WERMONT ATLAS OF DISASTER

REBUILD BY DESIGN

RALLY FOR THE PLANET

EACH YEAR, THE STREETS OF MONTPELIER, VERMONT ARE FILLED WITH YOUNG ACTIVISTS CHAMPIONING FOR THE **ENVIRONMENT AT THE "RALLY FOR THE PLANET."**

No participat

1820

VT

IMAGE SOURCE: VERMONT YOUTH LOBBY | APRIL 2023



REBUILD BY DESIGN PARTNERS WITH COMMUNITIES TO DESIGN REGIONAL AND LOCAL PROCESSES THAT CREATE AND IMPLEMENT INFRASTRUCTURE POLICY AND PROJECTS TO PREPARE COMMUNITIES FOR THE WORLD'S MOST PRESSING PROBLEMS.

WE RESEARCH, DEVELOP POLICY, AND EDUCATE THE NEXT GENERATION **OF RESILIENCE PRACTITIONERS. DO YOU HAVE A VEXING CHALLENGE** THAT NEEDS CREATIVE PROBLEM SOLVING? CONTACT US AT INFO@REBUILDBYDESIGN.ORG

EXECUTIVE SUMMARY

Twenty-two disasters in 14 years. Between 2011-2024, residents of the Green Mountain State have borne the impacts of severe floods, tropical storms, and winter storms. In July 2023, two days of extreme heavy rainfall overtopped rivers, washed homes and cars away, caused landslides, and damaged over 4,000 homes and 800 businesses, upending thousands of lives and causing at least two fatalities.

Climate change is here, and Vermonters are calling for action. The following pages utilize 2011-2024 county-level data to capture the reality that Vermonters are living through. This report includes eight maps that show where major disasters have occurred, where post-disaster support has been given, where the most socially vulnerable populations reside, and the energy reliability by utility area. It also provides county-level disaster data within General Assembly and Senate district boundaries, so legislators and their constituents can work together to advocate for the adaptation needs of their communities.

Since the disaster data was analyzed, multiple climate events have tested Vermont's adaptability. • In May 2023, a major freeze disrupted crop production and took a devastating economic toll on the state's agriculture industry-though it did not receive a federal major disaster declaration, it did

- receive a USDA disaster declaration.
- necessitating the rescue of over 100 people.
- peak.
- dozens of rescues-including 50 in Lyndonville-and caused at least one fatality

Though Vermont has taken steps to reduce greenhouse gas emissions and outlined a path toward climate resilience, the state has far to go to ensure its physical and social infrastructure is ready to withstand a future with more frequent and intense storms due to climate change. Bold action is needed to drastically cut carbon emissions and slow the rate of global warming. Simultaneously, Vermont needs policies and investments in programs and projects that will reduce the risk to Vermonters from the climate thresholds we have already surpassed.

Vermont needs new long-term climate adaptation infrastructure funding to support climate adaptation measures that will reduce the physical, economic, and social tolls of future extreme weather events, support communities looking to move away from risky areas, and protect and restore the natural environment. State funding would also leverage additional federal funding by providing a local match for programs that will be made available under the Inflation Reduction Act, the Infrastructure Investment and Jobs Act, the Justice40 Initiative, and other federal sources.

This report could not have been created without the incredible partnership of APTIM and iParametrics, as well as the generous support of the Siegel Family Endowment, the Rockefeller Family Fund, the Rockefeller Brothers Foundation, and Tiger Global Philanthropic Ventures. Rebuild by Design worked with an unbelievable team of engineers, researchers, finance experts, data managers, and volunteers supporting, identifying, analyzing, and synthesizing different data sets and ideas into an accessible compendium of county-by-county climate impacts. Special thank you to Judy Huynh and Joie Zhang for research and design on this report. You can view the data from all 50 states here. We are so fortunate to work with these partners, and we want to work with you, too. If you are passionate about these issues and are interested in our work, please reach out to info@rebuildbydesign.org to explore how to build climateforward communities together.

Two months later, in July 2023, the Winooski River crested at 21 feet-its highest since the 1920s-

In December 2023, a winter storm left more than 11,000 homes and businesses without power at its

Most recently, in July 2024, severe flooding led to nearly 700 damage reports, destroyed 68 homes, severely damaged 121 more, impacted 294 businesses (with average losses of about \$180,000 each), washed out roads, destroyed 16 bridges, triggered landslides, disrupted public water supplies, required



VERMONT STATISTICS SUMMARY (2011 - 2024)

25	CLIMATE DISAS
EVERY	COUNTY HAS H
4TH HIGHEST	PER CAPITA SPE
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7TH HIGHEST	NUMBER OF DIS
WASHINGTON	COUNTY WITH
9	COUNTIES WITH
ALL 14	COUNTIES WITH
С	ASCE INFRASTR
\$580 MILLION	FEMA + HUD PO
643 THOUSAND	POPULATION TO
\$600 MILLION	OF CLIMATE INF

TER DECLARATIONS

IAD FIVE OR MORE DISASTERS

ENDING ON CLIMATE DISASTERS IN THE COUNTRY

ENDING ON CLIMATE DISASTERS

SASTERS IN THE COUNTRY

THE HIGHEST DISASTER OCCURENCES

H TEN OR MORE DISASTERS

H FIVE OR MORE DISASTERS

RUCTURE REPORT CARD GRADE

DST-DISASTER FUNDING

OTAL

FRASTRUCTURE COULD BE SUPPORTED THROUGH A NCE SURCHARGE



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counties were hit hard by a historic flood in July 2023, resulting in extensive property damage, closure of 100+ roads, and significant damage to rail lines.²

IN A SPAN OF 38 HOURS,

VERMONT WAS DRENCHED WITH 6.23 TO 9.05 INCHES OF RAIN, ACCORDING TO THE NATIONAL WEATHER SERVICE. THE WINOOSKI AND LAMOILLE RIVERS SURGED PAST THEIR PREVIOUS WATER LEVEL RECORDS SET DURING THE DEVASTATING HURRICANE IRENE IN 2011.³

JULY 2023 | MONTPELIER

MIMAGE SOURCE: SENIOR MASTER SGT MICHAEL DAVISIUS AIR NATIONAL GUARD



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businesses and 4,000 homes were destroyed from extreme rainfall in July 2023.⁴

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OUTDOORS

NUT WITH THE





inches is the increase in average annual precipitation in Vermont between the early 1900s and 2020, averaging a rise of 1.4 inches per decade since 1960.⁵

\$558 MILLION IN LOSSES

ACCORDING TO THE VERMONT DEPARTMENT OF FINANCIAL REGULATION, WEATHER-RELATED INSURED LOSSES COST AUTO, HOMEOWNERS, AND FARM POLICIES \$558 MILLION FROM 2010 TO 2019.6

JULY 2023 | BARRE CITY

. Mile

IMAGE SOURCE: JONATHAN WILLIAMS

DISASTER OCCURRENCES 2011-2024

FEDERALLY DECLARED CLIMATE DISASTERS BY COUNTY



Every county in Vermont has had 5 or more recent climate disasters. 9 out of the 14 counties have had 10 or more disasters between 2011-2024.

Washington County has experienced 22 recent disaster declarations - the highest in the State.

Number of Disaster Events

Major Disaster Declarations (2011-2024)

0 occurences 1 occurrence 2-3 occurences 4-6 occurrences 7-9 occurrences

10+ occurrences



FEMA DATA COURTESY OF IPARAMETRICS

FEDERAL ASSISTANCE 2011-2024 POST-DISASTER PUBLIC ASSISTANCE AND HAZARD MITIGATION FUNDS **OBLIGATED BY COUNTY FOR CLIMATE DISASTERS**



FEMA Public Assistance and Hazard Mitigation

Federal Share Obligated (2011-2024)



14

Washington County has experienced 22 disasters and received a total of \$89.5M in FEMA funding, serving a population of 59K, which equals \$1,497 per capita.

MAP MADE BY REBUILD BY DESIGN FEMA DATA COURTESY OF IPARAMETRICS

WINDHAM COUNTY

IN 2011, SEVERE FLOODING FROM TROPICAL STORM IRENE SWEPT A BRIDGE DOWNSTREAM, POSING THREATS TO DAM SITES INCLUDING BALL MOUNTAIN LAKE DAM IN JAMAICA, VERMONT.⁷

SEPTEMBER 2011

IMAGE SOURCE: FRANK FEDELE I US ARMY CORPS OF ENGINEERS

\$5_29B

A 2021 study by University of Vermont predicts \$5.29 billion in flood damages along the Winooski River in the next century, affecting over 140,000 Vermonters.⁸

SOCIAL VULNERABILITY INDEX 2022

AREAS OF GREATEST SOCIAL VULNERABILITY

ENERGY RELIABILITY 2011–2021 COUNTIES AT GREATEST RISK OF POWER OUTAGES

Essex County, with 12 disasters and a population of just 6K in 2022, underscores how climate risks disproportionately affect rural areas with smaller populations.

Chittenden County, with 12 disasters and a 7% population increase from 157K in 2010 to 168K in 2022, faces increasing vulnerability as both disaster frequency and population density rise.







MAP MADE BY REBUILD BY DESIGN DATA SOURCE: CDC/ATSDR 2022 SVI 115,000 customers lost power during the Halloween storm of 2019 that drenched Vermont with 3-5 inches of rain in a day, causing over \$6 million in infrastructure damage.

Aggregated Annual Electric Outage Duration Including major events - SAIDI_W_MED





SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION MAPS COURTESY OF APTIM



Vermont's frequent freeze-thaw cycles are causing an increase in pothole formations, with the state spending up to \$1 million on repairs during severe years like 2018 and 2019.⁹

AIRFIELD

CHITTENDEN COUNTY

VERMONT, RANKED 12TH NATIONWIDE FOR POTHOLES, IS TACKLING THE ISSUE WITH VTRANS USING 1,500 TONS OF ASPHALT FOR ROAD REPAIRS, PARTICULARLY IN BURLINGTON - ONE OF THE WORST REGIONS IN THE STATE. STILL, THESE REMEDIES ARE SHORT-TERM, REVEALING A CONTINUOUS INFRASTRUCTURE PREDICAMENT.¹⁰

MARCH 2022

IMAGE SOURCE: VERMONT AGENCY OF TRANSPORTATION



DISASTER DECLARATIONS ALL 50 STATES (2011-2024)

STATE	TOTAL DISASTERS	STATE	TOTAL DISASTERS
California*	39	Georgia	15
Oklahoma*	30	New Jersey	14
Tennessee	30	Oregon*	14
lowa*	26	New Mexico*	14
Vermont	25	Virginia	14
Alaska	25	Maine	14
Mississippi	25	Hawaii	13
New York	23	South Carolina	11
West Virginia	23	Connecticut	11
Kentucky	23	Massachusetts	11
Washington*	23	Arizona*	11
South Dakota*	22	Pennsylvania	10
New Hampshire	22	Maryland	10
Florida*	21	Idaho	10
Nebraska*	21	Wisconsin	10
Texas	20	Illinois	9
Arkansas	20	Colorado	8
Kansas	20	Rhode Island	8
Louisiana	19	Utah	8
Alabama	19	Michigan	7
North Dakota*	18	Ohio	7
Montana	18	Wyoming	6
North Carolina*	17	Delaware	5
Missouri	17	Indiana	5
Minnesota	16	Nevada	4

FEMA AND HUD COST PER CAPITA ALL 50 STATES (2011-2024)

COUNTY	PER CAPITA*	COUNTY	PER CAPITA*
Louisiana	\$2,953	Tennessee	\$149
Hawaii	\$1,772	Georgia	\$145
New York	\$1,385	Arkansas	\$135
Vermont	\$902	Montana	\$116
New Jersey	\$854	Massachusetts	\$77
North Dakota	\$846	New Hampshire	\$77
Alaska	\$770	Kansas	\$77
Florida	\$571	Virginia	\$72
Texas	\$531	Illinois	\$67
West Virginia	\$531	Maine	\$62
Nebraska	\$453	Minnesota	\$61
North Carolina	\$428	Washington	\$61
Kentucky	\$341	Rhode Island	\$61
South Dakota	\$339	Pennsylvania	\$58
South Carolina	\$336	Maryland	\$41
lowa	\$329	Idaho	\$38
Alabama	\$314	Michigan	\$33
Oregon	\$294	Wyoming	\$30
Oklahoma	\$274	Wisconsin	\$27
Mississippi	\$272	Utah	\$23
New Mexico	\$256	Delaware	\$20
California	\$224	Ohio	\$19
Missouri	\$187	Nevada	\$11
Connecticut	\$158	Indiana	\$10
Colorado	\$157	Arizona	\$3

*In instances where tribal land is affected, federal disaster declarations may count the same event twice.

*Per capita is calculated using FEMA (PA+HM) & HUD CDBG-DR federal post-disaster funds.

Air temperatures have increased more than 4°F in winter and more than 2°F in summer over the past 50 years, according to the Vermont Department of Health.¹¹

Deborah Rawson Memorial Library

WE HAVE

AIR

CONDITIONING

COME ON IN

BURLINGTON MATCHED ITS EXISTING HIGH-TEMPERATURE **RECORD OF 96°F, A MARK SET IN THE SCORCHING** SUMMER OF JULY 1963.¹² THE CITY TYPICALLY EXPERIENCES AN AVERAGE OF EIGHT DAYS PER YEAR WITH TEMPERATURES SOARING ABOVE 90°F.¹¹

CHITTENDEN COUNTY

JULY 2018

IMAGE SOURCE: ELODIE REED



ILLUSTRATION: GEETHANJALI MR

HEALTH PROGRAM, "PREPARING FOR REGIONAL HEALTH IMPACTS OF CLIMATE CHANGE IN THE UNITED STATES," JULY 2020. GAIL CARLSON, "HUMAN HEALTH AND THE CLIMATE CRISIS," JONES AND BARTLETT LEARNING, JAN. 2022.

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Vermont ranks 5th nationally in per capita disaster relief costs from 2011-2023, with \$684 spent per resident. During the same period, the state received \$440 million in federal assistance.¹³

WINDSOR COUNTY

TROPICAL STORM IRENE'S DEVASTATING IMPACT IN 2011 UNDERSCORED VERMONT'S VULNERABILITY TO FLOODING, INFLICTING A SHOCKING \$733 MILLION IN DAMAGES. AS PER THE NATIONAL **OCEANIC ADMINISTRATION AGENCY, THE STORM**

RUTLAND COUNTY

PERSISTING DROUGHT CONDITIONS IN VERMONT CONTINUE TO STRAIN LOCAL FARMS, WITH REPORTS FROM ESTABLISHMENTS NOTING A SIGNIFICANT 50% DECREASE IN CATTLE FEED VOLUME AND QUALITY.¹⁵

MAY 2015

IMAGE SOURCE: PUTNEYPICS | FLICKR



million in estimated crop losses spurred a federal disaster declaration for 10 Vermont counties in 2020, due to severe drought conditions.¹⁶



VT GENERAL ASSEMBLY DISTRICTS

MAJOR DISASTER DECLARATIONS 2011-2021



VT DISASTER OCCURRENCES 2011–2023

2022 GENERAL ASSEMBLY DISTRICTS

DISTRICT	# OF DISASTERS	DISTRICT	# OF DISASTERS	DISTRICT	# OF DISASTERS
Addison-1	ADD (10)	Chittenden-4	CHI (12)	Rutland-3	RUT (6)
Addison-2	ADD (10)	Chittenden-5	CHI (12)	Rutland-4	RUT (6)
Addison-3	ADD (10)	Chittenden-6	CHI (12)	Rutland-5	RUT (6)
Addison-4	ADD (10)	Chittenden-7	CHI (12)	Rutland-6	RUT (6)
Addison-5	ADD (10)	Chittenden-8	CHI (12)	Rutland-7	RUT (6)
Addison-Rutland	ADD (10), RUT (6)	Chittenden-9	CHI (12)	Rutland-8	RUT (6)
Bennington-1	BEN (5)	Chittenden-Franklin	CHI (12), FRA (10)	Rutland-9	RUT (6)
Bennington-2	BEN (5)	Essex-Caledonia	ESX (12), CAL (9)	Rutland-Bennington	RUT (6), BEN (5)
Bennington-3	BEN (5)	Essex-Orleans	ESX (12), ORL (12)	Rutland-Windsor	RUT (6), WDR (6)
Bennington-4	BEN (5)	Franklin-1	FRA (10)	Washington-1	WAS (14)
Bennington-5	BEN (5)	Franklin-2	FRA (10)	Washington-2	WAS (14)
Bennington-Rutland	BEN (5), RUT (6)	Franklin-3	FRA (10)	Washington-3	WAS (14)
Caledonia-1	CAL (9)	Franklin-4	FRA (10)	Washington-4	WAS (14)
Caledonia-2	CAL (9)	Franklin-5	FRA (10)	Washington-5	WAS (14)
Caledonia-3	CAL (9)	Franklin-6	FRA (10)	Washington-6	WAS (14)
Caledonia-Essex	CAL (9), ESX (12)	Franklin-7	FRA (10)	Washington-Chittenden	WAS (14), CHI (12)
Caledonia-Washington	CAL (9), WAS (14)	Franklin-8	FRA (10)	Washington-Orange	WAS (14), ORA (12)
Chittenden-1	CHI (12)	Grand Isle-Chittenden	GI (7), CHI (12)	Windham-1	WDH (5)
Chittenden-10	CHI (12)	Lamoille-1	LAM (12)	Windham-2	WDH (5)
Chittenden-11	CHI (12)	Lamoille-2	LAM (12)	Windham-3	WDH (5)
Chittenden-12	CHI (12)	Lamoille-3	LAM (12)	Windham-4	WDH (5)
Chittenden-13	CHI (12)	Lamoille-Washington	LAM (12), WAS (14)	Windham-5	WDH (5)
Chittenden-14	CHI (12)	Orange-1	ORA (12)	Windham-6	WDH (5)
Chittenden-15	CHI (12)	Orange-2	ORA (12)	Windham-7	WDH (5)
Chittenden-16	CHI (12)	Orange-3	ORA (12)	Windham-8	WDH (5)
Chittenden-17	CHI (12)	Orange-Caledonia	ORA (12), CAL (9)	Windham-9	WDH (5)
Chittenden-18	CHI (12)	Orange-Washington-Addis	son ORA (12), WAS (14), ADD (10)	Windham-Windsor-Bennington	WDH (5), WDR (6), BEN (5)
Chittenden-19	CHI (12)	Orleans-1	ORL (12)	Windsor-1	WDR (6)
Chittenden-2	CHI (12)	Orleans-2	ORL (12)	Windsor-2	WDR (6)
Chittenden-20	CHI (12)	Orleans-3	ORL (12)	Windsor-3	WDR (6)
Chittenden-21	CHI (12)	Orleans-4	ORL (12)	Windsor-4	WDR (6)
Chittenden-22	CHI (12)	Orleans-Lamoille	ORL (12), LAM (12)	Windsor-5	WDR (6)
Chittenden-23	CHI (12)	Rutland-1	RUT (6)	Windsor-6	WDR (6)
Chittenden-24	CHI (12)	Rutland-10	RUT (6)	Windsor-Addison	WDR (6), ADD (10)
Chittenden-25	CHI (12)	Rutland-11	RUT (6)	Windsor-Orange-1	WDR (6), ORA (12)
Chittenden-3	CHI (12)	Rutland-2	RUT (6)	Windsor-Orange-2	WDR (6), ORA (12)
				Windsor-Windham	WDR (6), WDH (5)

Washington Districts (1-6): All have 14 disasters, the highest single-county count Chittenden Districts (1-25): All consistently show 12 disasters

WASHINGTON COUNTY

CLIMATE CHANGE-INDUCED EXTREME WEATHER IS DISRUPTING VERMONT'S \$1.6 BILLION SKI INDUSTRY.¹⁷ THE UNUSUALLY WARM WINTER OF 2015-2016 LED TO EARLY CLOSURES AT MANY RESORTS, INCLUDING MAD RIVER GLEN, WHICH

IMAGE SOURCE: ERIC FRIEDMAN | MAD RIVER GLEN

BO DAYS

The winter temperatures in Vermont are steadily rising, imperiling the ski industry with a forecasted loss of 30 days by 2080.¹⁹



VT SENATE DISTRICTS

MAJOR DISASTER DECLARATIONS 2011-2021



VT DISASTER OCCURRENCES 2011–2023

2022 SENATE DISTRICTS

DISTRICT	COUNTIES	# OF DISASTER
ADDISON	ADDISON, CHITTENDEN, WINDSOR	ADD (10), CHI (12), WDR (6)
BENNINGTON	BENNINGTON, WINDHAM	BEN (5), WDH (5)
CALEDONIA	CALEDONIA, ORANGE	CAL (9), ORA (12)
CHITTENDEN CENTRAL	CHITTENDEN	CHI (12)
CHITTENDEN NORTH	CHITTENDEN, FRANKLIN	CHI (12), FRA (10)
CHITTENDEN SOUTHEAST	CHITTENDEN	CHI (12)
ESSEX	CALEDONIA, ESSEX, ORLEANS	CAL (9), ESX (12), ORL (12)
FRANKLIN	FRANKLIN, GRAND ISLE	FRA (10), GI (7)
GRAND ISLE	CHITTENDEN, GRAND ISLE	CHI (12), GI (7)
LAMOILLE	FRANKLIN, LAMOILLE	FRA (10), LAM (12)
ORANGE	ORANGE	ORA (12)
ORLEANS	CALEDONIA, FRANKLIN, ORLEANS	CAL (9), FRA (10), ORL (12)
RUTLAND	RUTLAND	RUT (6)
WASHINGTON	LAMOILLE, ORANGE, WASHINGTON	LAM (12), ORA (12), WAS (14)
WINDHAM	WINDHAM	WDH (5)
WINDSOR	ORANGE, RUTLAND, WINDSOR	ORA (12), RUT (6), WDR (6)

Washington Senate District has the highest number of disasters, totaling 14, followed closely by Chittenden, Essex, and Orleans, each with 12 disasters.

10 DAYS

Climate change threatens Vermont's vital maple syrup industry, advancing the sugaring season's start and end by 10 days.²⁰

BENNINGTON COUNTY

VERMONT, WHICH PRODUCES 50% OF THE NATION'S MAPLE SYRUP, HAS DOUBLED ITS GROSS SALES TO \$54 MILLION FROM 2008 TO 2018.²¹ CLIMATE CHANGE THREATENS THIS BOOMING INDUSTRY THAT EMPLOYS OVER 4,000 VERMONTERS.²²

MARCH 2012

IMAGE SOURCE: SHANNON MCGEE



CILIIMATIE CHANGIE IINCREASES IINEQUITIES

The impacts of storms and flooding disproportionately affect the most vulnerable people. Disasters are not created by natural events alone; rather, they are the product of natural events and a combination of social, political, and economic stressors. Therefore, as climate change increases the frequency of flooding, it will further reinforce underlying vulnerabilities and systemic inequality.

DURING A FLOOD

Low-income communities experience greater challenges evacuating due to the cost of transportation and relocation, placing them at a greater risk of injury, disease, or death.

Residents who do not leave during a storm have increased health risks, such as exposure to contaminated water, interrupted acces to medical care, and difficulty acquiring food.

Low-income and minority populations, as well as elderly nursing home residents are more likely to have chronic health problems, increasing their vulnerability to other storm hazards.¹

AFTER A FLOOD

A medium-sized natural disaster leads to a 5% increase in the share of people with debt collections after one year, which doubles to 10% after four years.²

People in poverty are less likely to have flood insurance or to maintain flood insurance payments.

The Urban Institute has found that after 4 years, a medium-sized disaster has caused an average \Im il-point decline in credit scores for people living in communities of color, whereas people living in majority white communities experienced a 4^{l} -point decline.³

FEMA funding largely focuses on homeowners, meanwhile renters typically face rent hikes and mass evictions.

Lower income households may not have the financial and educational resources to advocate for fair buyouts, repair damages, and afford temporary housing.

After federal aid has been distributed to communities that have experienced a disaster, predominantly white, well-educated home-owners experience a significant increase in wealth. Conversely, communities of color, particularly those who are less educated renters, experience a decline in wealth.⁴



Benefit - Cost Ratio for Investing in Hazard Mitigation Infrastructure



The National Institute of Building Sciences (NIBS) found that every \$1 invested in disaster mitigation by three federal agencies (FEMA, EDA, & HUD) saves society \$6.

HAZARD MITIGATION FUNDING IS A STRATEGIC INVESTMENT IN OUR FUTURE, REDUCING RISKS AND COSTS ASSOCIATED WITH CLIMATE CHANGE WHILE BUILDING MORE RESILIENT AND SUSTAINABLE COMMUNITIES.

Project types range from green infrastructure, such as wetlands restoration or bioswales for stormwater management, to grey infrastructure, such as right-sizing a dam or bridge.



IMAGE SOURCE: BURO HAPPOLD

Economic Impacts for USA



The staggering cost borne by the US over the past 50 years due to weather, climate, and water hazards

The economic gain from decarbonizing and becoming a net zero US economy.

The cost of insufficient climate action to the US economy over the next 50 years.

^{1.} Lane et. al, "Health Effects of Coastal Storms and Flooding in Urban Areas: A Review and Vulnerability Assessment," 2013 2. Urban Institute, "Insult to Injury: NaturalDiasasters and Residents' Financial Health," 2019.

^{3.} Urban Institute, 2019.

^{4.} Howell & Elliott, "DamagesDone, the Longitudinal Impacts of Natural Hazards on Wealth Inequality in the United States;'; Muf'ioz & Tate, "Unequal Recovery? Federal ResourceeDistribution after Midwest FloodDisaster;'2016.

^{5.} Deloitte, "The cost of inaction: The economic impact of climate change in the United States", 2018



A GUIIDE FOR STATIES TO LEAD EQUITABLE

BUILD A COLLABORATIVE PROGRAM



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In order to address the worsening impacts of climate change and head off future damages, we need bold action. Governments must work alongside communities and cross-sector partners to identify infrastructure investments that will drive physical, social, and ecological co-benefits and create hundreds of thousands of middle-class jobs – before climate events strike, not after communities have suffered. Using a co-creation process with stakeholders, states can deliver new, upgraded, innovative, and climateready infrastructure that protects communities in the face of climate vulnerabilities; work to make existing investments more resilient; and create a new source for "local match" to leverage additional federal funding opportunities.

Investing in climate infrastructure will bring shortand long-term benefits to both the state and the community where projects are implemented by creating new jobs and seeding new local industries, improving community physical and mental health outcomes, protecting and enhancing ecosystems, and providing a framework for future investments.

Building on the successes of the <u>Rebuild by Design</u> Hurricane Sandy Design Competition, the <u>National</u> <u>Disaster Resilience Competition</u>, <u>Bay Area Resilient by</u> <u>Design</u>, and the great work that is already underway in many communities throughout the U.S., Rebuild by Design proposes that this fund be coupled with a two-stage Statewide Community Planning Process that leads communities through a process to identify their specific vulnerabilities to climate hazards such as flooding, heat, wind, and drought.

PROGRAM OBJECTIVES:

Use funding to catalyze regional strategies for planning, designing, and building to drive

investments in multi-benefit infrastructure that addresses physical, environmental, and social vulnerabilities;

Fully engage local stakeholders to create a better understanding of the risks and impacts that increasingly frequent and intense climate events will bring to their communities;

Support the needs of the most physically and socially vulnerable first;

Create jobs and job training opportunities, revitalize local/regional economies, promote healthy communities, and increase social resilience;

Create a replicable process that provides insight into other challenges in the community and can be recreated to address other challenges.



Communities are the experts of their neighborhoods. They know exactly what happens when there is a heat wave or a flood; they understand their community's existing needs and vulnerabilities; they know who is most affected and who needs the most assistance. Adapting to climate change presents a significant opportunity to create new or rebuild existing infrastructure that is designed to support the needs of communities on sunny days and promote climate resilience on days of increased rainfall, heat waves, storm surges, or fires. This type of infrastructure is known as "multi-benefit" since it is designed to serve more than one purpose. For example, a park that is designed to store and filter water during heavy rainfall events can provide multiple other benefits to the surrounding community, such as space for recreation and exercise, shade during hot days, species habitat, improvements to mental health, carbon capture, and cooling of local temperatures.

By using a collaborative design methodology, the State can incentivize regional planning processes to design and build infrastructure with multiple benefits alongside the communities who are most affected to ensure each project addresses local physical and

IMAGE SOURCE: CAMERON BLAYLOCK | REBUILD BY DESIGN

social vulnerabilities and embeds local knowledge and expertise with current and future needs. Additionally, the involvement of stakeholder support from the very start ensures that projects are built faster and that every dollar invested goes further by addressing the specific needs of the intended community.

States can lead a two-stage *Statewide Community Planning Process*:

(1) STAKEHOLDER INCLUSION, RESEARCH, RISK ASSESSMENT: align community and government aspirations in the face of climate change, and to create a shared understanding of the interdependencies between local and regional infrastructural, ecological, and social systems that will be further affected by the increased occurrences and severity of climate events.

(2) COLLABORATIVE DESIGN: create a comprehensive vision with specific fundable projects, policies, or initiatives that will directly address the vulnerabilities identified in Stage One

These stages are further detailed in the <u>Atlas of</u> <u>Disaster</u> on page 369.

WE ALL BENEFIT

Climate change is a collective risk that will pose challenges to all of our lives and livelihoods. Thus, everyone stands to benefit from adaptation interventions. Resilient green and gray infrastructure can have multiple benefits while fulfilling their primary purpose of reducing the risk of climate impacts. For example, the adaptation measures provided to vulnerable communities can help reduce risk to individuals and property from extreme harm or loss during climate events, which can in turn reduce the payout from insurance companies after an event. In addition, infrastructure that can better withstand shocks and stressors can also contribute to the stabilization of the supply chain by reducing the frequency and length of disruptions to production, costs, and delivery.

Even in the absence of extreme weather, communities will benefit from multi-purpose resilient infrastructure:

+ **Economic:** An investment in resilient infrastructure pays off economically with investments in manufacturing, construction, trade, labor, and

development, which can spur the creation of new jobs and economic growth, along with investments in long-term maintenance. Simultaneously, the creation of high quality, high paid jobs must be coupled with intentional efforts to train workers who would otherwise be unqualified.

- + Health: Where green infrastructure projects are implemented, communities gain from the additional benefits of cleaner air, cooling from tree coverage, green space to exercise and socialize, improved neighborhood aesthetics, and more. This means healthier environments for children to grow up in, more walkable streets for seniors and people with disabilities, and less emergency room visits for people with underlying conditions.
- + **Social:** Investments in physical infrastructure, namely public spaces and green spaces, help build social resilience within communities. These spaces, such as libraries and parks, enable communities to build social connections. In the event of a disaster, these communities fare better, as neighbors are more likely to check on each other, understand each other's needs, and rebuild together.

INVESTMENTS IN RESILIENT INFRASTRUCTURE

RESILIENCE WORKFORCE

PROJECT EXAMPLES:

IMPROVING SHORELINES AND STORMWATER MANAGEMENT SYSTEMS **RESTORING WETLANDS AND PROTECTING MIGRATION PATHWAYS • BUILDING** BERMS, DIKES, AND LEVEES

REMOVING DAMS

RIGHT-SIZING CULVERTS AND ELEVATING STREETS AND RAILWAYS • DAYLIGHTING RIVERS • ADAPTING SEWAGE TREATMENT PLANTS, WATER SUPPLY SYSTEMS, AND OTHER UTILITIES • BUYING OUT HOMES AND BUSINESSES FROM HARM'S WAY

ACQUIRING LAND THAT CAN REMAIN PROTECTED • STABILIZING SOIL FOR FARMLAND • CREATING NEW PARKS OR ECOLOGICAL ENHANCEMENTS

ABSORBING ENERGY FROM STORMS • PROVIDING GRANTS OR TAX INCENTIVES FOR THE RELOCATION OF CRITICAL INFRASTRUCTURE

INCENTIVIZING GREEN BUILDING ADAPTATION OR ELECTRICAL VEHICLE INFRASTRUCTURE

FOREST MANAGEMENT



STIEIP TWO: IFIINANCIING RESIILIENT INIFRASTRUCTURE

Innovative processes call for innovative finance solutions. Each state in the U.S. should create a Resilient Infrastructure Fund to serve as a catalyst to support innovative, data-driven, and community-led approaches to address climate risk throughout the United States. A Resilient Infrastructure Fund would enable investment in state-priority projects at both the regional and systems levels and in both individual and community actions by leveraging state and federal dollars to support capital projects that enhance communities' physical and social resilience and create a funding source to provide the "local-match" for federal investment.

A Resilient Infrastructure Fund can catalyze local planning and community understanding of what is needed to address the risks of future climate events and drive projects that support the well-being of communities every day, not just during extreme weather.

INVESTMENT SOURCES

The United States is always chasing the last storm. We need to get ahead of the physical and financial costs by utilizing creative and urgent financing solutions that invest in adaptation and mitigation efforts before communities suffer. Many states have capital programs and infrastructure banks to cover certain types of capital investments. However, in order to meet current and future needs, we need to invest a lot more in these programs than we currently are. Regardless of the source, funding should be held in a protected fund (such as an infrastructure bank) to ensure that the money is safe from other competing future needs. The following strategies could support the creation of State-led Resilient Infrastructure Funds:

Leverage a Two-Percent Surcharge on Property and Casualty (P&C) Insurance:

The increase in billion-dollar climate events is pushing the insurance system beyond its capacity, and all policyholders are paying the price without reaping the benefits of a safer community ahead of the next storm. To head off insurance premium spikes and insurance insolvency, states can utilize a pro-consumer model by applying a two-percent (for example) surcharge on P&C insurance (not including Medical Malpractice and Workers' Compensation). A small surcharge could leverage from \$600 million to over \$27 billion in states across the U.S, for a total of \$287 billion across the U.S. This surcharge on certain types (lines) of property-casualty insurance could support a statewide Resilient Infrastructure Fund that gives communities the funding they need to build more resiliently and to leverage private, state, and federal budget sources. As climate adaptation and hazard mitigation interventions are implemented, the risk of loss or damage will decline, reducing the property and casualty payouts for some insurers (such as those who write policies for commercial flood and basement backup riders). This would also lower flood insurance premiums by five to 45 percent for those in the FEMA flood zones through FEMA's Community Rating System.

This will give the insurance industry a lifeline by creating new funding sources that can support physical and social infrastructure before an event, slowing down their exposure to large payouts. A surcharge on certain types of property-casualty insurance can be equitable because community members with more resources are likely to insure more numerous, expensive, and energy-consumptive items (e.g., multiple homes, boats, cars), while community members with less resources are likely to insure less or have no insurance at all.

\$600 MILLION

COULD BE RAISED THROUGH A 2% SURCHARGE ON CERTAIN LINES FO P&C INSURANCE, BONDED OVER TEN YEARS, IN VERMONT.

Additionally, states could exempt lower income policyholders from the surcharge or to exempt vital community services such as affordable housing or schools. States can also decide to hold some of this allocation aside before it is leveraged for the maintenance of new climate infrastructure.

Establish a Climate Superfund:

While taxpayers across the US have been experiencing rising costs from the impacts of climate change, the largest oil and gas companies have been experiencing record-breaking profits.

A "Climate Superfund," or "Polluter Pays" model, calls on the largest oil and gas companies to reinvest some of those profits into state climate mitigation and adaptation measures. This fund is modeled after the EPA's Superfund program, which was established in 1980 to hold companies responsible for toxic waste sites accountable for the cleanup.

\$2.5 BILLION COULD BE RAISED THROUGH CLIMATE SUPERFUND IN VERMONT.

A bill to charge the biggest climate polluters for a share of the cleanup costs has passed the New York State Senate. Similar legislation has been introduced in Massachusetts and Maryland. A campaign to establish a Climate Superfund in Vermont is calling for the biggest oil and gas companies to pay into a fund that would help modernize Vermont's infrastructure, weatherproof schools and public buildings, address public health costs of climate change, and clean up after storms and more.





Stat Sou othe

States use their own funding sources, coupled with federal and other sources to support climate infrastructure:

According to Trimble, a construction technology firm, states spend from \$100 million to \$44 billion per year on building and upgrading infrastructure.¹² States can earmark existing dollars in the capital budget over the next ten years to support a Resilient Infrastructure Fund that can support the additional dollars needed to upgrade existing projects up to risk standards and can support new projects where existing ones will not be enough. Both capital and expense dollars will be needed to build and maintain the infrastructure. Better protection from extreme climate events means less damage to the physical environment and less suffering for communities. According to data collected by Trimble, approximately 0.5 percent of the Infrastructure Bill funds allocated to states will be spent on resilience or the environment and 9.6 percent will be spent on water infrastructure. The other 89.9 percent of funds will go towards highways, bridges, public transportation, airports, EV expansion, and broadband.¹² See page 665 of the Atlas of Disaster for examples of state-funded resilience programs.

Funding Allocated to States through the Infrastructure Investment and Jobs Act



FIGURE SHOWS THE BREAKDOWN OF SPENDING BY CATEGORY DATA SOURCE: TRIMBLE TRIMBLE

ARE THERE NEW FUNDING TOOLS WE SHOULD EXPLORE?

States can use traditional approaches to support the building or rebuilding of infrastructure that will address an increasingly uncertain environment. However, there is a market under development for a new suite of tools that could be investigated as part of this investment:

Environmental Impact Bond (EIB) - Otherwise known as "Pay For Performance." The borrower will pay back their bond investors contingent on the performance of the adaptation measures, such as green infrastructure.

Green Bonds - Bonds that are specifically earmarked to be used for climate and environmental projects. These bonds are typically asset-linked and backed by the issuer's balance sheet, and are also referred to as climate bonds. Green bonds come with tax incentives such as tax exemption and tax credits.

- Resilience Bonds Generate risk reduction rebates from a city's catastrophe insurance premiums to pay for resilience projects. Resilience Bonds create incentives for cities to invest in resilience so as to reduce the human and financial cost of catastrophes when they strike.
- Catastrophe Bonds Or "cat bonds." Financial instruments designed to help manage the financial risks associated with extreme natural disasters. These bonds kick in after a disaster and do not raise money for resilience planning.

Resilience Districts - There has been a lot of discussion regarding leveraging the power of a location to pool resources to finance shared, community-wide infrastructure, known in shorthand as "resilience districts," which functions on the principle of "everyone pays, everyone benefits." One example is the City of Boston's Climate Resilience Fund, a form of Land Value Capture that recognizes that upgraded and new infrastructure benefits the private sector by offering a lower risk. The City asks developers to pay into a fund that will support community-wide infrastructure.

106 out of 150 members in the Vermont House and 26-3 in the Senate approved the Climate Superfund Act, reflecting strong bipartisan support for holding fossil fuel companies accountable for climate damages.²⁹

FUTURE

FOSSIL FUELS

VERMONT'S CLIMATE SUPERFUND ACT MANDATES THAT FOSSIL FUEL COMPANIES RESPONSIBLE FOR OVER **1 BILLION TONS OF GREENHOUSE GAS EMISSIONS** PAY FOR CLIMATE DAMAGES, WITH AN INITIAL ASSESSMENT OF COSTS DUE BY JANUARY 15, 2025.29

CLIMATE **SUPERFUND ACT**

SEPTEMBER 2021 IMAGE SOURCE: IVAN RADIC



total funding authorized by the 2018 Environmental Bond Act to support climate adaptation, environmental resource protection, and infrastructure improvements in Massachusetts.

CLIMATE ACTION PLAN

FROM 1990 TO 2019, VERMONT'S GREENHOUSE GAS EMISSIONS ROSE 2%.²⁴ UNDER THE MANDATE OF THE **GLOBAL WARMING SOLUTIONS ACT, VERMONT'S** CLIMATE COUNCIL CREATED A CLIMATE ACTION PLAN TO IDENTIFY PATHWAYS TO REDUCE GHG EMISSIONS ACROSS ALL SECTORS AND PREPARE COMMUNITIES FOR WORSENING IMPACTS FROM CLIMATE CHANGE.23

DECEMBER 2021

IMAGE SOURCE: VPIRG

CHAMPIONS OF CHANGE

1. GLOBAL WARMING SOLUTIONS ACT

In September 2020, the Vermont State Legislature passed the Vermont Global Warming Solutions Act (H.688), creating legally binding emissions reduction targets. The Act calls on the state to reduce greenhouse gas pollution to 26% below 2005 levels by 2025, 40% below 1990 levels by 2030, and 80% below by 2050. The Act also created the Vermont Climate Council and charged them with developing an initial state Climate Action Plan. Notably, the Act creates a pathway for private citizens to take legal action against the State, should it not create, implement, or enforce rules necessary to achieve the targets.²³

2. MIDDLEBURY RIVER RESTORATION

In a groundbreaking effort, the town of Middlebury spearheaded the restoration of the Middlebury River in 2019. By investing \$3 million, they reconnected the river with its floodplain, enhancing stability and reducing erosion by 20%. Local collaborations further improved fish habitats and bolstered the region's resilience to climate change. This innovative project turns a oncedegraded river into a symbol of Vermont's commitment to environmental integrity, reflecting a forward-thinking approach to climate adaptation that promises lasting impacts on the state's ecological landscape.²⁵

3. BARRE CITY HOME BUYOUTS

Facing repeated flooding, Barre City implemented a strategic home buyout program in 2013. Investing over \$1.2 million in funds from federal, state, and local sources, the city acquired and demolished 15 properties in flood-prone areas. These spaces were transformed into public parks and natural flood barriers, mitigating flood damage by an estimated 30%. The program stands as a compelling example of turning climate vulnerability into community strength, providing both safety and aesthetic value to the city's landscape.²⁵

4. THE AFFORDABLE HEAT ACT

Enacted into law in 2023, The Affordable Heat Act (S.5) aims to provide financial support to low-income households struggling with heating costs. The Act offers subsidies and support to eligible individuals, while ushering a transition to cleaner energy. The legislature will vote on its implementation in 2025.²⁶

5. REGIONAL GREENHOUSE GAS INITIATIVE

Vermont's Regional Greenhouse Gas Initiative has been instrumental in reducing the state's carbon footprint, with a 20% decrease in greenhouse gas emissions from power plants since 2008. The program also generated over \$100 million in revenue for the state, further supporting its environmental efforts.²⁷

6. GREEN INFRASTRUCTURE IN HINESBURG

Hinesburg, Vermont, sets a commendable example with its adoption of a green infrastructure plan. The town is pioneering strategies to manage stormwater and reduce flooding, contributing to the entire state's resilience and adaptation in the face of climate change.²⁸





IMAGE SOURCE: VPIRG | STUDENT CLIMATE RALLY 2019

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IMAGE SOURCE: VPIRG | STUDENT CLIMATE RALLY 2019

			Total		2011				2012 2013 2014					2015 2017 2018						2019	2020		2021		2023		2024										
WIEIR	MC	TIM		1995: SEVERE S FLOOD	TORMS AND 4001: SEVI	ere storms and Looding	0 4022: TROPICAL S IRENE	STORM 4043: SEVERE	STORMS AND 4066 DDING TORNA	SEVERE STORM, 412 DO, AND FLOODING	20: SEVERE STORM FLOODING	S AND 4140: SEVERE STO FLOODING	RMS AND 4163: SEVERE STORM	WINTER 4178: S IS	Evere storms an Flooding	D 4207: SEVERE WIN STORM	TER 4232: SEVERE FLOO	STORM AND 4	330: SEVERE STORMS A FLOODING	ND 4356: SEVERE S FLOODIN	TORM AND 4380:	SEVERE STORM AN FLOODING	D 4445: SEVERE STORM: FLOODING	AND 4474: SEVERE S	STORM AND 4621	1: SEVERE STORM AND FLOODING	4695: SEVERE STOR FLOODING	4720: SEVERE STORM FLOODING, LANDSLIDE AND MUDSLIDES	S, 4744: SEVERE STOR S, FLOODING	MS AND 4762: SEVERE	STORM AND 4770: NG	SEVERE WINTER STORM	4810: SEVERE FLOODING, LAN AND MUDSL	STORM, 4816: SEVE DSLIDES, FL JDES FL	RE STORMS AND FI	1826: SEVERE STOF LOODING, LANDSLI AND MUDSLIDE!	RMS, LIDES, ES
GEOID COUNTY NAME	# OF DISASTER	RS FEMA TOTAL	PA Obligations HM Oblig	gations PA Obligations	HM PA Obligations Obligation	HM Obligations	PA Obligations Obli	HM PA igations Obligations	HM PA Obligations Obliga	HM tions Obligations Ob	PA HN Obligations Obligations	M PA tions Obligations Obl	HM PA gations Obligations O	HM PA Obligations Obliga	A HM ations Obligations	PA H Obligations Obliga	M PA ations Obligations	HM Obligations	PA HM Obligations Obligation	PA s Obligations O	HM P. Obligations Obliga	PA HM ations Obligation	PA HN s Obligations Obligations	ons Obligations	HM Obligations Obli	PA HM igations Obligations	PA H Obligations Oblig	M PA HM ations Obligations Obligation	PA ns Obligations Obl	HM PA gations Obligations	HM PA Obligations Obligat	HM ons Obligation	PA Obligations O	HM PA bligations Obligation	HM Obligations OI	PA Hi Obligations Oblig	IM gations
50000 50000: Statewide	22	\$151,577,075.93	\$146,855,179.29 \$4,721,	896.64 \$6,777,748.62	\$11,338.00 \$546,863	.80 \$19,715.00	0 100,818,193.36 \$3,24	42,619.40				\$165,041.93 \$	6,205.86 \$31,796.67	\$30,583.23 \$66,	580.48 \$123.3	4 \$105,162.20 \$8	584.76 \$126,092.90	\$7,539.64 \$	1,560,280.22 \$83,750	34 \$298,199.09	\$76,252.74 \$119	,583.31 \$28,370.	37 \$754,812.90 \$24,	09.41 \$1,307,192.07	\$535,729.55 \$35	56,203.17 \$36,375.00	\$98,465.36	\$0.00 \$33,189,056.76 \$600,00	0.00 \$93,514.04	\$0.00 \$109,079.13	\$0.00 \$82,8	28.32 \$0	.00 \$82,828.32	\$0.00 \$82,828	32 \$0.00	\$82,828.32	\$0.00
50001 50001: Addison Coun	ty 11	\$15,315,339.10	\$13,442,989.63 \$1,872,	349.47 \$288,312.48	\$236,548.00		\$3,628,573.07 \$1,44	47,926.47	\$129,	\$0.00						\$146,185.18	\$0.00 \$715,977.08	\$0.00	\$651,505.32 \$0	00 \$69,643.10	\$0.00			\$3,451,384.10	\$0.00			\$1,436,457.54 \$187,87	5.00 \$2,865,117.35	\$0.00			\$60,198.62	\$0.00			
50003 50003: Bennington Co	ounty 5	\$10,443,549.50	\$8,673,033.63 \$1,770,	515.87			\$6,339,295.86 \$1,00	01,021.00											\$70,865.22 \$0	00			\$130,265.82 \$769,4	94.87	\$1,47	76,401.77 \$0.00		\$656,204.96 \$	0.00								
50005 50005: Caledonia Co	unty 11	\$18,390,254.85	\$15,749,820.56 \$2,640,	434.29	\$2,799,333	.45 \$0.00	\$2,242,701.89 \$10	04,849.25				\$229,521.78	\$0.00 \$48,694.83	\$7,312.54 \$45,	601.87 \$0.0	0 \$85,165.06	\$0.00		\$371,916.61 \$0	00							\$66,356.30	\$0.00 \$9,527,545.73 \$2,528,27	2.50				\$332,983.04	\$0.00		\$0.00	\$0.00
50007 50007: Chittenden Co	ounty 14	\$18,684,395.37	\$16,139,181.90 \$2,545,	213.47 \$2,460,958.28	\$225,772.00		\$439,636.58 \$98	87,678.78		\$1,4	,436,953.12	\$0.00 \$1,254,214.16	\$0.00 \$68,376.63	\$0.00		\$236,295.61	\$0.00 \$484,503.50	\$0.00		\$141,546.49	\$0.00 \$1,498	\$,243.27 \$0.	00	\$3,276,315.26	\$363,876.44		\$12,053.10	\$0.00 \$4,783,073.84 \$967,88	6.25		\$37,5	02.81 \$0.	.00 \$9,509.25	\$0.00			
50009 50009: Essex County	16	\$2,401,074.86	\$2,391,600.11 \$9,4	474.75 \$391,201.97	\$0.00 \$1,396,986	5.13 \$0.00	\$52,197.20	\$0.00		r s	\$147,746.32	\$0.00	\$0.00	\$9,474.75 \$239,	730.49 \$0.0	0 \$0.00	\$0.00			\$0.00	\$0.00		\$28,459.53	\$0.00 \$0.00	\$0.00		\$0.00	\$0.00 \$107,609.25 \$	0.00	\$27,669.22	\$0.00	\$0.00 \$0	.00 \$0.00	\$0.00		\$0.00	\$0.00
50011 50011: Franklin Cour	ity 11	\$9,375,959.26	\$6,395,386.32 \$2,980,	572.94 \$290,862.31	\$0.00		\$300,874.19 \$2,39	97,563.25 📕 \$600,020.21	\$0.00				\$855,920.22	\$0.00 \$113,	227.26 \$0.0	0 \$0.00	\$0.00			\$149,230.33	\$0.00			\$3,872,814.21	\$84,934.69		\$138,589.72 \$498	,075.00 \$26,975.00 \$	0.00		\$46,8	72.87 \$0	.00				
50013 50013: Grand Isle Co	ounty 7	\$642,564.40	\$642,564.40	\$0.00 \$642,564.40	\$0.00		\$0.00	\$0.00					\$0.00	\$0.00						\$0.00	\$0.00	\$0.00 \$0.	00				\$0.00	\$0.00 \$0.00 \$	0.00								
50015 50015: Lamoille Cour	nty 17	\$34,343,761.13	\$31,382,480.00 \$2,961,	281.13 \$909,281.39	\$28,458.00		\$1,536,311.59 \$1,02	26,150.78	\$263,	101.94 \$0.00 \$	\$285,965.05 🍢 \$148,4	406.85 \$28,426.65	\$0.00 \$4,460,623.54	\$0.00 \$386,	450.09 \$0.0	0 \$2,202,072.51	\$0.00			\$2,569,800.26	\$0.00 \$1,262	\$0.	00	\$7,687,510.49	\$0.00		\$2,855,022.49	\$0.00 \$5,548,023.13 \$1,758,26	5.50	\$1,161,139.73	\$0.00 \$218,4	13.16 \$0.	.00 \$7,586.25	\$0.00 \$0.	00.00		
50017 50017: Orange Count	у 14	\$21,939,865.76	\$20,983,933.82 \$955,	931.94	\$167,666	5.71 \$0.00	\$5,790,764.61 \$46	61,749.44				\$746,862.22	\$0.00	\$127,	598.29 \$0.0	0 \$94,472.42	\$0.00	\$	3,012,836.81 \$0	00 \$22,236.60	\$0.00	\$0.00 \$0.	00 \$601,276.37	\$0.00 \$3,809.56	\$0.00		\$20,231.89	\$0.00 \$9,657,174.31 \$494,18	2.50	\$693,831.51	\$0.00		\$45,172.52	\$0.00			
50019 50019: Orleans Coun	ty 16	\$16,929,883.61	\$15,386,238.95 \$1,543,	644.66 \$1,111,247.93	\$0.00		\$1,920,785.11 \$40	05,908.83	\$602,	\$0.00		\$118,956.26	\$0.00 \$159,765.18	\$7,317.83 \$104,	766.27 \$0.0	0 \$25,155.79	\$0.00			\$3,465.90	\$0.00	\$0.00 \$0.	00	\$1,765,578.61	\$0.00		\$30,028.07	\$0.00 \$9,311,738.22 \$1,130,41	3.00	\$183,656.60	\$0.00	\$0.00 \$0.	.00 \$9,020.33	\$0.00		\$39,183.77	\$0.00
50021 50021: Rutland Count	ty 7	\$22,296,320.37	\$18,464,880.16 \$3,831,	440.21			\$12,181,097.24 \$3,46	66,726.94				\$178,004.62	\$0.00			\$188,010.18 \$76	786.87		\$871,770.07 \$0	00			\$1,823,467.54 \$146,	31.40				\$3,181,334.95 \$141,19	5.00	\$41,195.56	\$0.00						
50023 50023: Washington C	ounty 22	\$89,492,221.22	\$69,068,093.45 \$20,424,	127.77 \$836,626.66	\$0.00 \$5,634,948	1.63 \$91,571.00	\$9,115,274.23 \$3,13	35,431.02 \$241,066.93	\$0.00 \$22,	132.80 \$0.00	\$44,018.30	\$0.00 \$2,113,577.51	\$0.00 \$717,163.88	\$156,204.00 \$740,	567.98 \$0.0	0 \$683,998.41 \$325	849.94	\$	3,201,209.33 \$260,021	12 \$797,556.42	\$0.00 \$115	i,962.72 \$0.	00 \$2,566,916.26	\$0.00 \$1,856,573.71	\$0.00 \$21	14,176.47 \$0.00	\$1,401,103.40	\$0.00 \$38,261,439.70 \$16,455,05	0.69 \$49,386.47	\$0.00 \$159,793.07	\$0.00 \$40,3	19.07 \$0.	.00 \$254,281.50	\$0.00			
50025 50025: Windham Cou	nty <mark>6</mark>	\$44,746,824.00	\$41,351,888.12 \$3,394,	935.88			\$28,690,916.52 \$2,36	68,999.63 \$105,280.23	\$0.00											\$1,075,219.83	\$0.00				\$5,32	29,183.59 \$276,210.00		\$5,353,466.29 \$749,72	6.25	\$797,821.66	\$0.00						
50027 50027: Windsor Court	ity 7	\$84,051,799.49	\$77,166,111.58 \$6,885,	687.91			\$43,722,812.95 \$5,21	14,674.54				\$1,348,367.98 \$	88,012.87			\$182,575.42	\$0.00	\$	3,018,473.45 \$0	00			\$2,953,328.28	\$0.00				\$23,427,777.65 \$1,633,00	0.50	\$2,512,775.85	\$0.00						
Total Total	25	\$540,630,888.85	\$484,093,381.92 \$56,537,	506.93 13,708,804.04	\$502,116.00 10,545,798	.72 \$111,286.00	216,779,434.40 25,26	61,299.33 \$946,367.37	\$0.00 \$1,017,	761.44 \$0.00 \$1,9	,914,682.79 \$148,4	406.85 \$6,182,973.11 \$	54,218.73 \$6,342,340.95	\$210,892.35 \$1,824,	522.73 \$123.3	4 \$3,949,092.78 \$411	221.57 \$1,326,573.48	\$7,539.64 \$1	2,758,857.03 \$343,771	46 \$5,126,898.02	\$76,252.74 \$2,996	\$541.03 \$28,370.	37 \$8,858,526.70 \$940,9	35.68 23,221,178.01	\$984,540.68 \$7,37	75,965.00 \$312,585.00	\$4,621,850.33 \$498	,075.00 44,467,877.33 26,645,87	2.19 \$3,008,017.86	\$0.00 \$5,686,962.33	\$0.00 \$425,9	\$6.23 \$0.	.00 \$801,579.83	\$0.00 \$82,828.	\$0.00 \$	¢122,012.09	\$0.00

APPENDIX IMAPPING THE IMPACT

DATA VISUALIZATION TOOLS

It is evident the U.S. is already paying a steep price for this challenge. Rebuild by Design partnered with APTIM and iParametrics to create the following visual tools to demonstrate how climate events have affected each state. The set of six maps depicts which areas have been hit the hardest by recent climate events, where recovery funds are focused, where those individuals with high social vulnerabilities live, and which areas have the least energy reliability.

The U.S. needs to change the way it is making funding decisions. Where we make priority investments is equally important to what we invest in. Returns on investments (ROI) in the form of social benefits to communities needs to be part of grant evaluations. The U.S. need to utilize new decision-making frameworks that are forward-looking. The final map in the set includes an example of a new decisionmaking framework that takes into account current vulnerabilities and future climate risks. This is one example of how physical and social vulnerability indicators could inform where investments in adaptation infrastructure can yield high returns in social benefits to the most impacted communities. Our team recognizes, however, that there are other decision-making frameworks to explore, and further research is needed to understand which indicators should be included in any state-specific model. Given the ever-present constraints on funding availability, the intent of presenting these maps together is to prompt investments that address multiple known vulnerabilities simultaneously within projects, furthering comprehensive climate adaptation planning.

The following data are designed as a tool to help communities understand their risks to make betterinformed choices with higher returns on investment, though each state should determine their own framework for investment.

There are always many ways to present these data. For the purposes of this report, we chose to analyze the years 2011-2021. The following six maps and two tables are presented in this format with the following considerations and limitations:

GEOGRAPHIC MAP

The map provides topographic and geographic context for each state and its surrounding areas, indicating whether the state encompasses coastal, riverine, lake, alpine, or desert land.



GEOGRAPHIC MAP. SOURCE: ESRI

DISASTER DECLARATIONS (RED)

This map shows federally declared climate disasters of sufficient severity and magnitude to warrant major by county from 2011-2021 – providing a snapshot of disaster assistance under this Act to supplement the magnitude of climate disasters across the country the efforts and available resources of States, local in recent history. This report only identifies federally governments, and disaster relief organizations in declared disasters, as there is no entity that collects alleviating the damage, loss, hardship, or suffering and publishes state disaster declarations. It should caused thereby." be noted that the declarations shown in this report do not reflect every climate event that has occurred Importantly, extreme heat waves do not fit the criteria between 2011-2021; the report instead only shows for federal disaster declarations despite being the those which have met the cost threshold for a federal leading cause of deaths among climate hazards. disaster declaration. Therefore, the findings overall Likewise, sea level rise is not included in this definition underestimate the number of occurrences and the despite the threat it poses to numerous communities, suffering that some communities have experienced. including damage to property, loss of land, and displacement.

According to the Stafford Act, as amended in May 2021, a "major disaster" includes "any natural catastrophe (including any hurricane, tornado, storm, high water, winddriven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm, or drought), or, regardless of cause, any fire, flood,



DISASTER DECLARATIONS. SOURCE: FEMA 2021 | MAPS COURTESY OF IPARAMETRICS.

or explosion, in any part of the United States, which in the determination of the President causes damage

It should be noted that while most disaster declarations are due to climate events, there are a few instances of disasters due to other natural hazards, such as earthquakes and volcanic eruptions. Though these events are not increasing in magnitude or frequency due to climate change, the severity of their impact may be connected. As climate impacts degrade household and critical infrastructure, communities may become more vulnerable to other natural hazards. Retrofitting infrastructure after these events often requires the same measures as floods, tornadoes, fires, etc., so these events were included in the report to demonstrate the need to prioritize multi hazard adaptation approaches.

FEDERAL ASSISTANCE (ORANGE)

The map shows the amount of federal dollars allocated to counties through FEMA's Public Assistance and Hazard Mitigation Grant Programs between 2011-2021 which allocates funding to individual counties and statewide. The map does not show where "statewide" allocations were spent within the state, but rather only shows county allocations. However, these statewide allocation amounts are included in the Disaster Declaration table at the end of each chapter and included in the "FEMA Total" provided next to the map. The adjacent table adds HUD's Community Development Block Grant Disaster Recovery funds - which are only available to states after a disaster - to the FEMA Total for an estimate of federal post-disaster spending in each state.



FEDERAL ASSITANCE. SOURCE: FEMA 2023

The Disaster Declaration tables provided at the end of each chapter show all federal Disaster Declarations declared between 2011-2021 and the corresponding FEMA obligations associated with those events. However, in some instances, FEMA continues to obligate funds for years following a declaration. Some states have received funds for events that took place between 2011-2021 after 2021, so the total sum of funds associated with that event are not captured. All FEMA funds allocated to counties between 2011-2021 are shown in the federal assistance map; however, they do not show up in the Disaster Declaration table if their corresponding event took place prior to 2011. For example, counties in the State of Illinois are still receiving funds from a 1960s storm. The funds obligated to those counties are included in the map, but that event is not included in the Disaster Declaration table at the end of the chapter.

There are additional sources of federal funding made available to governments or individuals in response to disasters, such as the U.S. Army Corp of Engineers (USACE) projects, Small Business Administration (SBA) loans, and private insurance payouts, which are not included in this report because they are harder to uniformly track and/or must be paid back. Therefore, our findings underestimate the total support available to states and individuals post-disaster.

Since disaster aid is allocated to repair physical damage to property, events such as extreme heat, which largely creates physical damage to persons and not property, rarely qualify for federal disaster recovery aid. Additionally, there is only a shallow understanding of the economic impact of social and health-related costs and environmental degradation after a disaster.

SOCIAL VULNERABILITY INDEX (GREEN)

Social vulnerability refers to the potential negative effects on communities caused by external stresses on human well-being. Such stresses include natural or human-caused disasters or disease outbreaks. The factors that determine social vulnerability are directly tied to social determinants of health or the social, economic, and physical factors - such as race, socioeconomic status, and environmental conditions - that influence health. Socially vulnerable populations fare the worst during a disaster and often take longer to recover. The Center for Disease Control/ Agency for Toxic Substance and Disease Registry Social Vulnerability Index (CDC/ATSDR SVI) uses 15 U.S. census variables to help local officials identify communities that may need support before, during, or after disasters. The map presents the SVI on a census block level, indicating where the most socially vulnerable populations within each county live. The 15 indicators are grouped into four themes: Socioeconomic Status







SOURCE: US ENERGY INFORMATION

(below poverty, unemployed, income, no high school diploma); Household Composition & Disability (aged 65 or older, aged 17 or younger, older than age 5 with a disability, single-parent households); Minority Status & Language (minority, speak English "less than well"); and Housing Type & Transportation (multi-unit structures, mobile homes, crowding, no vehicle, group quarters).

Social Vulnerability Index data are not being used to make post-disaster assistance funding decisions. HUD only requires Low and Moderate Income for a portion of their funding. FEMA does not consider it in their allocations. To learn more about how vulnerable populations fare during climate events, turn to p. 10.

ENERGY RELIABILITY (BROWN)

Climate events often lead to energy disruptions for utility practices, maintenance patterns, and capital hours, days, or weeks. This map shows the annual investment strategy, among others, which all play a average interruption time (in minutes) across the part in a utility's overall reliability performance. The different energy utility providers within a state. Regions U.S. Energy Information Administration produces an (or utility territories) in the darkest shade, on average, Annual Electric Power Industry Report which utilizes experience longer energy outages. These data are data collected from U.S. electric utilities reflecting aggregated by utility territory, not county, meaning their reliability performance against certain industry more than one provider can serve a county or group of standards and performance metrics. Utilities have the counties. flexibility to report interruptions according to duration

Viewing the Energy Reliability Map next to the SVI Map, one can begin to infer which regions have the most socially vulnerable residents and are served by the least reliable energy providers. Energy reliability is increasingly becoming related to climate disasters and weather events. Inclusion of these maps is to support evaluation of need for concurrent flood and energy resilience projects. To read more about how energy reliability is calculated, see Appendix A.



ENERGY RELIABILITY

System Average Interruption Duration Index (SAIDI) is one of the performance metrics used to measure the reliability of an electric utility's service. This metric measures the total time (in minutes) an average customer experiences a non-momentary power interruption over a one-year (calendar) period. A Major Event Day (MED) is another metric which occurs when the SAIDI exceeds a specific threshold within a given day and tends to reflect outages on the longer end of the spectrum. The data presented in this report shows a metric of SAIDI combined with MED to highlight and report electric reliability in areas (utility territories) irrespective of the root cause of the interruption. The Energy Reliability Map displays the SAIDI_W_MED metric for utility territories and highlights areas that are susceptible to electric system vulnerabilities based on reliability performances. These vulnerabilities serve as an indicator as to where investments and improvements in the distribution grid should be focused.

Electric utilities experience power interruptions due to a variety of issues. Those issues include inclement weather, vegetation management practices,

and frequency either with major events, without major events, or both.

The annual SAIDI is the summation of the individual SAIDIs for each non-momentary interruption event over the entire year:

 Σ (Duration of Interruption × No. of Sustained Customer Interruptions) SAIDI Total No. of Customers Served

For utilities that report SAIDI metrics using the Institute of Electrical and Electronics Engineers (IEEE) standards, "non-momentary" interruptions are those lasting longer than five minutes. A Major Event Day (MED) is another metric which occurs when the SAIDI exceeds a specific threshold within a given day and tends to reflect outages on the longer end of the spectrum.

Utilities have certain flexibilities when reporting with these metrics. Including MED in the SAIDI metric (SAIDI_W_MED) provides an overall picture of the electric reliability experienced by customers. Excluding MED from the SAIDI metrics (SAIDI_WO_MED) tends to separate power interruption events by their durations, which provides an indicator of the source of the power interruption (i.e., distinguishes a Major Event vs. Systematic Operation interruption).

Our methodology utilizes SAIDI_W_MED as the primary measurement indicator for the electric reliability experience of the end user (customer). Our SAIDI_W_ MED metric highlights the reported electric reliability in areas (utility territories, counties, and states) irrespective of the root cause of the interruption. Our metric does not exclude interruptions categorized as MEDs.

This report endeavors to highlight areas across the national electric distribution network (utility territories) that are susceptible to electric system vulnerabilities based on historical reliability of performance. We view vulnerabilities caused by major events (longer duration outages) on par with vulnerabilities caused by systematic failures (shorter duration outages) and believe they should equally drive electric grid investment and improvement decisions.

These investments should also incorporate solutions aimed at mitigating systemic vulnerabilities that stem from issues like vegetation management practices, distribution automation improvements to major event vulnerabilities with root causes embedded in grid hardening, distribution generation schemes, and Automated Metering Infrastructure (AMI) upgrades aimed at minimizing customer interruption numbers and durations.

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