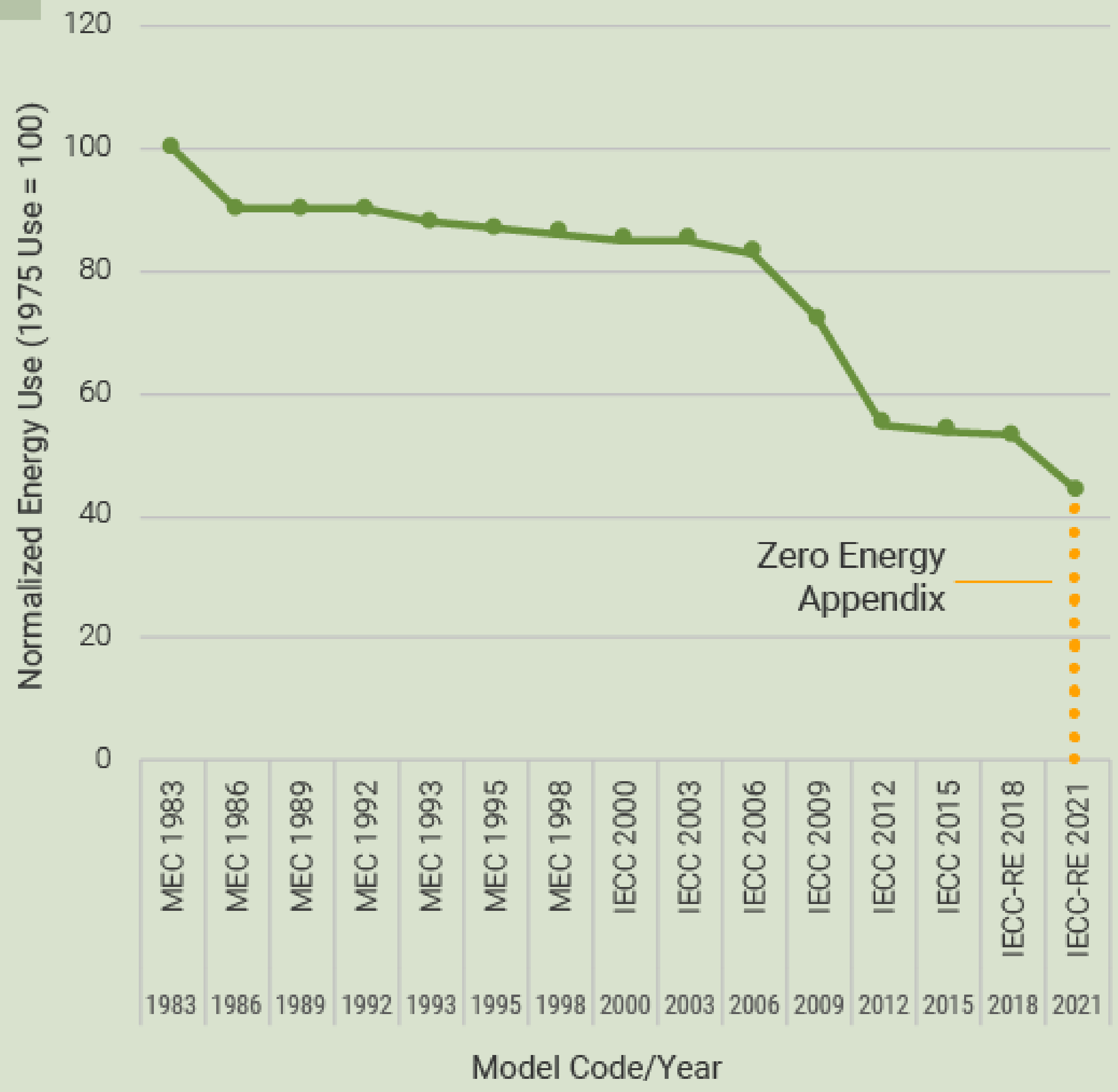
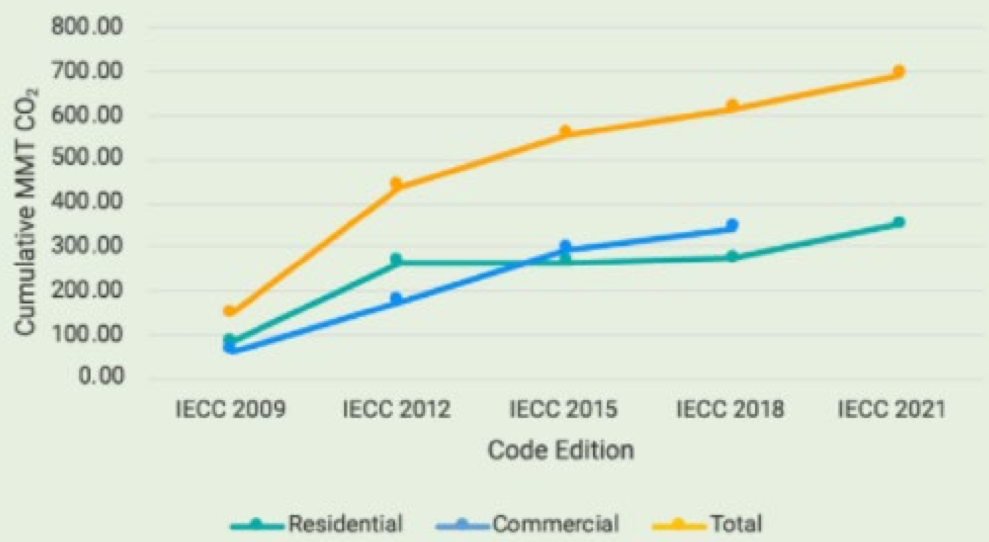
Improvement in Energy Use for Residential Model Energy Codes (1983–2021)

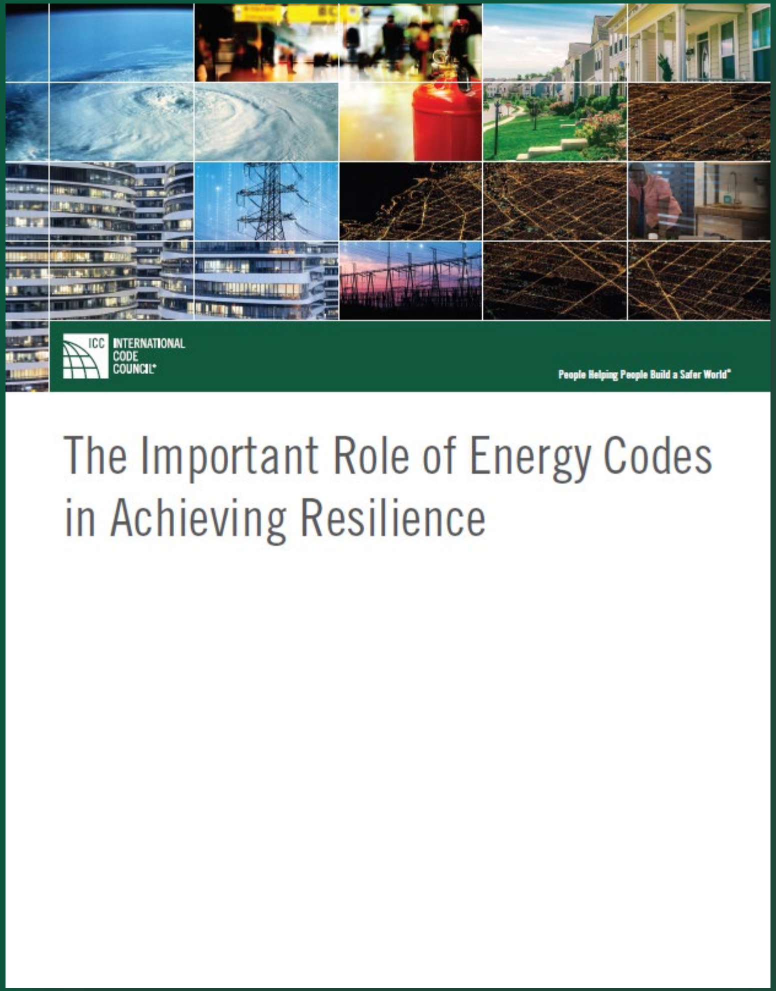
Courtesy of Pacific Northwest National Laboratory



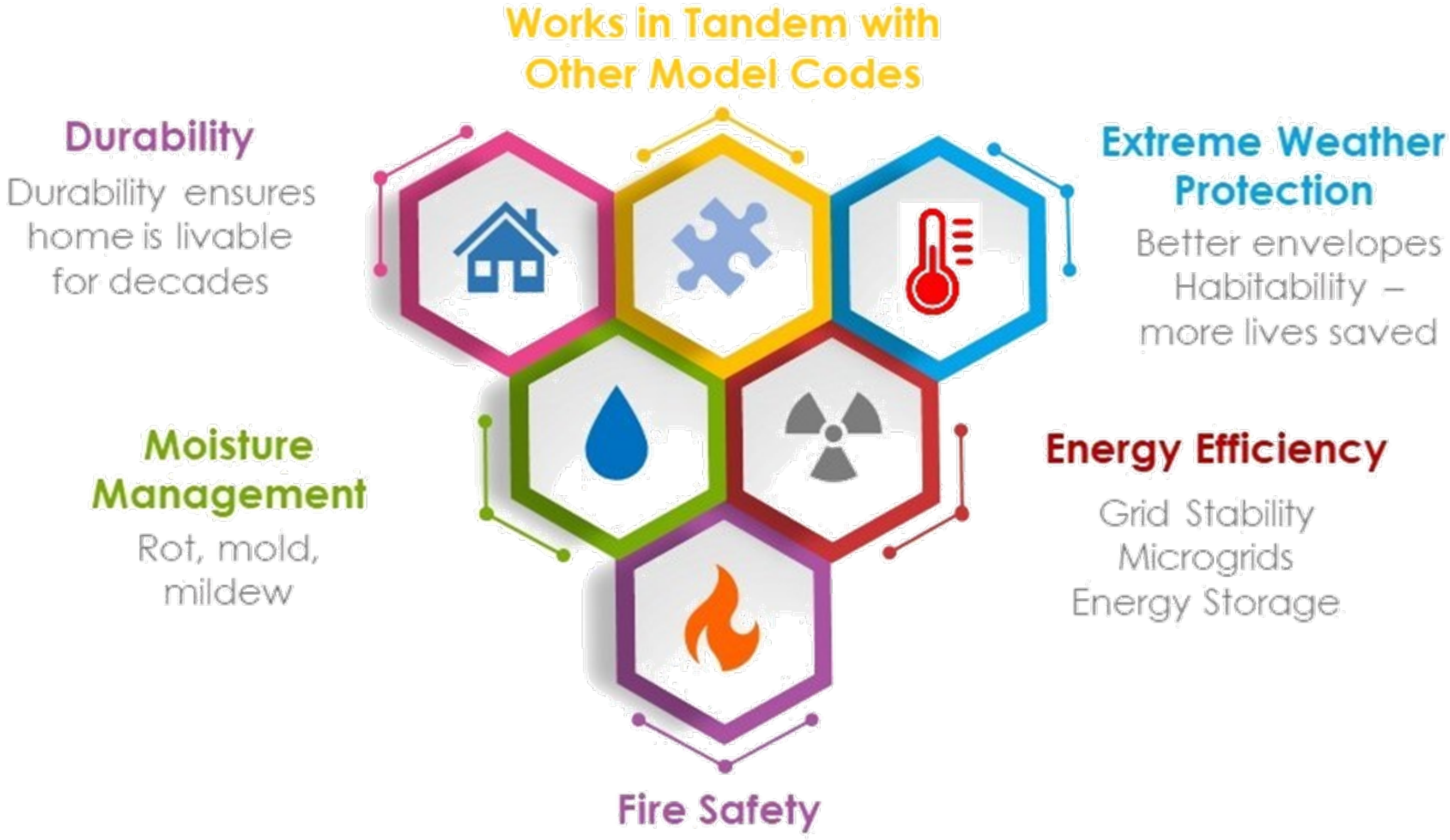
Cumulative CO_2 Savings from Each Edition of the IECC (2009-2021)



Energy Codes are a Resilience Strategy



Second in a series



https://www.iccsafe.org/wp-content/uploads/19-18078_GR_ANCR_IECC_Resilience_White_Paper_BRO_Final_midres.pdf

Resilience Benefits of Energy Efficiency

Benefit type	Energy efficiency outcome	Resilience benefit
Emergency response and recovery	Reduced electric demand	Increased reliability during times of stress on electric system and increased ability to respond to system emergencies
	Backup power supply from combined heat and power (CHP) and microgrids	Ability to maintain energy supply during emergency or disruption
	Efficient buildings that maintain temperatures	Residents can shelter in place as long as buildings' structural integrity is maintained.
	Multiple modes of transportation and efficient vehicles	Several travel options that can be used during evacuations and disruptions
Social and economic	Local economic resources may stay in the community	Stronger local economy that is less susceptible to hazards and disruptions
	Reduced exposure to energy price volatility	Economy is better positioned to manage energy price increases, and households and businesses are better able to plan for future.
	Reduced spending on energy	Ability to spend income on other needs, increasing disposable income (especially important for low-income families)
	Improved indoor air quality and emission of fewer local pollutants	Fewer public health stressors
Climate mitigation and adaptation	Reduced greenhouse gas emissions from power sector	Mitigation of climate change
	Cost-effective efficiency investments	More leeway to maximize investment in resilient redundancy measures, including adaptation measures

Figure 6. Resilience Benefits of Energy Efficiency (Ribiero et.al. 2015)

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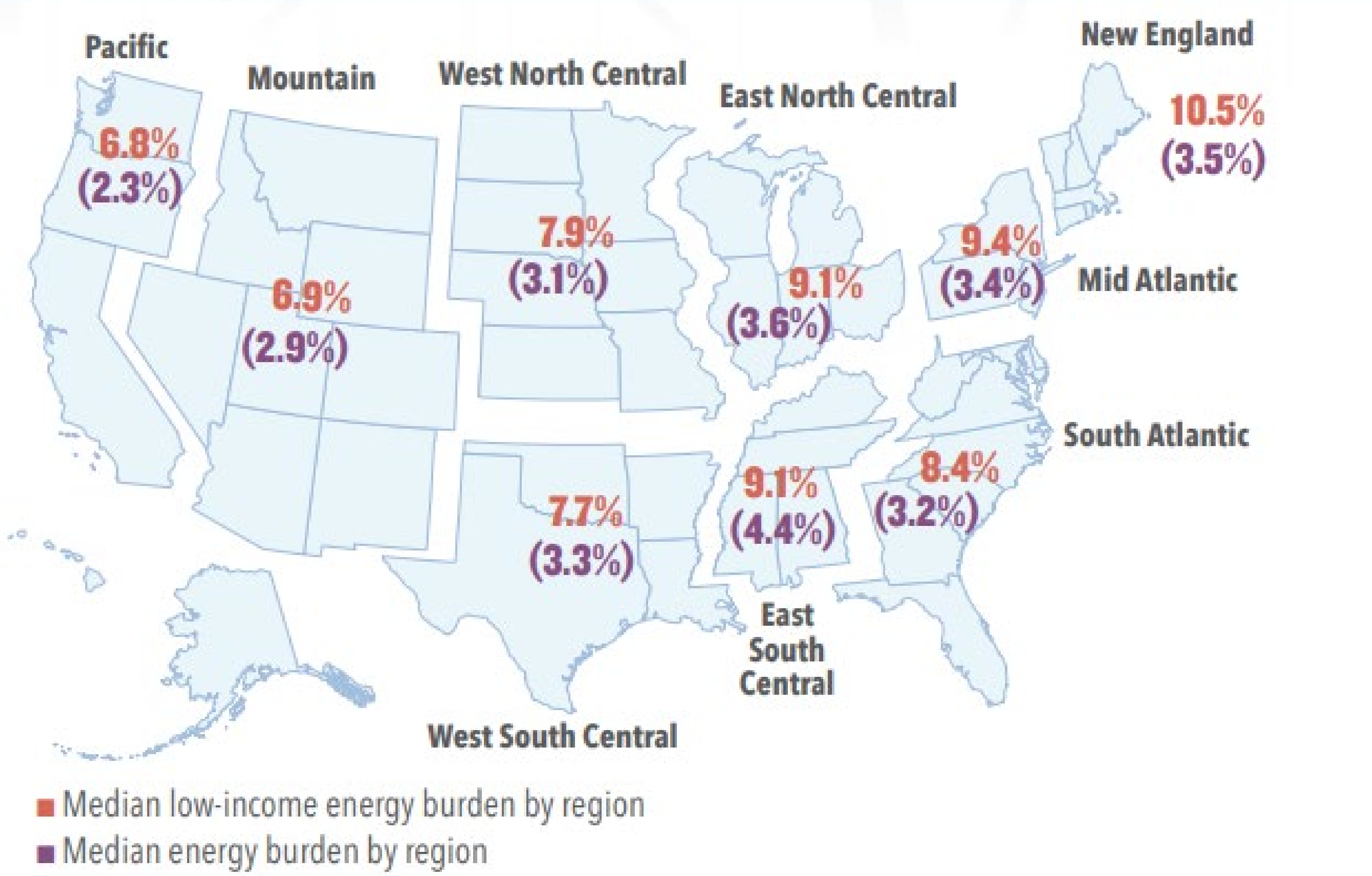
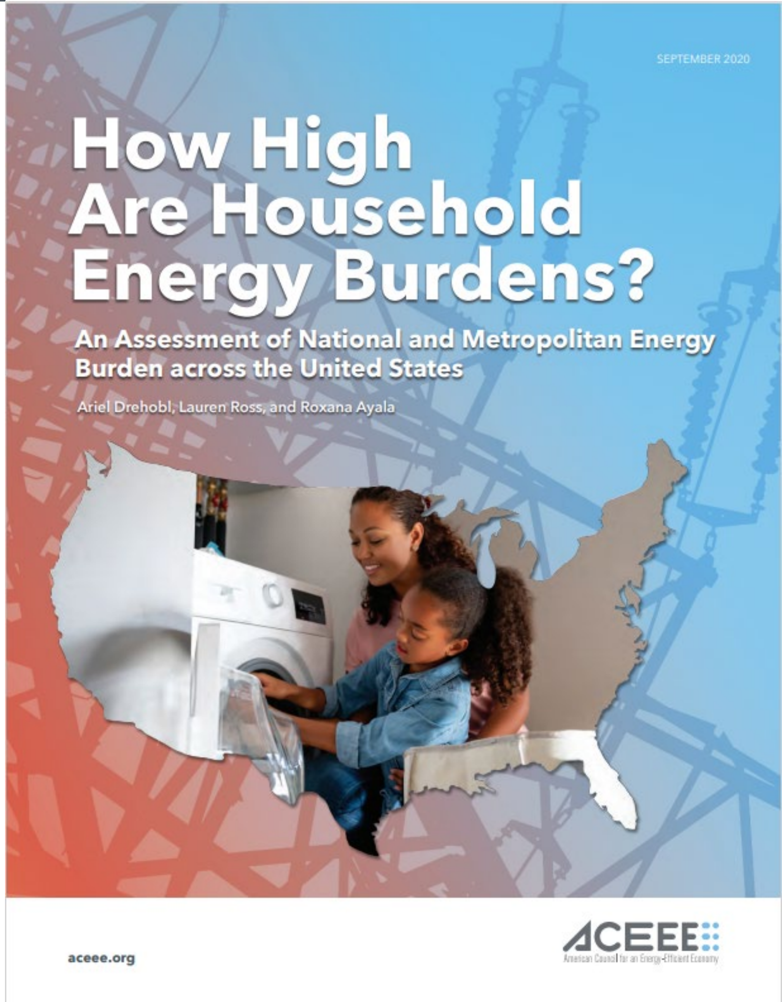
Energy Burdens & Low-Income Households

FIGURE 3. Median low-income (< 200% FPL) energy burdens by region (red) compared to median energy burdens by region (purple)



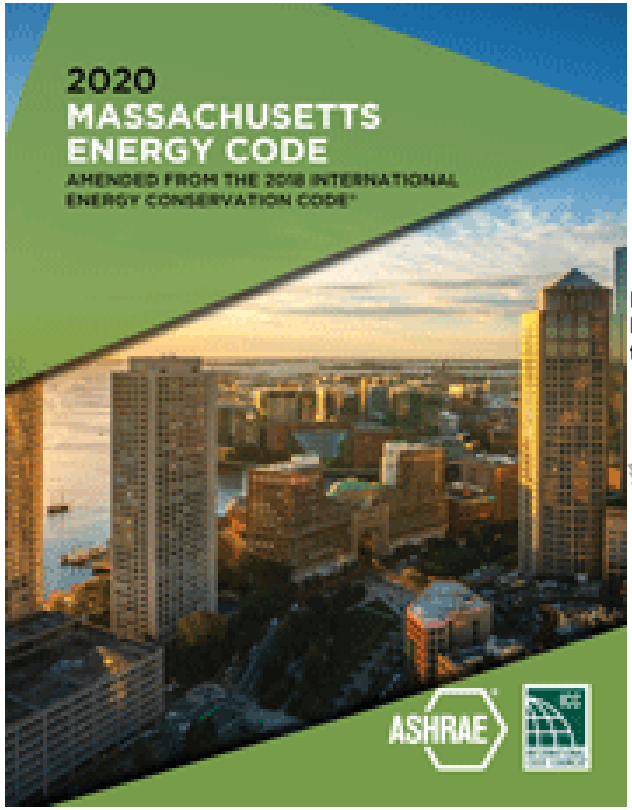


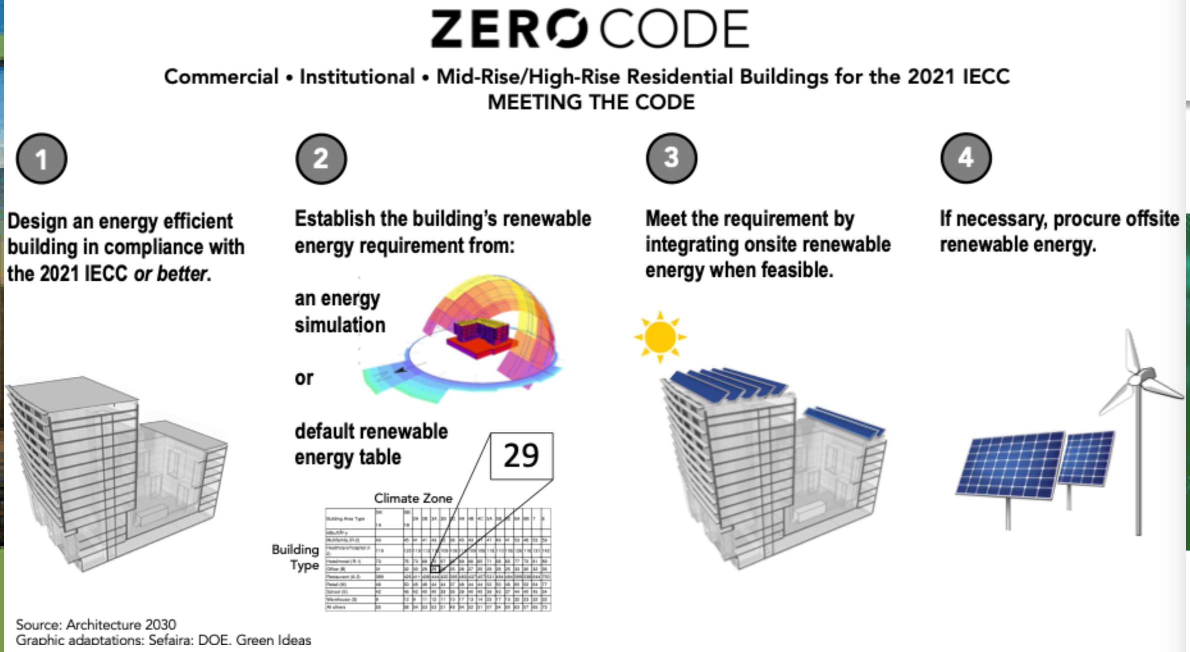
https://www.aceee.org/research-report/u2006

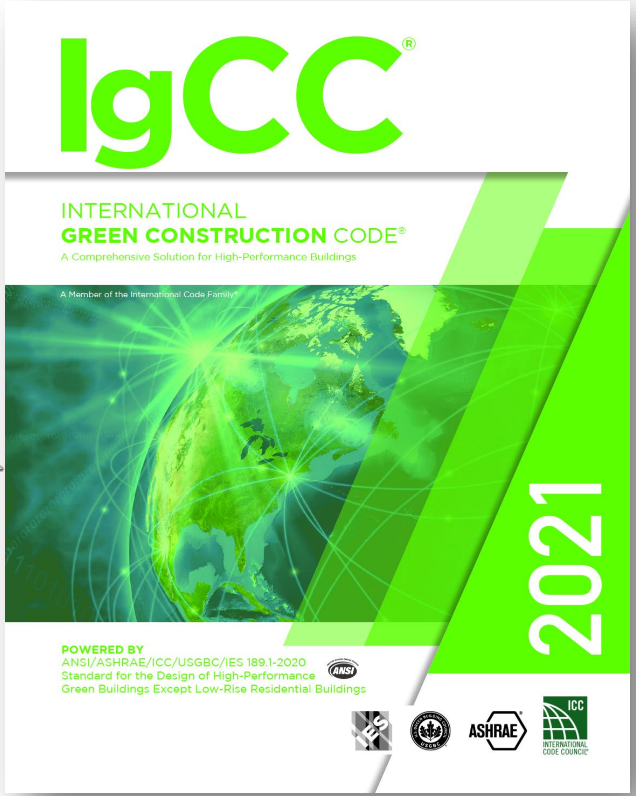
Stretch Energy Codes

- "Above" or "Reach" Codes
- Policy Tool to Enhance Energy Efficiency
- 2020 Massachusetts Energy Codes

- International Energy Conservation Code
- International Green Construction Code
  - ASHRAE, USGBC, IES Collaboration





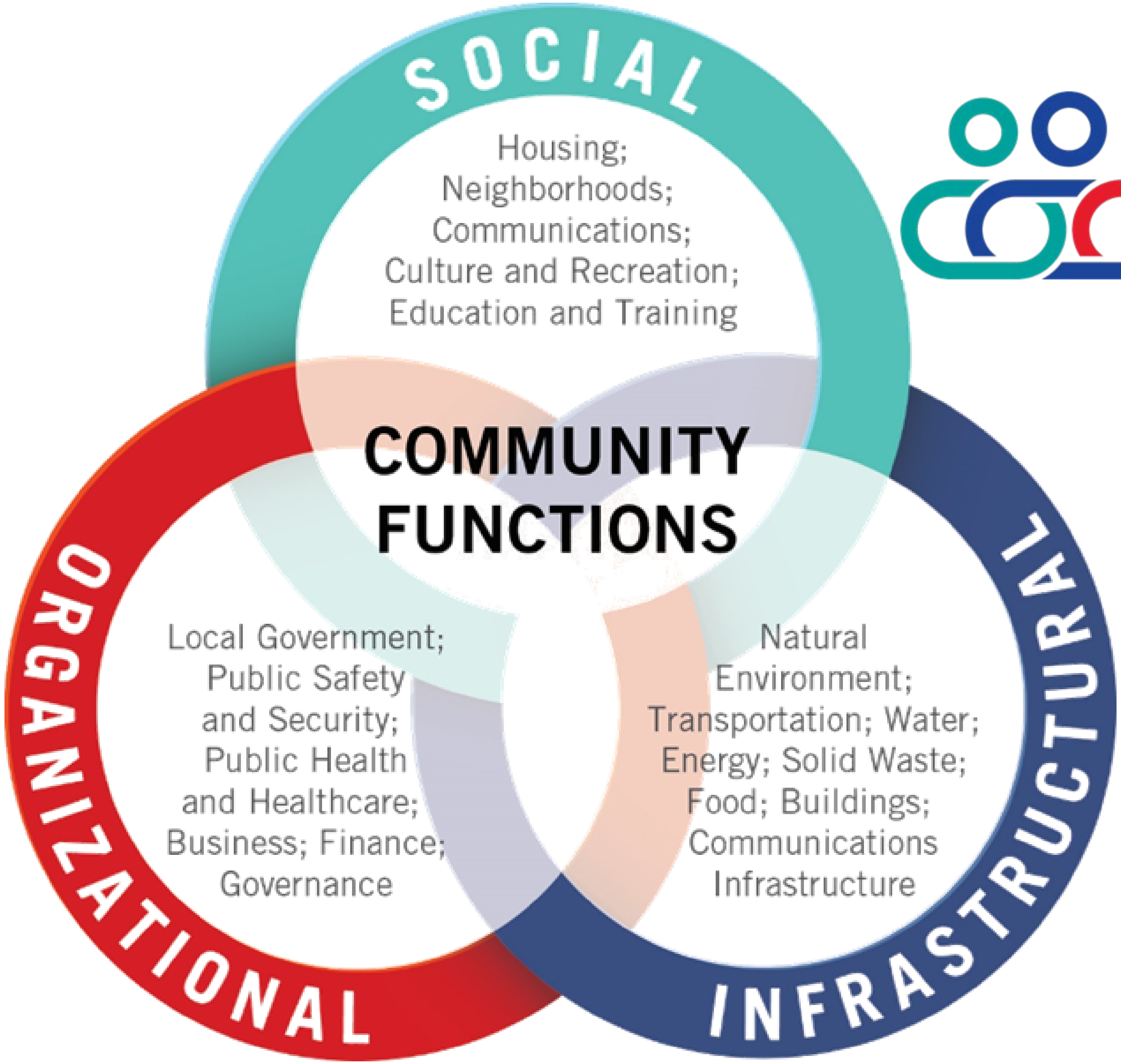


Federal Assistance for Building Energy Codes

- Infrastructure Investment and Jobs Act (IIJA)
  - Section 40511: Cost-effective Codes Implementation for Efficiency & Resilience
    - $225M for the Resilient and Efficient Codes Implementation (RECI) program
  - State Energy Program (SEP) – $500 million
  - Energy Efficiency and Conservation Block Grant (EECBG) – $550 million
- Inflation Reduction Act (IRA)
  - Section 50131: Assistance for Latest and Zero Building Energy Code Adoption
    - $330M supporting adoption of the latest model energy codes
      - 2021 IECC or ASHRAE Standard 90.1-2019
    - $670M supporting adoption of zero energy codes
      - Zero energy provisions of the 2021 IECC (or equivalent stretch code)

Visit www.iccsafe.org/federalgrants for more information

Supporting Community Resilience



Alliance for National & Community Resilience®

www.resilientalliance.org
@ANCResilience

BUILDING SAFETY MONTH

Building Safety Month 2023
"It Starts with YOU!"

Building Safety Starts at Home

Week 1

Building Safety Professionals and You

Week 2

Prepare Your Community

Week 3

Advocate for Your Community

Week 4

Solving Challenges Together

Week 5

Buildingsafetymonth.org

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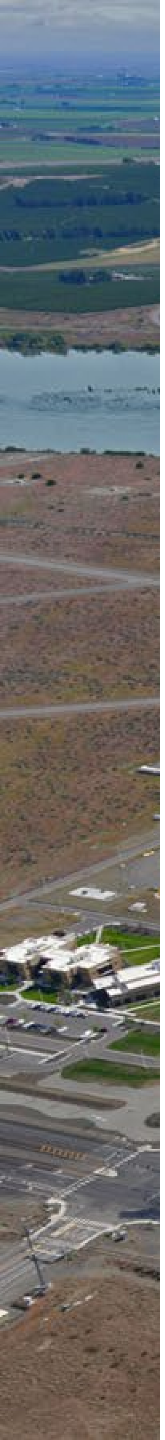


Pacific Northwest
NATIONAL LABORATORY

2023 National Energy Codes Conference

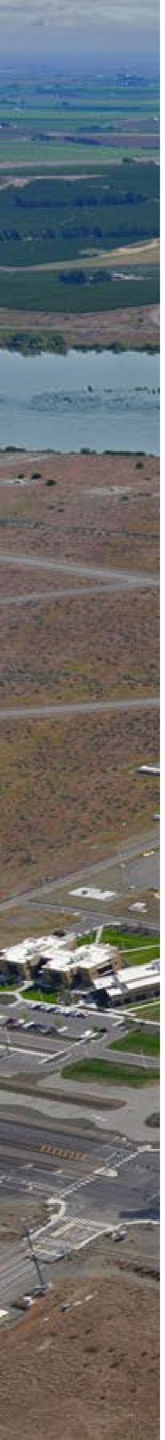
Valuing Energy Efficiency for Energy Resilience

Ellen Franconi, Pacific Northwest National Laboratory

May 4, 2023

U.S. DEPARTMENT OF ENERGY BATTELLE

PNNL is operated by Battelle for the U.S. Department of Energy



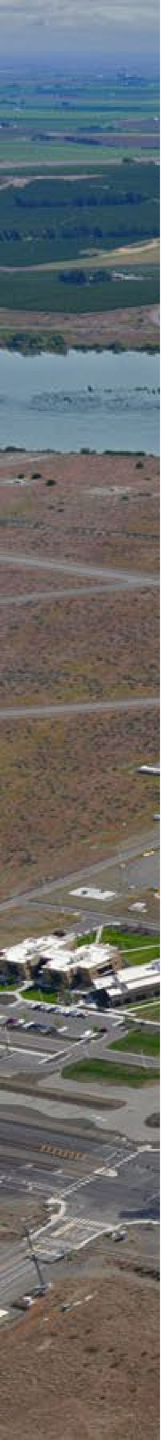
Valuation of Energy Efficiency for Energy Resilience

A collaborative **PNNL, NREL, and LBNL** project guided by a **technical advisory group** and funded by **DOE**

Project objective: develop a **standardized** methodology to **quantitatively** assess how building efficiency impacts energy resilience.

	PNNL	NREL	LBNL	DOE
Team Leads	Ellen Franconi Overall PI and PM	Eliza Hotchkiss Lab PM	Tianzhen Hong Lab PM	Michael Reiner Christopher Perry Jeremy Williams
Building Types	New single family New and existing multifamily	Existing single family	Nursing home case study	
Modeling Platform	Code modeling framework	ResStock	EnergyPlus	
Resilience Analysis Method Development	Extreme event excess death analysis	Extreme event-power outage probability	Extreme weather event characterization	

Project Scope



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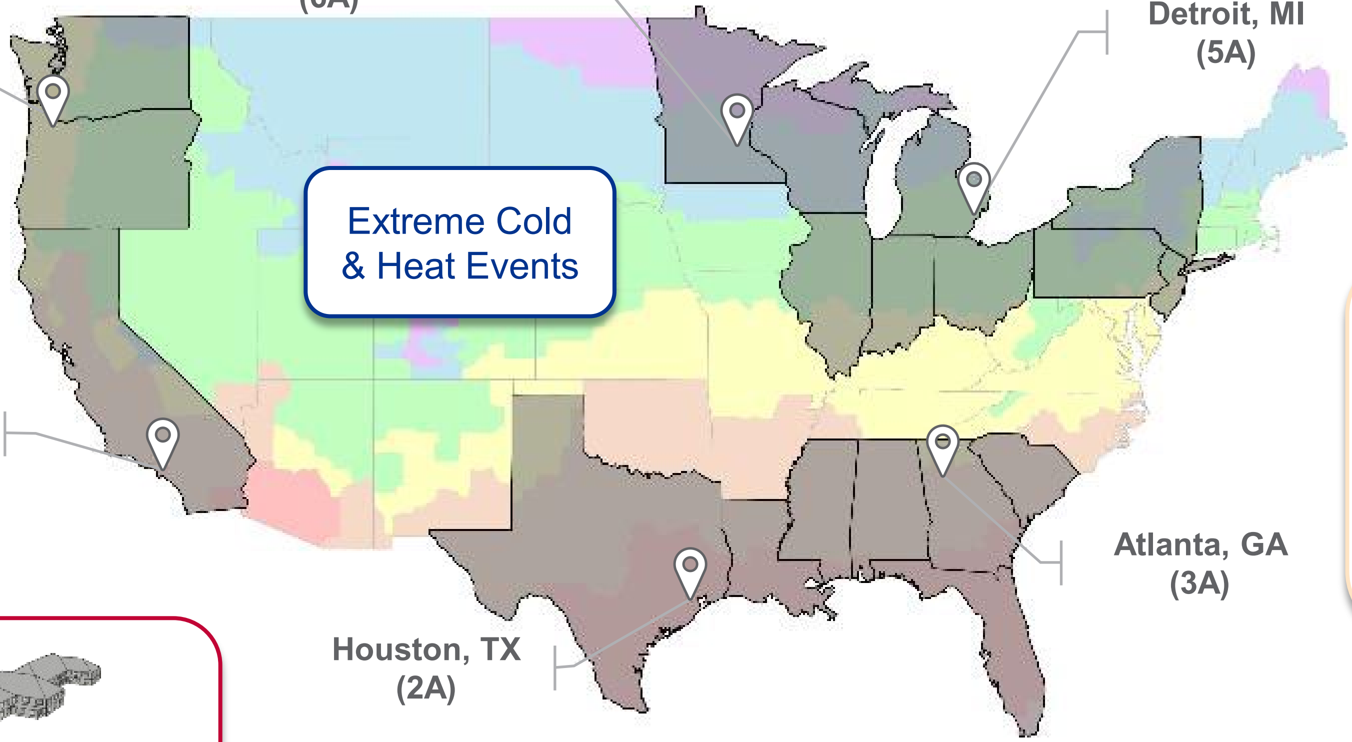
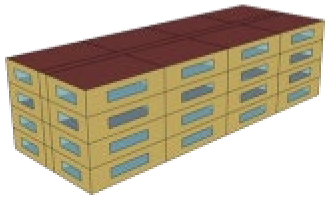


Extreme Cold & Heat Events



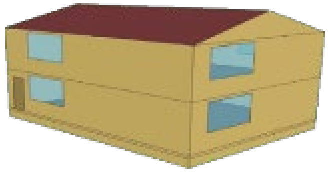
Multi-Family

New & Existing

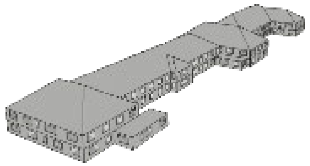
Baseline Condition
Historic Code/Existing Stock

Current Code
ASHRAE 90.1-2019 & IECC-R 2021

Beyond Code
Informed by 2021 Passive House



Single-Family



Assisted Living Facility

Counterfactual Case Study

2021 Texas Winter Storm and Extreme Heat Event

Metrics & Valuation

Thermal Resilience: Standard Effective Temperature, Heat Index
Mortality: Gasparrini Relative Rate Model
Investment: Benefit Cost Ratio (BCR)

Project Approach

Hazard Risk Analysis

- Extreme temperature event identification
- Power outage data
- Extreme event weather file creation

Coincident probability

Exposure Analysis

- Baseline and efficiency packages
- Building energy models
- Building simulation analysis

Indoor conditions effect on habitability

Damage Analysis

- Susceptibility factors
- Loss data or fragility models
- Damage and loss

Property damage and excess mortality

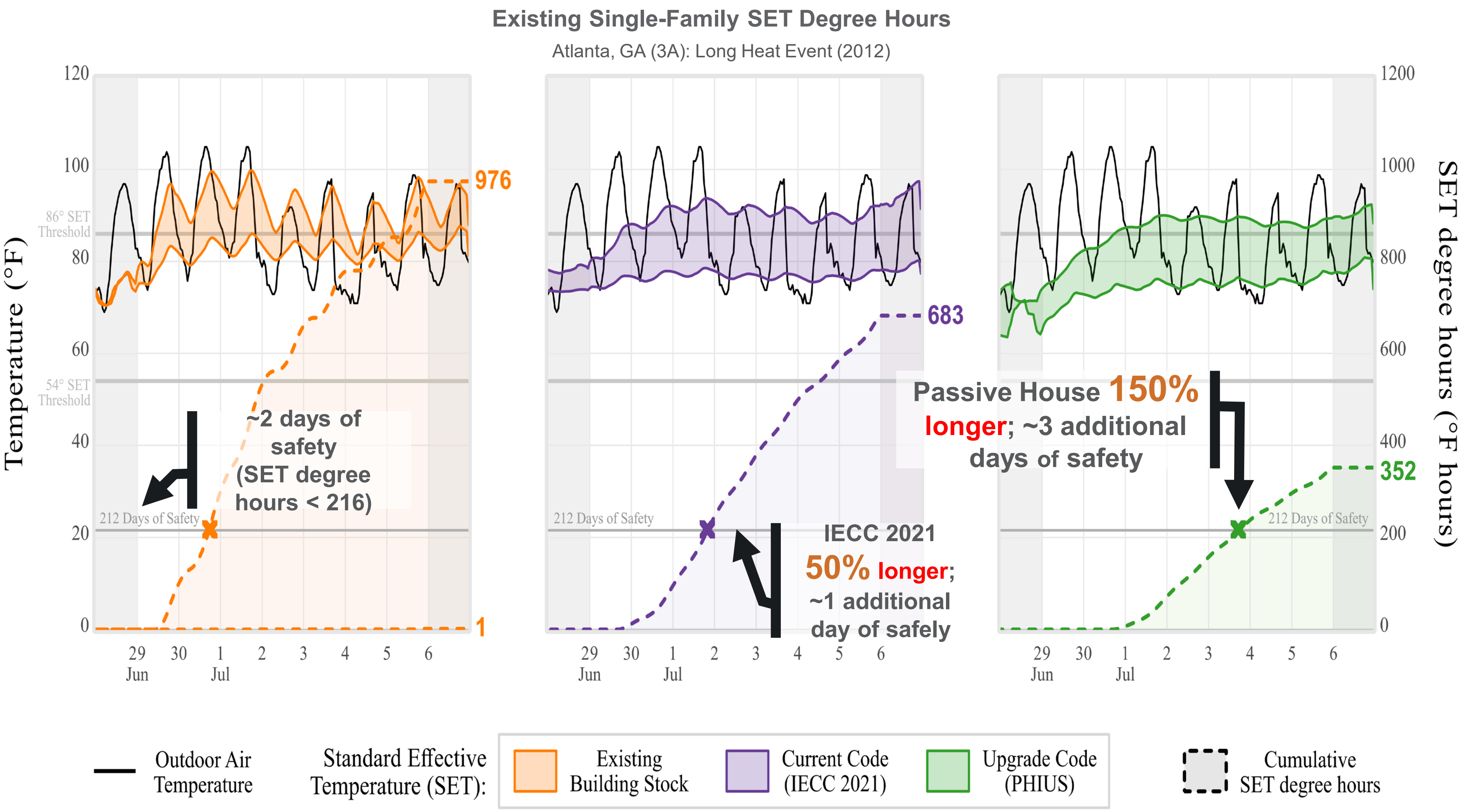
Mitigation Valuation

- Valuation of loss
- Mitigation costs
- Annualized impacts
- Net present value analysis

Return on efficiency investment

Exposure Analysis

What is the fluctuation in indoor comfort conditions extreme temperature events? How does it affect habitability?

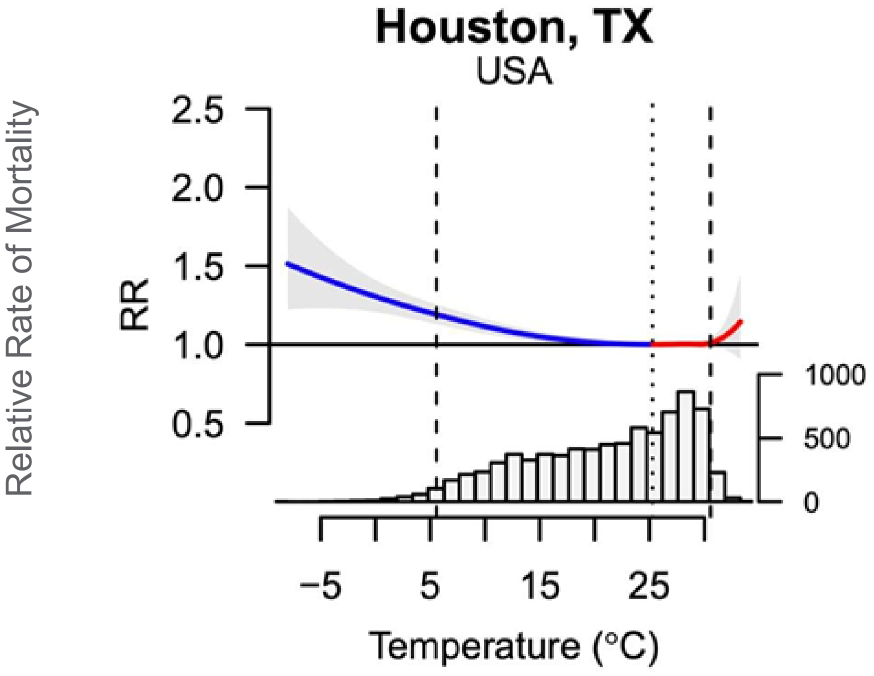


Area outlines illustrate the 5th and 95th percentiles of the building samples.

Damage Analysis

How does extreme heat and cold impact mortality rate?

Relative rate of death curves as a function of **outdoor temperature** published by Gasparrini available for over 130 U.S. locations



Mean Daily Outdoor Air Temperature (C)

Notes: Vertical dashed lines indicate the temperature at 2.5th percentile and 97.5th percentile. The vertical dotted line indicates the temperature at which the relative rate of death is one or the temperature at which deaths are not attributed to severe temperatures

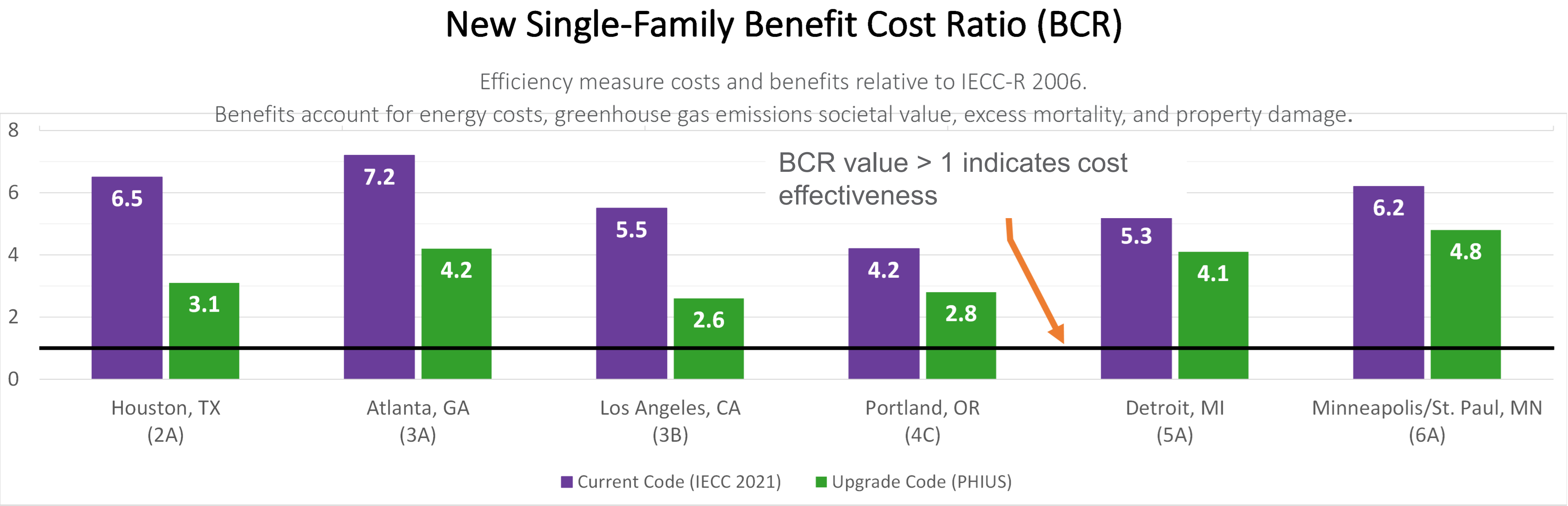
Example Exposure and Damage Results

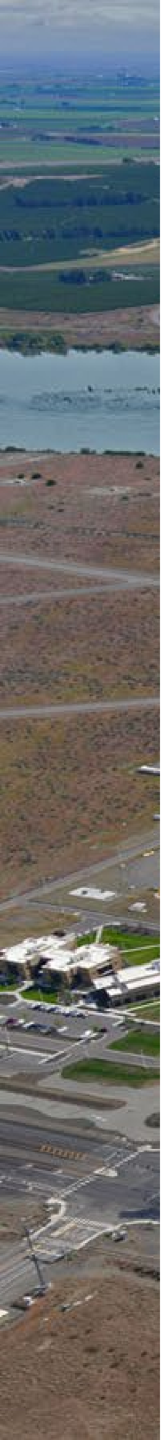
Location (Climate Zone)	Event	SET Degree Hours*			Days of Safety			Improvement from Basecase		Lives Saved per Event		Improvement from Basecase	
		Existing Stock	Current Code IECC 2021	Beyond Code PHIUS	Existing Stock	Current Code IECC 2021	Beyond Code PHIUS	Current Code IECC 2021	Beyond Code PHIUS	Current Code IECC 2021	Beyond Code PHIUS	Current Code IECC 2021	Beyond Code PHIUS
Houston, TX (2A)	Long Cold	749	222	-	3.8	6.9	7	82%	85%	20.0	43.2	32%	69%
	Long Heat	600	141	-	4.0	7	7	75%	75%	42.1	50.2	80%	96%
Atlanta, GA (3A)	Long Cold	2,558	1,610	200	1.4	2.3	7	64%	409%	3.6	8.7	21%	52%
	Long Heat	438	59	-	2.9	7	7	140%	140%	0.9	5.9	14%	93%
Los Angeles, CA (3B)	Long Cold	87	-	-	7	7	7	-	-	5.2	5.4	25%	25%
	Long Heat	100	-	-	7	7	7	-	-	126.9	202.8	53%	84%
Portland, OR (4C)	Long Cold	2,963	1,849	237	1.1	2.4	6.8	123%	523%	3.2	8.6	22%	58%
	Long Heat	371	319	-	4.7	5.5	7	16%	49%	-2.6	24.5	-8%	71%
Detroit, MI (5A)	Long Cold	4,248	3,020	1,778	0.9	1.7	2.4	82%	159%	5.1	10.8	14%	30%
	Long Heat	223	53	0.3	6.8	7	7	2%	2%	6.9	26.0	9%	35%
Minneapolis/ St. Paul, MN	Long Cold	5,397	3,699	2,190	0.6	1.2	1.8	100%	214%	7.3	14.0	19%	36%
	Long Heat	215	66	5	7	7	7	-	-	4.4	14.7	8%	27%

* SET Degree Hours are cumulative SET hourly values > 86 F for extreme heat and < 54 F during extreme cold. The values in the table are based on a 7-day period. The threshold for habitability is 216, which is in accordance with the USGBC LEED resilience credit.

Example Benefit Cost Ratio Results

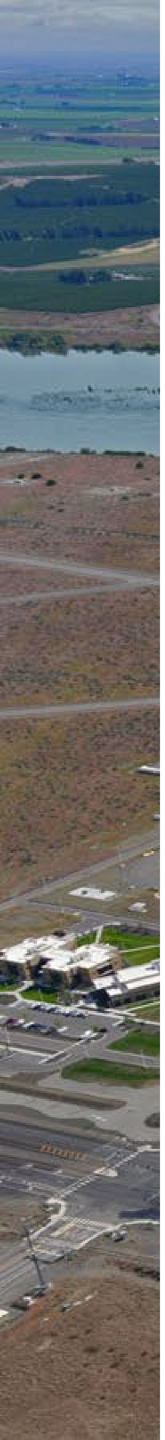
What is the return on building efficiency investment with annual energy cost saving, societal value of reduced CO2e emissions, and annualized excess deaths?





Methodology Robustness Assessment

Category	Component	Robustness
1. Hazard Risk Identification	Develop weather data files representative of extreme temperature events	
	Develop coincident probability risk factors to annualize event losses and benefits	
2. Exposure Analysis	Assess relative impact of efficiency measures on habitability	
	Determine indoor habitability conditions exceeding thresholds	
3. Vulnerability Assessment	Evaluate occupant exposure effect on mortality, health, and well-being	
	Evaluate property exposure effect on active building state and systems	FUTURE
4. Mitigation Valuation	Quantify the monetary value of resilience	
	Inform resilience planning efforts	



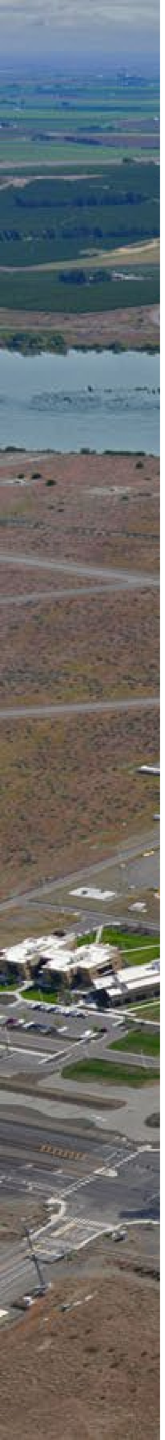
Key Trends and Take-Aways

- For most single-family cases evaluated, increased efficiency improved thermal resilience and extended the days of safety during extreme temperature events.

- Locations having the highest risk of extreme temperature-power outage events, realized the highest resilience benefit from the efficiency investment.

- Increasing efficiency at the time of construction provides a good investment opportunity for addressing resilience.

- For more details, see the final report available this summer
  - *Enhancing Resilience in Buildings Through Energy Efficiency*, PNNL-SA-177117
  - https://www.energycodes.gov/energy-resilience



Pacific
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Thank you

Distributed Energy Resources (DER) & Resilience

National Energy Codes Conference
May 4, 2023
Kristen Hagerty

IREC

IREC builds the foundation for rapid adoption of clean energy and energy efficiency to benefit people, the economy, and our planet.

PNNL-SA-177117

Efficiency → Resilience

"Energy-efficient buildings lower power demand, ***reducing the stresses to the grid."***

"Grid-enabled technologies, such as smart thermostats and heat pump water heaters, can ***adjust load consumption*** *to support time-sensitive peak demand periods."*

"Following disaster, certain efficiency strategies, such as mechanical ventilation systems, can also help the building rebound by ensuring adequate access to fresh air and ***reducing the potential for mold growth and other lasting moisture damages."***

Pacific Northwest NATIONAL LABORATORY

NREL NATIONAL RENEWABLE ENERGY LABORATORY

BERKELEY LAB

Enhancing Resilience in Buildings Through Energy Efficiency

December 2022

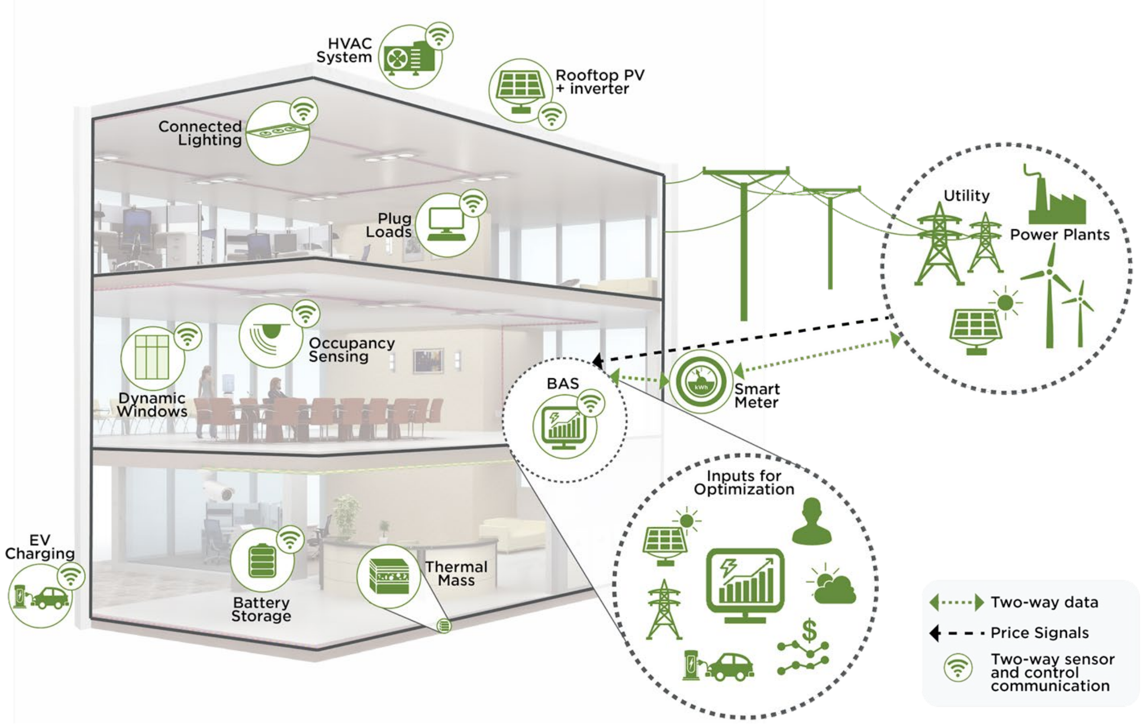
Department of Energy
Jeremy Williams, Christopher Perry, and Michael Reiner
Pacific Northwest National Laboratory
Ellen Franconi, Mark Weimar, Luke Troup, Yunyang Ye, Chitra Nambiar, and Jeremy Lerond
National Renewable Energy Laboratory
Eliza Hotchkiss, Jordan Cox, Sean Ericson, Eric Wilson, Philip White, Conor Dennehy, Jordan Burns, Jeff Maguire, and Robin Burton
Lawrence Berkeley National Laboratory
Tianzhen Hong, Linqian Sheng, and Kaiyu Sun

U.S. DEPARTMENT OF ENERGY

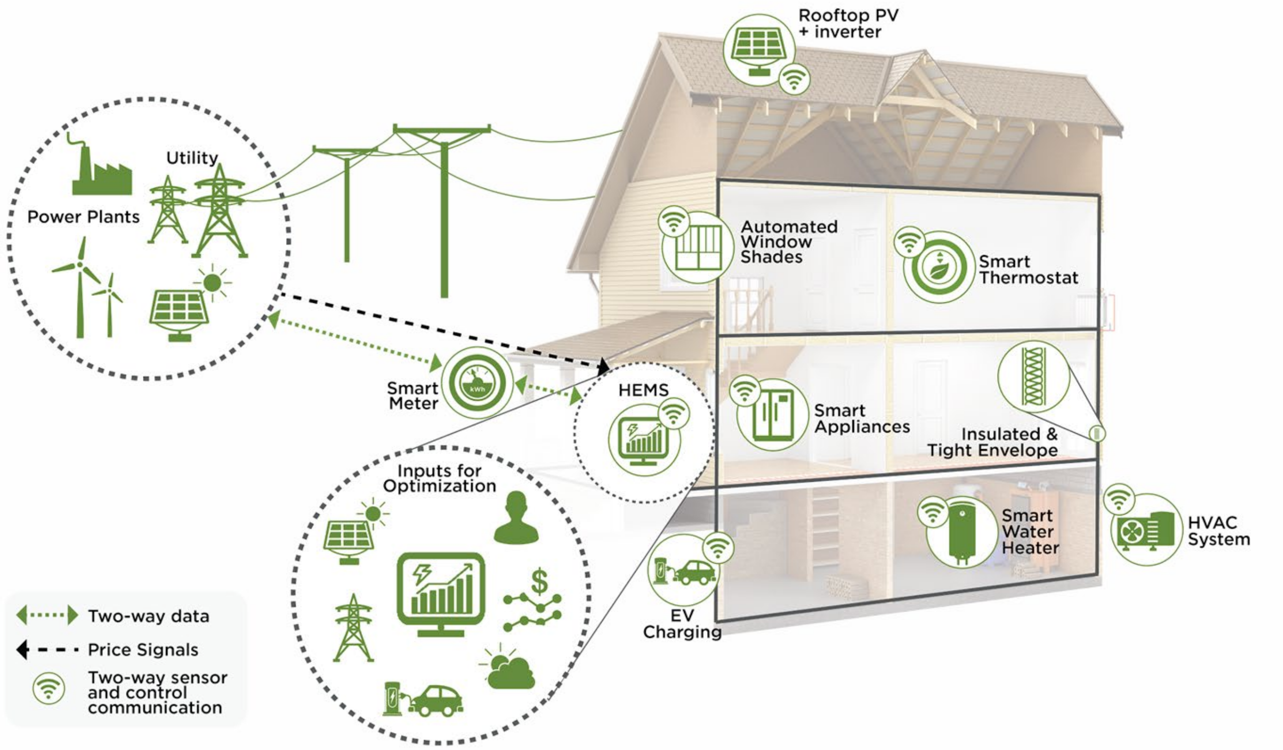
IREC

Distributed Energy Resources → Resilience

Grid-Interactive Efficient Commercial Buildings



Grid-Interactive Efficient Homes



Images: Guidehouse

IREC

Opportunity: Education about Safety & Efficiency Codes

Insulation →	Does insulation and wall assembly present new/ different fire risks?
Efficient electric heating and cooling →	How well does it work in all climates?
Wiring for electric vehicle charging →	Can it put power back to the utility grid?
Energy storage →	How far apart can the units be?

IREC

Opportunity: Education

Education about the safety and resilience support of DERs can extend the message that the energy code is life-safety related.

- Code development
- Adoption
- Implementation
- Enforcement

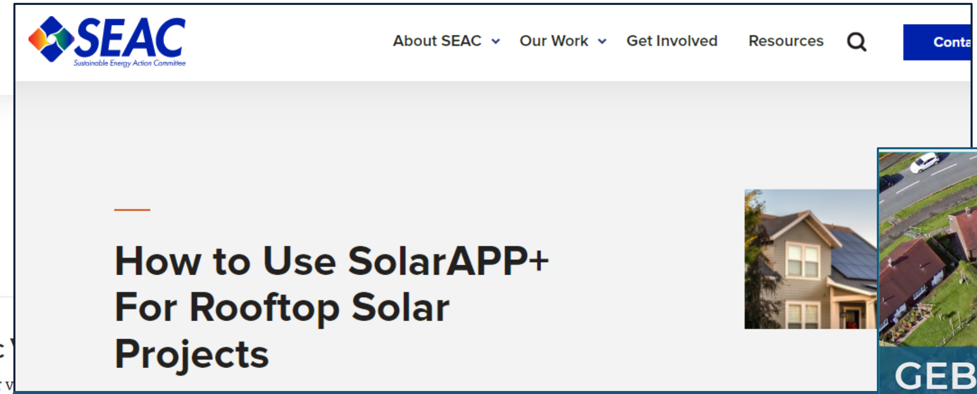
IREC

Target Audience for Safe DER Building Integration

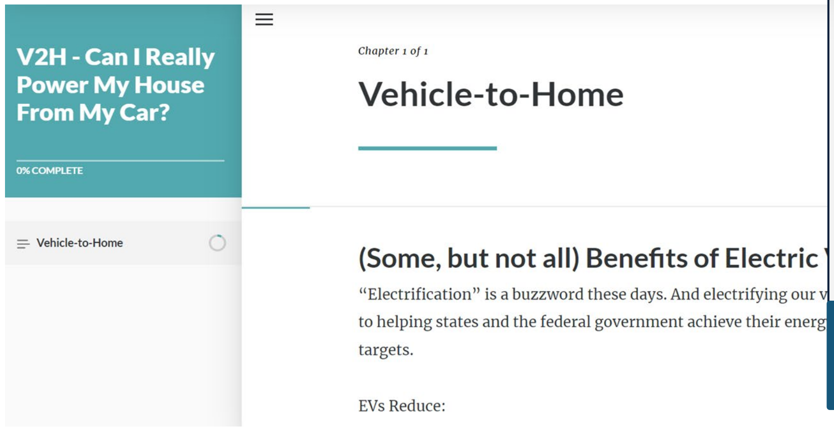
- Code officials
- Fire marshals
- First responders
- Building managers and operators
- Installers/ contractors
- Architects
- Designers/ engineers

IREC

Educational Resources: CleanEnergyClearinghouse.org

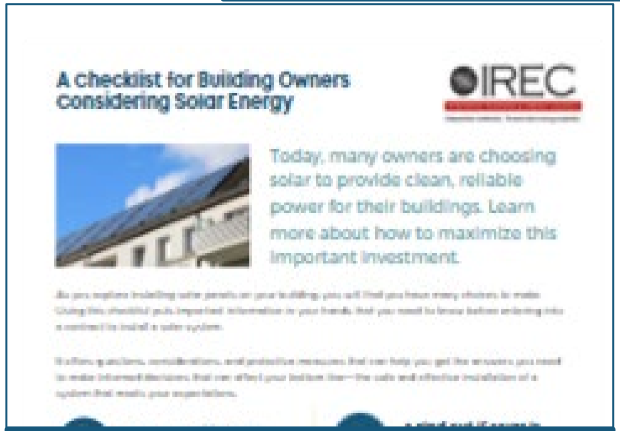


Articles/ blog posts - Design validation



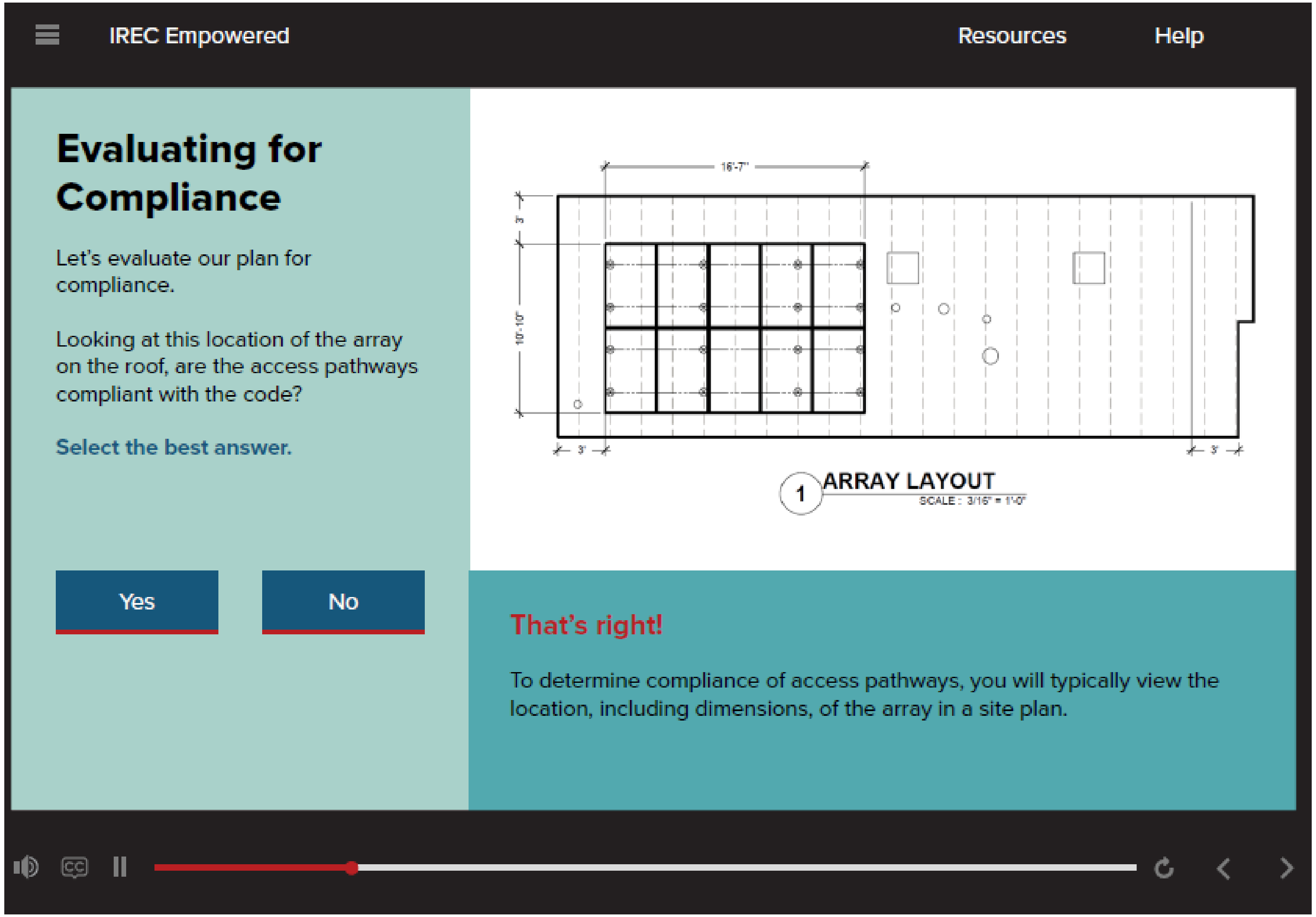
Interactive lessons - Vehicle-to-Home

Infographics - *Model codes*



Downloadable checklists - PV

Job-Focused Training: CleanEnergyTraining.org



Distributed Energy Resources & Resilience

- Efficiency (reducing needed load) and DERs (generation and load shifting) can increase both building resilience and grid resilience.
- Communities with more resilient structures and infrastructure can recover from and more successful adapt to adverse events.
- Structures built to the latest energy codes can support a more resilient energy grid.
- Education about the safe and code compliant installation of DERs that meet energy code and support resilience is critical to energy code adoption.

Suggestions welcome

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Interstate Renewable Energy Council
Kristen Hagerty, Senior Director of Workforce Development
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IREC

Building a more Resilient Miami-Dade County

Dr. Patricia Gomez

Director of Energy and Deputy Chief Resilience Officer, Miami-Dade County

DOE Energy Codes Conference

How Valuing Resilience Demonstrates Energy Codes Benefits for Grid Stability and Life Safety

May 4, 2023

MIAMI-DADE COUNTY

OFFICE OF RESILIENCE

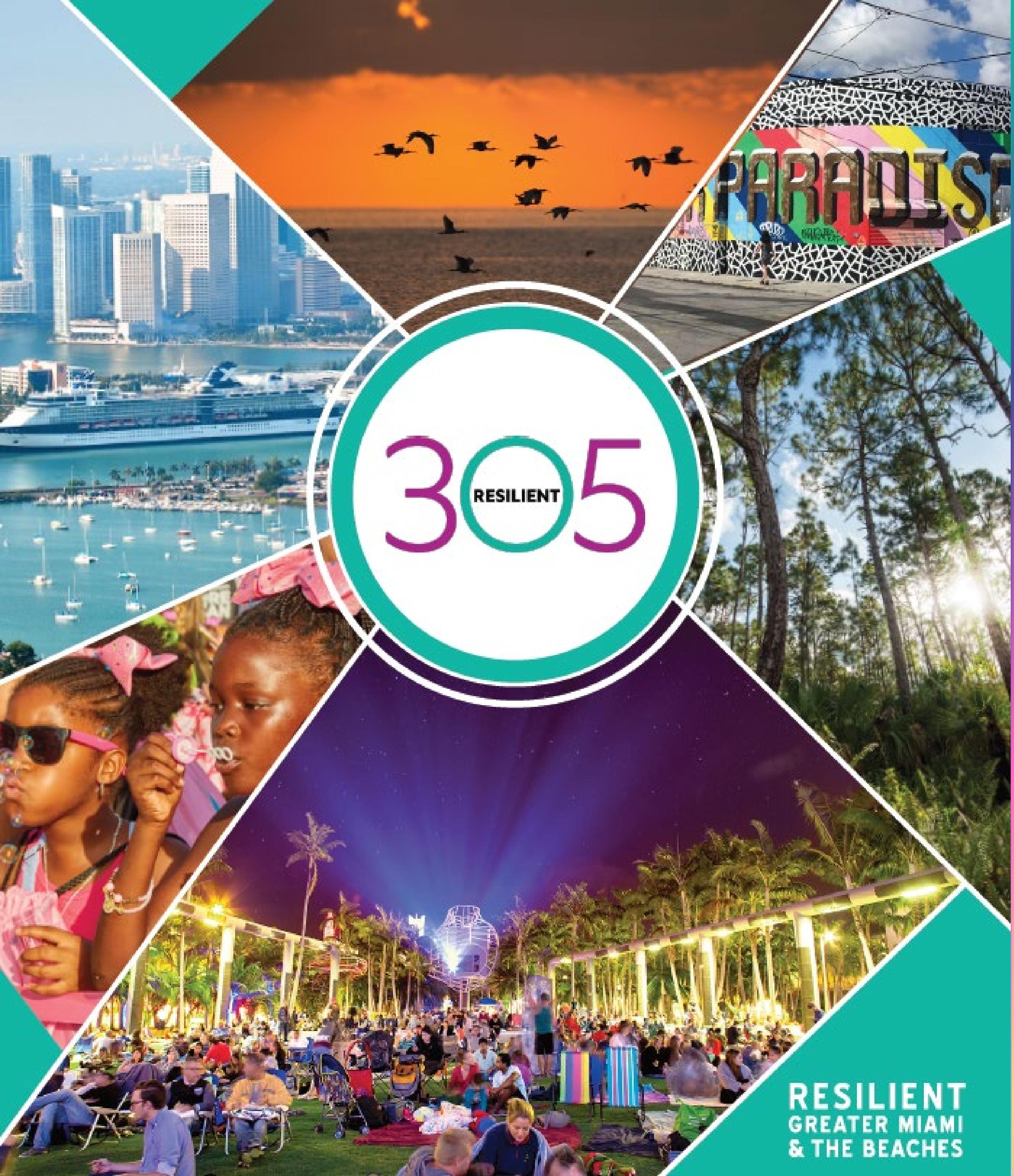
REGULATORY AND ECONOMIC RESOURCES

miamidade.gov/resilience

MIAMI-DADE COUNTY

The Office of Resilience's mission is to lead Miami-Dade County to a resilient and sustainable future by identifying vulnerabilities, coordinating stakeholders, and facilitating innovative solutions.

ENERGY AND CLIMATE MITIGATION	ADAPTATION	COMMUNICATION	BISCAYNE BAY	EXTREME HEAT	FUTURE READY	ZERO WASTE
Reduce Sources of Climate Change	Address Sea Level Rise Impacts	Engage & Connect Stakeholders	Protect and Restore	Implement Heat Risk Reduction Efforts	Resilience Implementation & Planning	Minimize Waste & Reduce Consumption

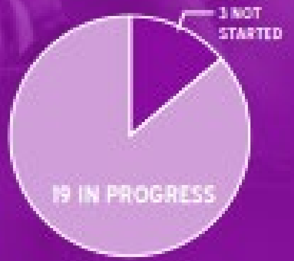


PLACES

Through our "Places" actions, we aim to address place-based challenges by enhancing our climate resilience through design and planning for the future; creating, connecting, and improving mobility and housing options; and safeguarding our ecosystems.

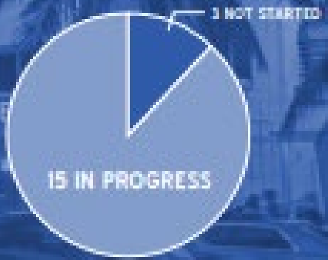
PEOPLE

Through our "People" actions, we aim to improve the lives of our residents every day, whether sunny or stormy, by supporting job and wealth creation; addressing specific health needs for the most vulnerable among us; and preparing and empowering neighborhoods and networks to anticipate and respond to disruptions, both large and small.



PATHWAYS

Through our "Pathways" actions, we aim to build the connections, collaborations, and committed leadership needed to change the status quo, enabling GM&B to become a global leader in resilience. We can achieve this by setting common goals and committing to actions that bring together governments, businesses, and academic and community organizations.



MIAMI-DADE COUNTY

Connected Strategies

Regional collaboration to meet regional challenges

- Miami-Dade County works closely with our local and regional partners through the **Southeast Florida Regional Climate Change Compact** to address the full range of climate change causes and outcomes.
  - Regional Climate Action Plan (RCAP) - the Compact's guiding tool for coordinated climate action in Southeast Florida to reduce greenhouse gas emissions and build climate resilience.

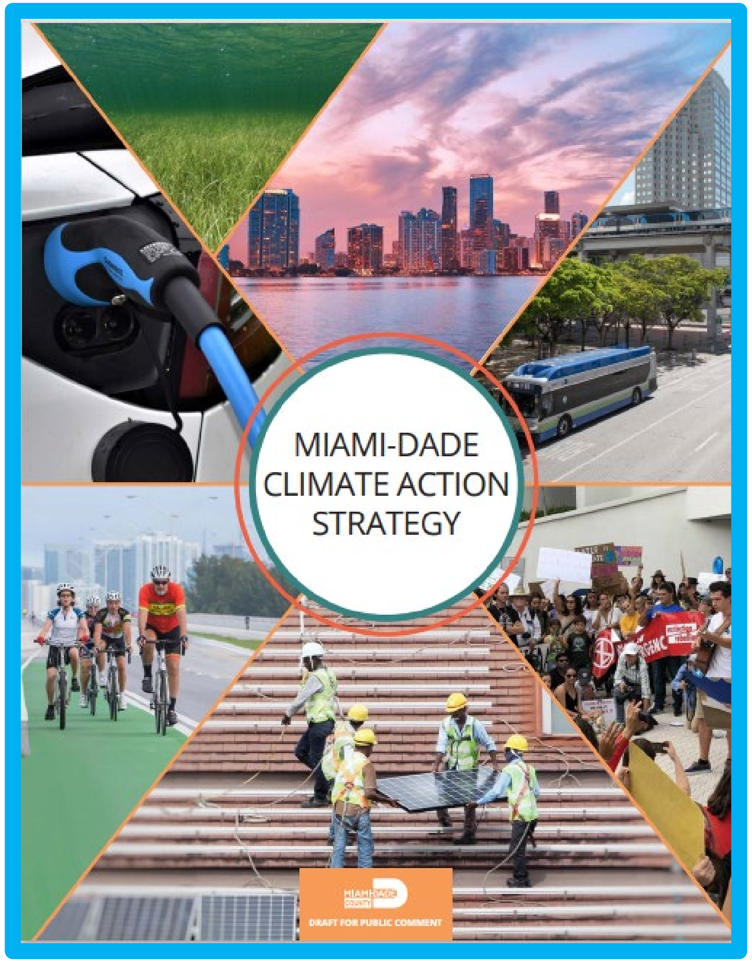
SOUTHEAST FLORIDA
REGIONAL COMPACT
CLIMATE CHANGE

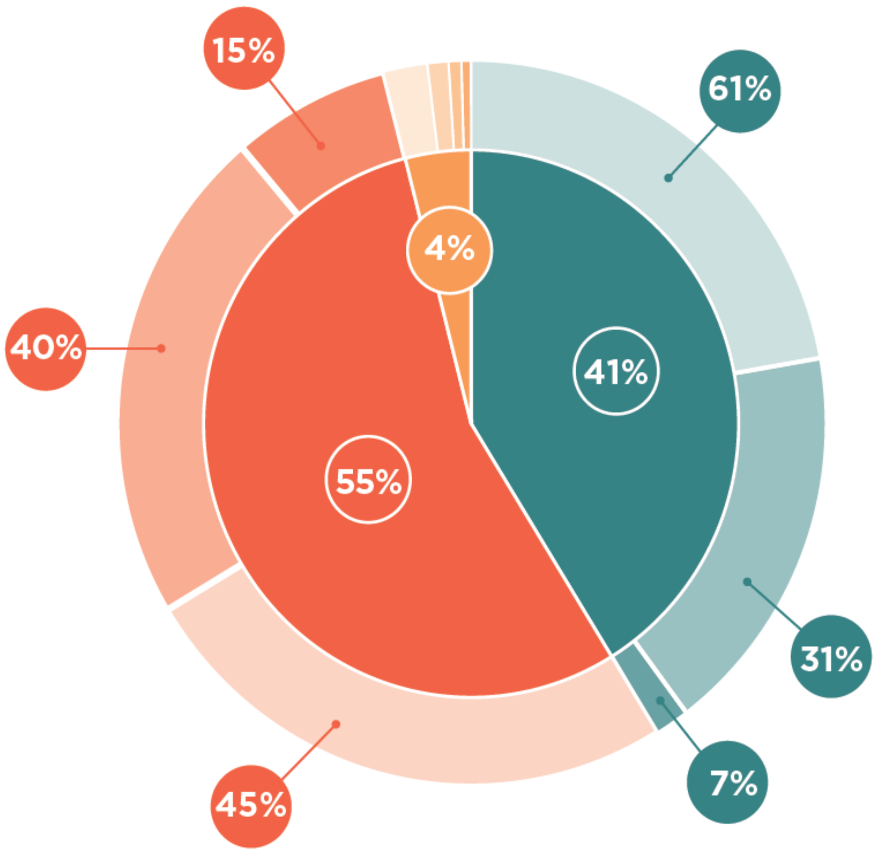
BROWARD COUNTY FLORIDA

MIAMI-DADE COUNTY

MONROE COUNTY 1823

PALM BEACH COUNTY FLORIDA





Communitywide Sources of Emissions

- **Buildings and Energy 41%**
  - Electricity **61%**
  - Other Fuels **31%**
  - Natural Gas **7%**
- **Transportation and Land Use 55%**
  - Air Travel **45%**
  - Ground - Gasoline **40%**
  - Ground - Diesel **15%**
- **Water and Waste 4%**
  - Landfilled Waste **53%**
  - Wastewater Energy **25%**
  - Incinerated Waste **12%**
  - Other **10%**

Miami-Dade Climate Action Strategy

Climate Action Strategy Targets

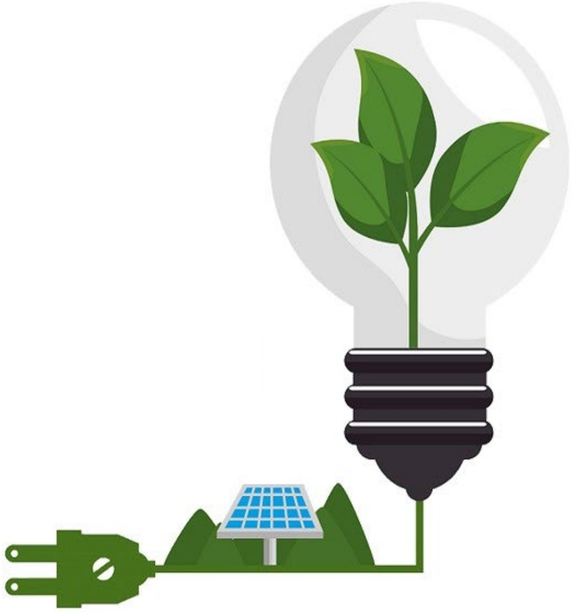
Emission reductions from 2019 levels

50%	by 2030

Net Zero by 2050

RACE TO ZERO

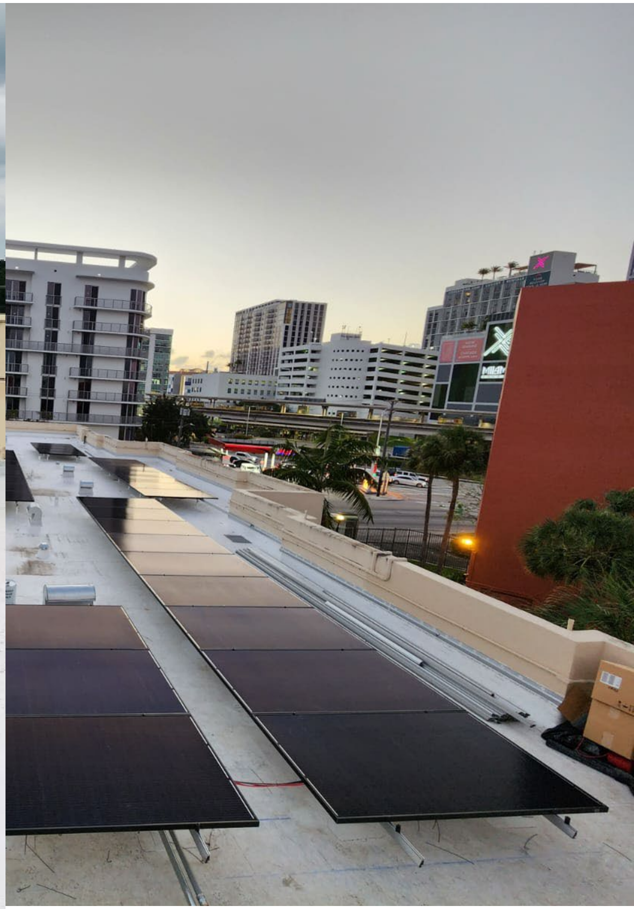
Miami-Dade County Mayor Daniella Levine Cava created a Director of Energy for Miami-Dade County in March of 2023.



The Director of Energy will:

- Help develop and execute energy resilience priorities.
- Strategically plan and steer the County toward carbon neutrality.
- Lead policy and coordination, contracting, administration, management, and reporting of all energy related services and functions of Miami-Dade County.
- Serve as the primary point of contact with Florida Power & Light (FPL) and other energy-related utilities and vendors

Energy Highlights in Miami-Dade County
Gibson Plaza Cool Roof + Solar



Energy Highlights in Miami-Dade County
North Dade Library Solar Installation

COMMUNITY HIGHLIGHT: Miami-Dade lights up County operations with solar

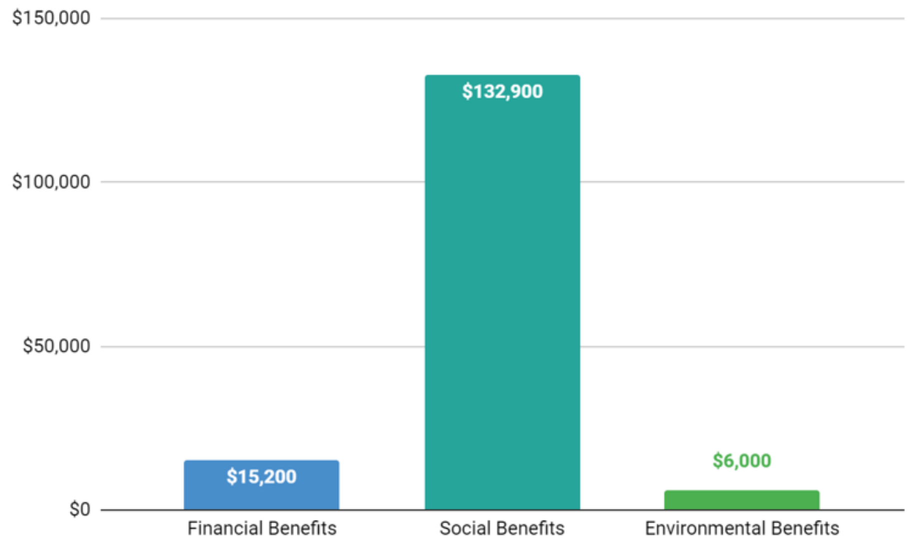
In the Summer of 2022, installation of large-scale solar installations began at three buildings, including the North Dade Regional Library, South Dade Regional Library, and the Metrowest Detention Center. The County's roof-top solar pilot project will produce a combined total of 1.4

The first large-scale solar installation on a county owned building at the North Dade Regional Library.

Energy Highlights in Miami-Dade County
Autocase Triple Bottom Line Analysis of Proposed Cool Roof Policy

Category	Stakeholder	Impact	Net Present Value (NPV)	$ NPV / ft²
Financial	Owner	Upfront Capital Costs	$0	$0.00
Financial	Owner	Financial Savings from Electricity	$2,090	$0.42
Social	Community	Health - Heat Island Effect	$20,700	$4.14
Environmental	Community	Carbon Emission Reductions	$550	$0.11
Environmental	Community	Air Pollution Reductions	$280	$0.06
Financial Benefits			$2,090	$0.42
Social Benefits			$20,700	$4.14
Environmental Benefits			$830	$0.17
Triple Bottom Line Lifetime Benefits			**$23,620**	**$4.73**

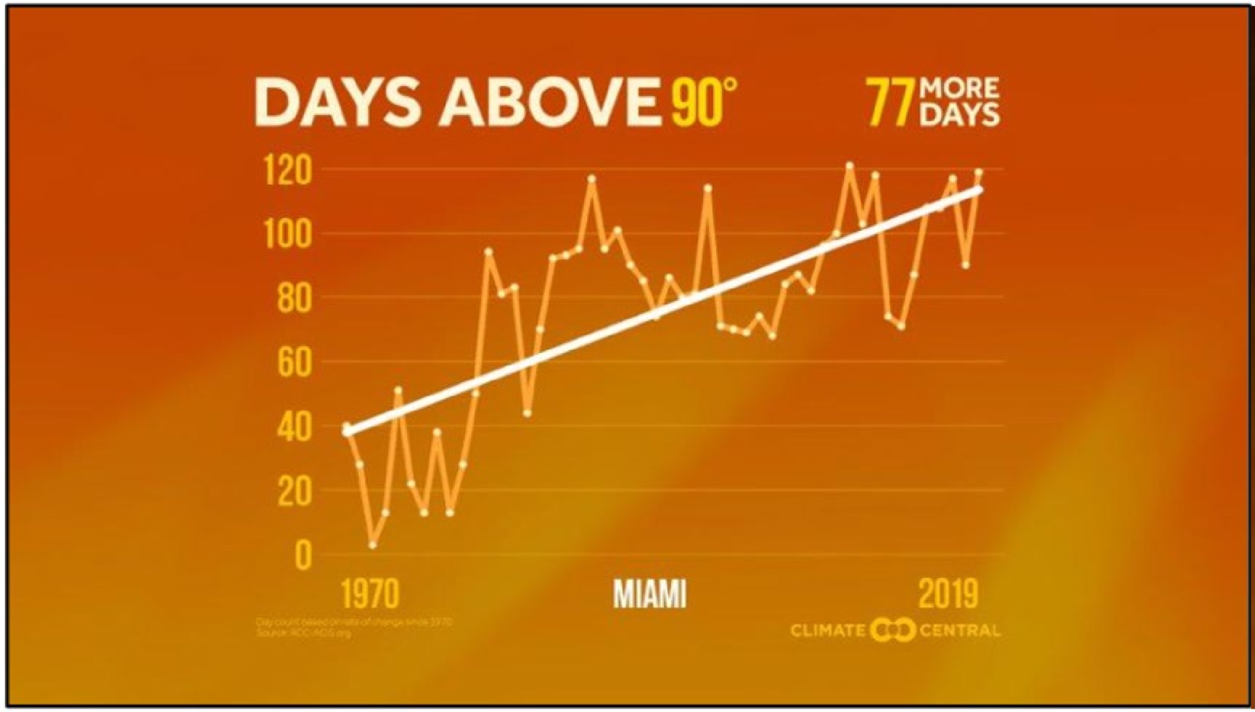
Figure 1: Net Present Value of Economic Impacts - Cool Roof SR: 5% to SR: 63% over 25 years ($2021)[1]

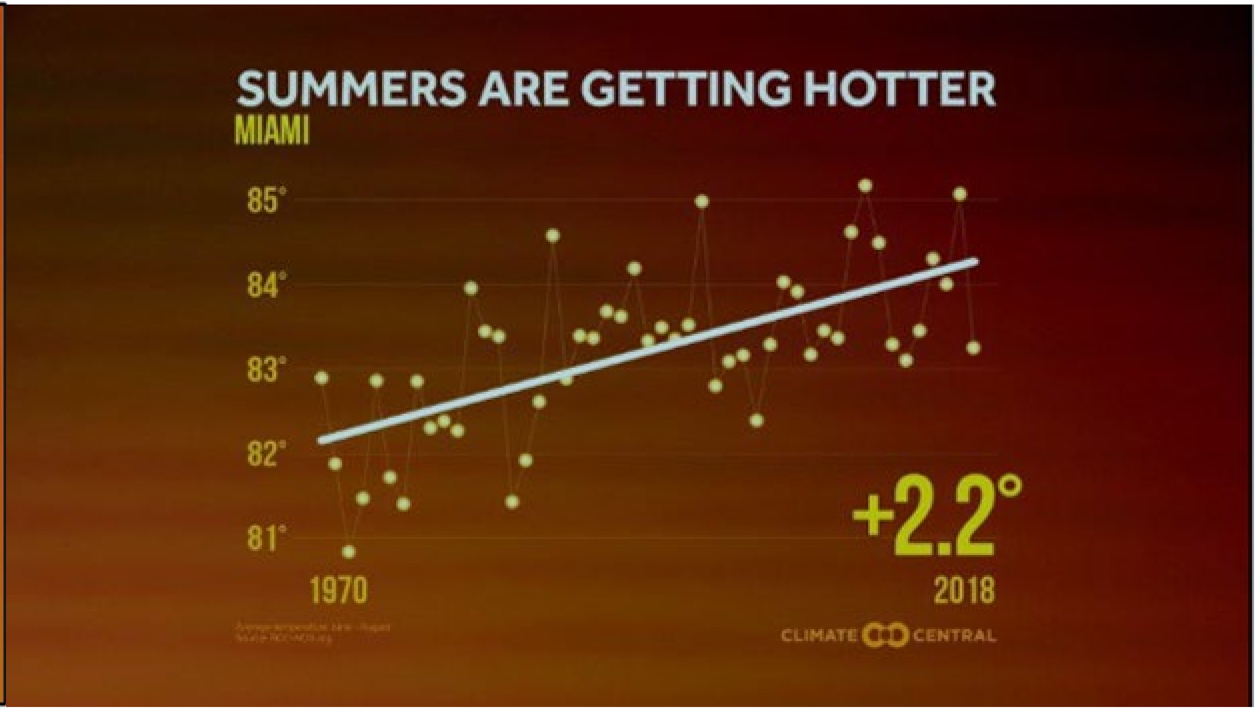


Extreme Heat

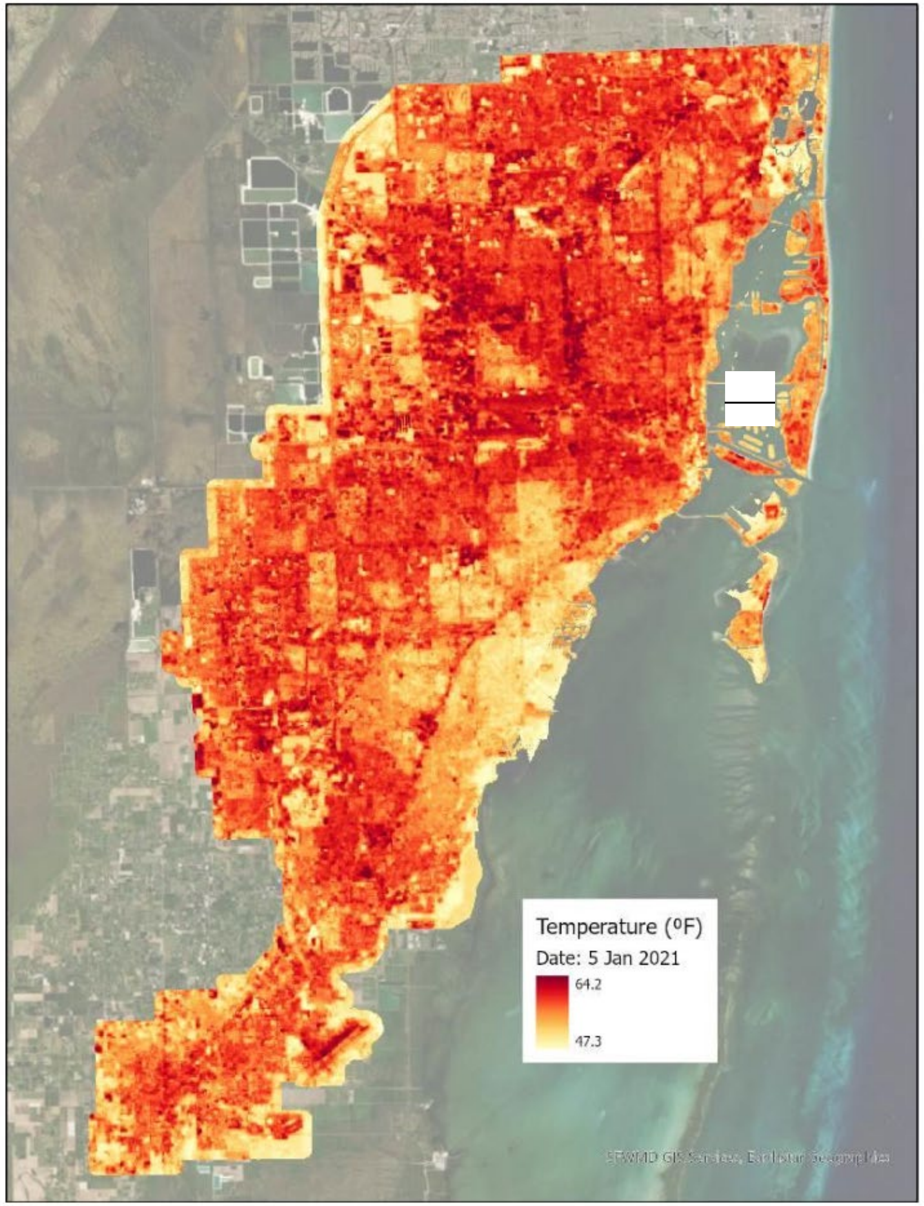
- Heat is the leading weather-related killer in the United States
- High heat and humidity can lead to heat-related illness, including heat cramps, heat exhaustion and heat stroke
- Most HRIs and deaths are preventable
- High risk groups experience a disproportionate amount of health impacts
- Marginalized communities, the elderly, young children, pregnant women and outdoor workers are more vulnerable to heat related illnesses and deaths
- Extreme heat conditions are increasing due to climate change and urban development.

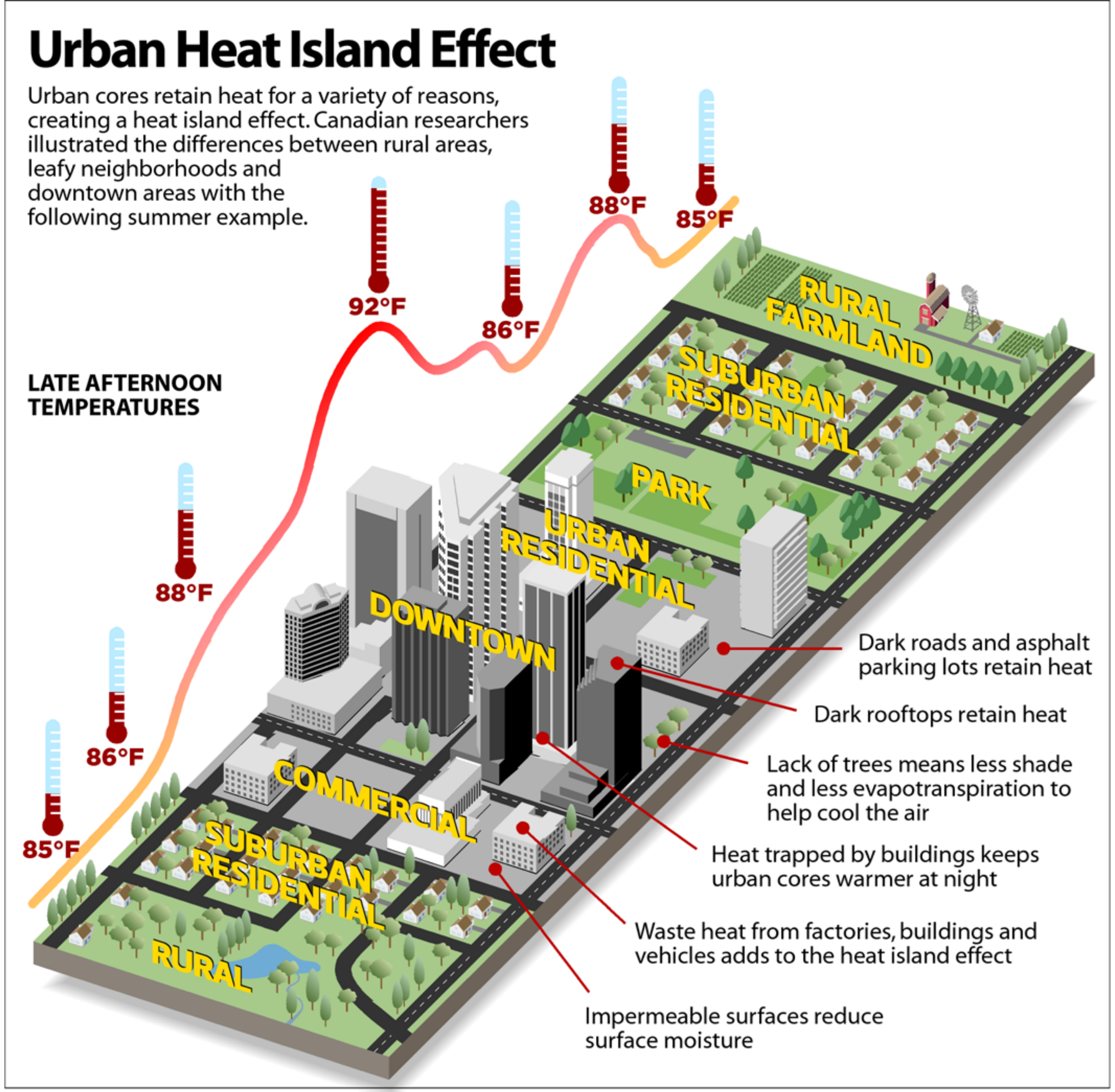
Background: Currently in Miami





Risks to human health and wellbeing are **INCREASING**





SOURCE: D.S. Lemmen and F.J. Warren, Climate Change Impacts and Adaptation   PAUL HORN / InsideClimate News

Extreme Heat Action Plan

Goal 1: Inform, Prepare and Protect People

Goal 2: Cool our Homes and Emergency Facilities

Goal 3: Cool our Neighborhoods

Goal 1: Inform, Prepare and Protect People

Foster healthy and resilient communities by bolstering outreach and education efforts, improving extreme heat warning systems and emergency protocols, protecting outdoor workers and building the capacity of healthcare practitioners to identify and respond to heat vulnerability and illness in their patients.

1. **Build on the Success of the Heat Season Campaign**
2. **Enhance Messaging and Protocols**
3. **Engage and Support Employers of Outdoor Workers**
4. **Seek Worker Protections at all Levels of Government**
5. **Engage and Prepare Healthcare Practitioners**
6. **Leverage Urban Heat Research Group for Continued Learning**

Goal 2: Cool our Homes and Emergency Facilities

Improve access to efficient and reliable cooling in homes and to a place to cool off in the event of a power outage.

7. Seek Increased Support for Efficiency and Cooling Upgrades
8. Advocate for Heat Safe and Affordable Housing Policies
9. Improve Coordination and Expand Outreach on Energy Efficiency
10. Invest in Energy Resilience at Evacuation Shelters
11. Ensure Compliance with Assisted Living/Nursing Home Generator Rule
12. Incorporate Extreme Heat in Countywide Resilience Hub Plan

Goal 3: Cool our Neighborhoods

Reduce the excessive heat burden in urban areas by expanding the tree canopy and vegetation, improving access to water features and shade structures, and cooling our surfaces.

13. Create a Bold Tree Plan
14. Cool our Commutes
15. Cool Our Schools
16. Expand Access to Water and Shade
17. Plant and Protect Trees on County Land
18. Pilot and Scale Cool Pavements
19. Ramp up Engagement and Citizen Science

Thank you!

Contact the Office of Resilience
We are always available to discuss ideas and hear concerns.
Email: resilience@miamidade.gov

Dr. Patricia Gomez
Director of Energy and Deputy Chief Resilience Officer
Miami-Dade County
Patricia.Gomez@miamidade.gov

Sign up for our newsletter: miamidade.gov/resilience