U.S. DEPARTMENT OF ENERGY

Incorporating Climate Change into Energy and Water Resilience Planning

July 11, 2023

PNNL-SA-186770

FEMP
Federal Energy Management Program

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Notice

This training is eligible for CEUs.

If you haven't already, register for today's training here:

https://wbdg.org/continuing-education/femp-courses/femplw07112023

At the end of this week, log back into your account and you can access the quiz questions for CEUs.

Today's Speakers & Trainers

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Goal and Purpose of Today's Training

- Explain how climate change projections and trends can be incorporated into **risk-informed** resilience planning to assess potential outcomes of climate change scenarios
- Go over the availability of climate resources for use in planning and sensitivity analyses
- Cover the intersection of climate mitigation (i.e., emissions reduction) and resilience planning

- **Upon completion of this course, attendees will be able to:**
  - Access and use key Technical Resilience Navigator (TRN) tool actions
  - Understand where to find and how to use reliable climate change resources
  - Understand differences between climate change mitigation and adaptation actions to help identify solutions to address these different goals, including solutions that can help to address both.

FEMP Focuses on Federal Agency Support

FEMP works with key stakeholders to support all stages of energy management in federal agencies' critical areas

Key Stakeholders

- White House
- Industry
- Agencies
- National Labs
- Congress
- MUSH Markets

Technical Areas

- Facilities
- Fleets
- Grid

FEMP Support Moves Agencies Forward

Access off-the-shelf resources and request specialized support.

Request Technical Assistance
FEMP's project facilitators and technical experts learn about your needs and provide customized support.

Access Tools
Available tools help collect data, assess resilience, identify opportunities for carbon pollution-free electricity, and much more.

Join a Community
Communities are available for federal employees & industry stakeholders to share lessons learned and drive decision-making.

Apply for Funding & Access Support
$250M in AFFECT funding is available as well as performance contracting support.

Get Recognition
Nominate individuals, projects, and sites for a variety of available federal recognition programs.

Take Training
On-site, in-person, and on-demand FEMP-delivered training supports an informed, capable workforce.

FEMP Tools & Support

- Smart Facility Accelerator
- FEDS Spotlight
- REopt
- ESPC
- Technical Resilience Navigator
- Federal Utility Partnership Working Group
- Re-tuning Trainings
- EVI Locate
- UESC
- CDF Calculator
- Treasure Hunts
- Interagency Task Force
- Federal Energy & Water Management Awards
- Energy Exchange
- AFFECT Funding
- Electricity Procurement Analysis

and much, much more...

Enhancing Resilience Through Energy and Water Management

Resilience is the ability to anticipate, prepare for, and adapt to changing conditions; to withstand, respond to, and recover rapidly from disruptions through adaptable and holistic planning; and to develop resilience solutions that address operational, institutional, and technical gaps.

- Electricity*
- Water*
- Natural Gas*
- Communications
- Cybersecurity
- Transportation
- Supply Chain
- Asset Reliability
- And More...

* The Technical Resilience Navigator focuses on energy and water resilience

What is Resilience?

RESOURCEFULNESS

Preparedness with optimized performance of energy and water systems and adequate planning, personnel training, and testing to manage through a disruption

REDUNDANCY

Availability of back-up resources and islandable onsite generation systems that enable continuity to critical loads during primary system disruptions

ROBUSTNESS

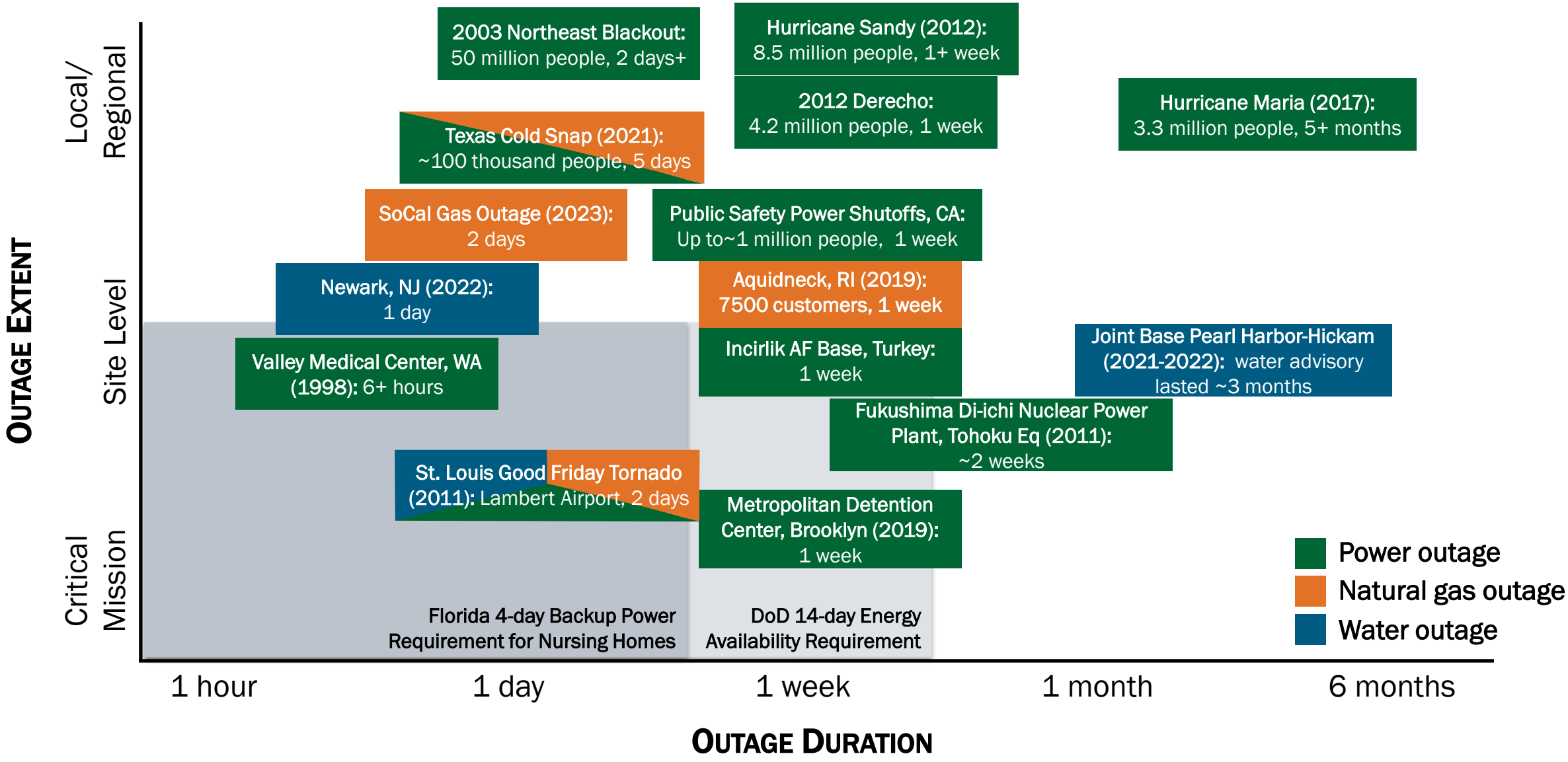
Ability to maintain critical operations during a disruptive event through building, infrastructure, and redundant system design, as well as system substitution capability

RECOVERY

Ability to return to normal operating conditions as quickly and efficiently as possible after a disruption

Agencies seek to ensure their facilities and operations adapt to and are increasingly resilient to climate change impacts. Actions include climate vulnerability assessments, integrating climate-readiness across missions, and managing and mitigating climate risks.

Energy and Water Resilience is Increasingly Important



Achieving Resilience Through Proactive Planning

A site that is energy and water resilient has:

★ Optimized systems and operations

★ Identified risk, consequences, and cost

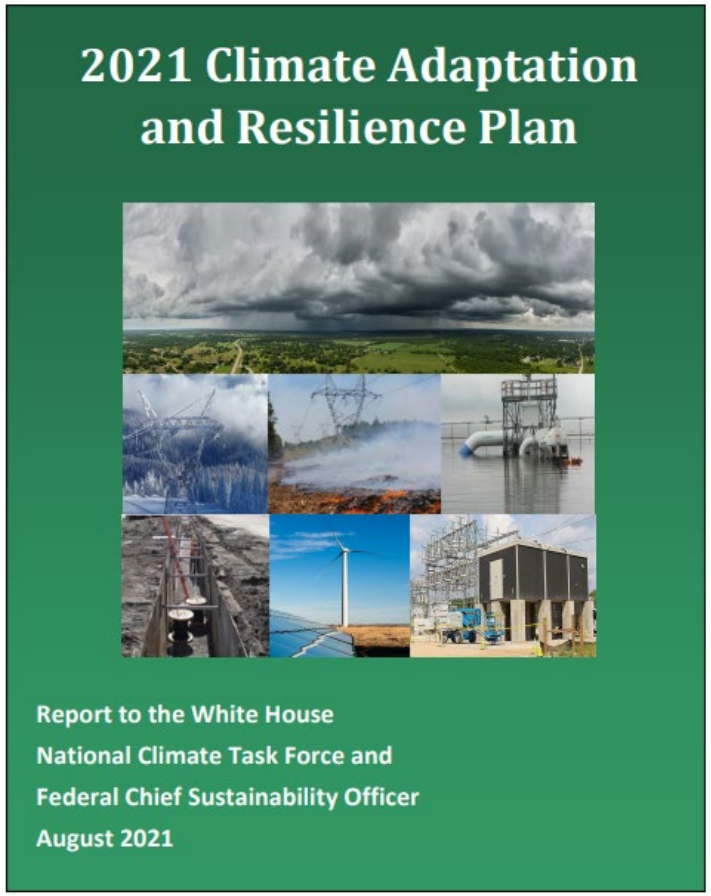
★ Trained personnel and capabilities

★ Actionable strategies to achieve diverse solutions

Federal facilities must be climate resilient

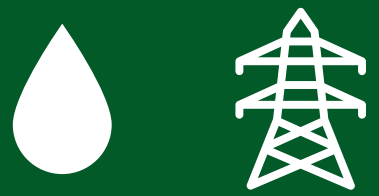
- **DOE adaption approaches:**
  - Reduce energy demand and increase energy efficiency
  - Enhance climate adaptation and mitigation co-benefits at DOE Sites
  - Deploy microgrids, distributed energy resources, and storage

- **Conduct site vulnerability studies and develop resilience plans (Vulnerability Assessment and Resilience Plans)**



Source: https://www.energy.gov/articles/doe-announces-agency-climate-adaptation-and-resilience-plan

TRN
TECHNICAL RESILIENCE NAVIGATOR



Focuses on Energy and Water Resilience

Replicable and Robust Planning Process

Online Webtool with Downloadable Option for Data Security

Visit: https://trn.pnnl.gov/

Training Agenda & Key Links

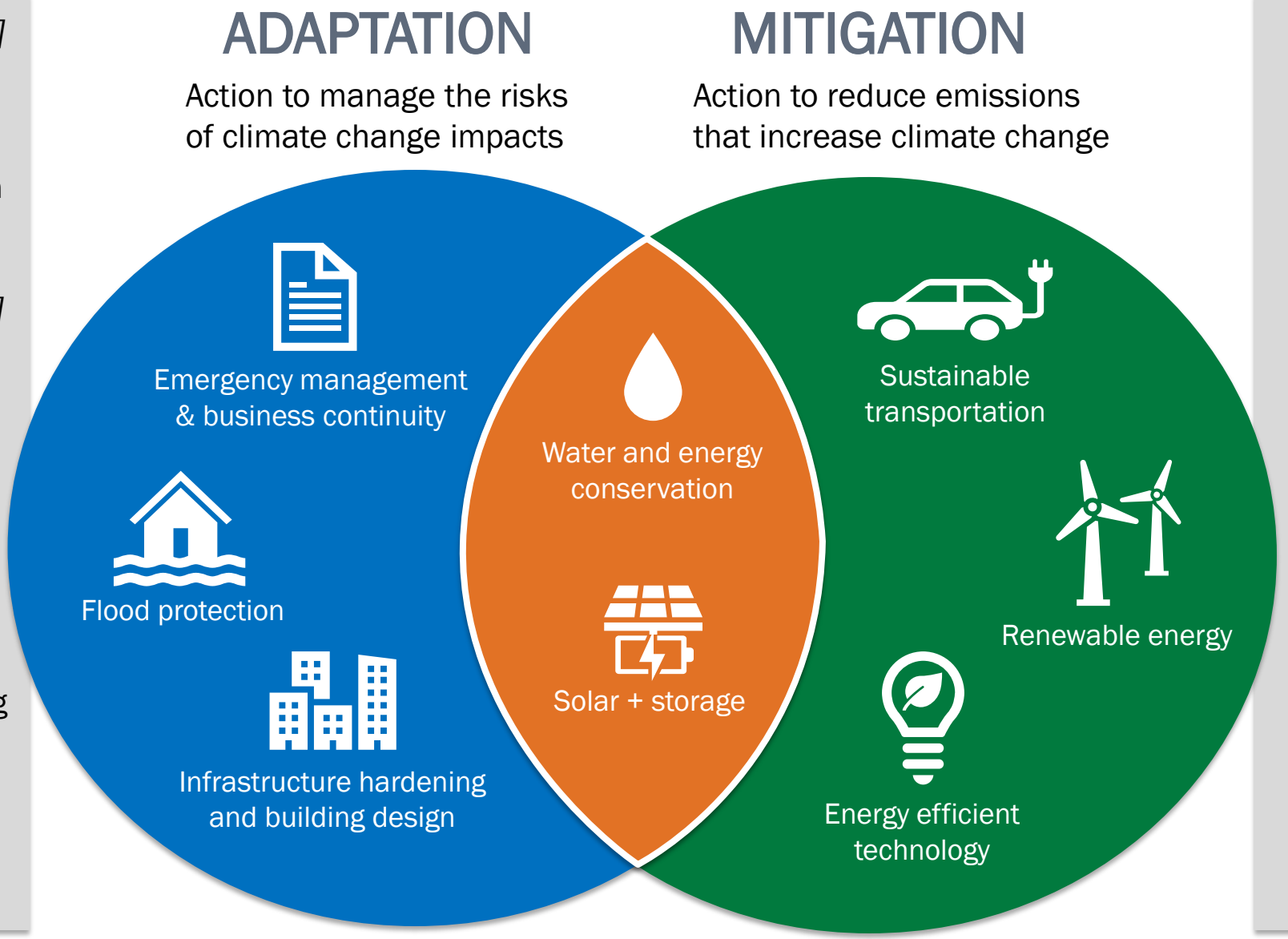
Training Segment	Description	Links
Climate adaptation & mitigation	Reviews Executive Order drivers, definitions	www.sustainability.gov/
Understanding the anticipated impact of climate change on hazards	Reviews regional projections of climate change and availability of downscaled data	www.climate.gov www.trn.pnnl.gov/toolkit
Technical Resilience Navigator Example	Reviews example of how risk drivers at a site may change due to climate change	www.trn.pnnl.gov

Achieving climate resilience

E.O. 14008 *[Sec. 211]*
- Climate Action Plans and Data & Information Products to improve adaptation and increase resilience

E.O. 14057 *[Sec. 102]*
- Climate resilient infrastructure and operations
- Climate- and sustainability-focused Federal workforce

E.O. 14072 *[Sec. 2]*
- Climate-smart management and conservation planning to address threats to mature and old-growth forests on Federal lands



E.O. 14057 *[Sec. 102]*
- 100% carbon pollution-free electricity on net annual basis by 2030
- 100% zero-emission vehicle acquisitions by 2035
- Net-zero emissions building portfolio by 2045
- 65% reduction in scope 1 and 2 GHG emissions by 2030 from 2008 levels
- Net-zero emissions from Federal procurement

Achieving climate resilience

Example for site in SW Florida: Projections indicate an increase in the frequency and intensity of heavy precipitation events.

Extreme rainfal

Flooding increases with extre
rainfall

Heavy downpours result in
trees falling on power lines

Power outages & floods can
affect the wastewater system

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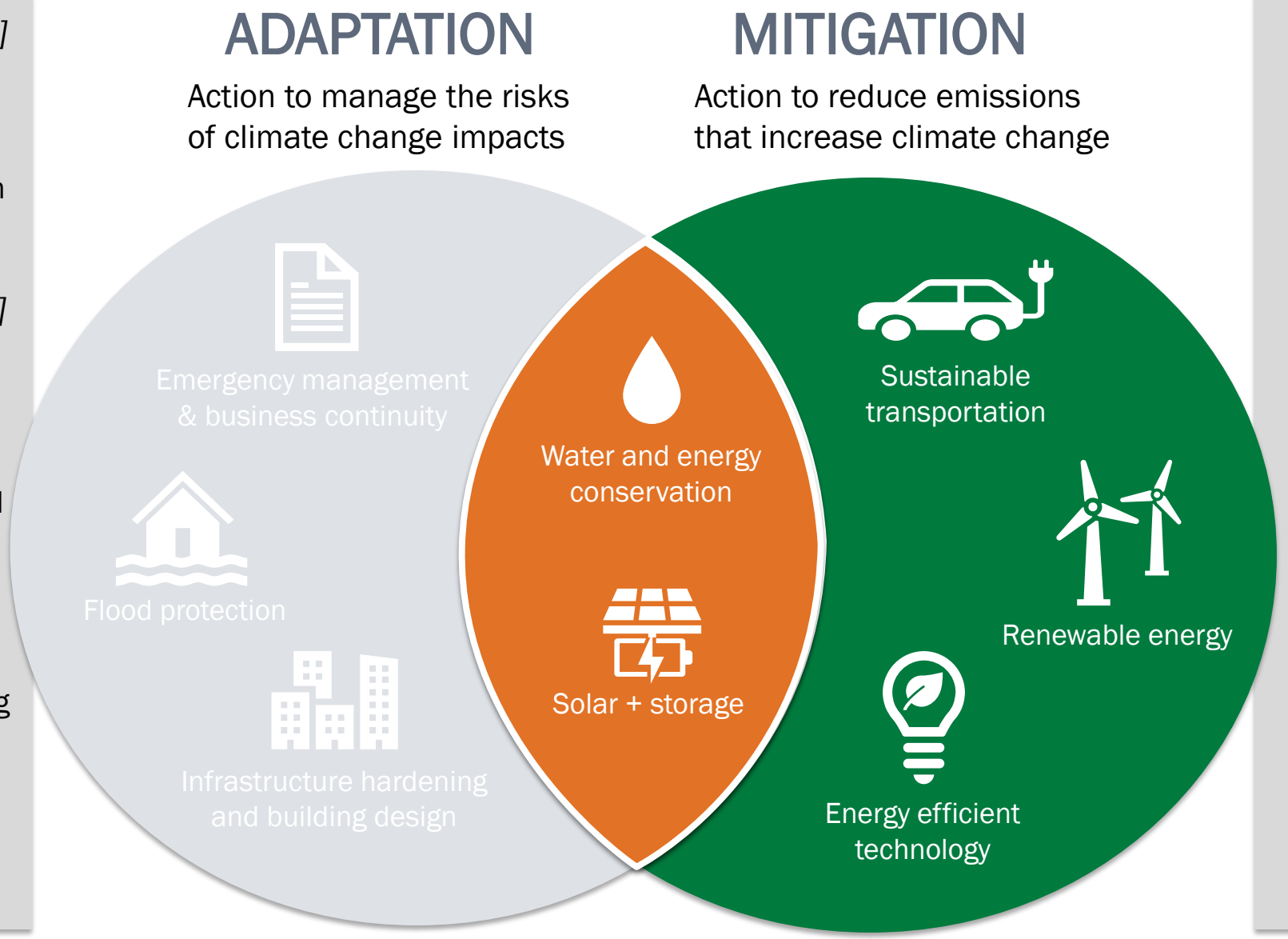

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In Focus: Modeling Potential Emissions Impact in the TRN

Evaluates potential emissions impact from:
1) Changes in energy use
2) Shift in electricity supply

Solution emissions compared against current site emissions

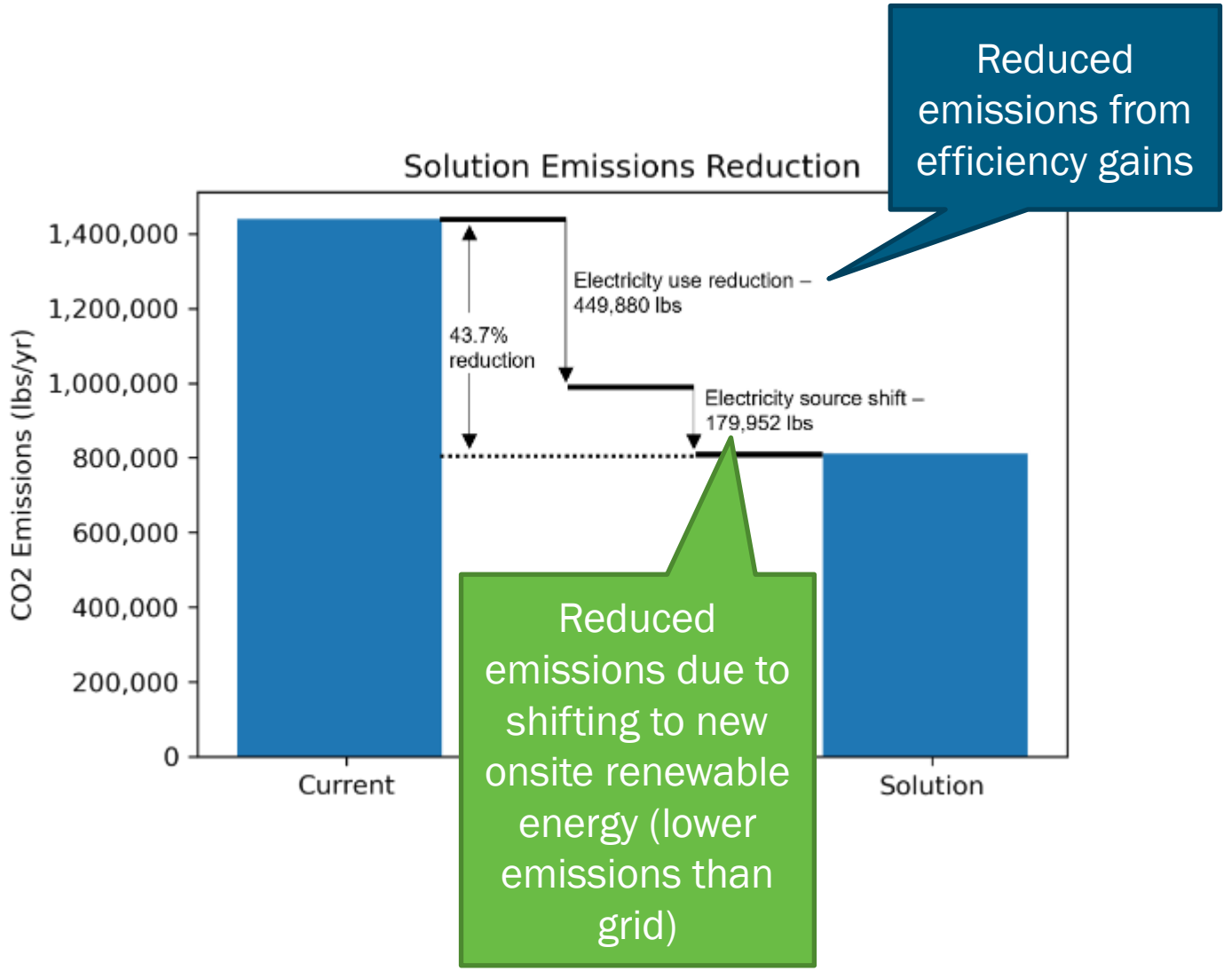

Figure Source: Elliott, D.B., H.S. Rabinowitz, A. Delgado, and J. Rotondo. Decarbonization in Climate Resilience Planning. 2022. ACEEE Summer Study.

Climate Change Mitigation Solutions

Climate mitigation actions focus on reducing greenhouse gas emissions by enhancing energy efficiency and decarbonizing/diversifying energy supply.

Enhancing energy efficiency

- Choose energy-efficient appliances, equipment, and lighting
- Improve insulation sealing duct work to reduce energy loss during heating and cooling
- Install efficient heat pumps
- Modernize HVAC control systems

DOE. "Heat Pump Systems." https://www.energy.gov/energysaver/heat-pump-systems

Climate Change Mitigation Solutions

Climate mitigation actions focus on reducing greenhouse gas emissions by enhancing energy efficiency and decarbonizing/diversifying energy supply.

Decarbonizing and diversifying energy supply

- Install onsite renewable energy generation such as wind or solar energy
- Install microgrids with energy storage to support the integration of renewables
- For propane/diesel generator usage, switch to solar energy systems with battery backup, alternative fuel types with reduced emissions, or dual fuel equipment

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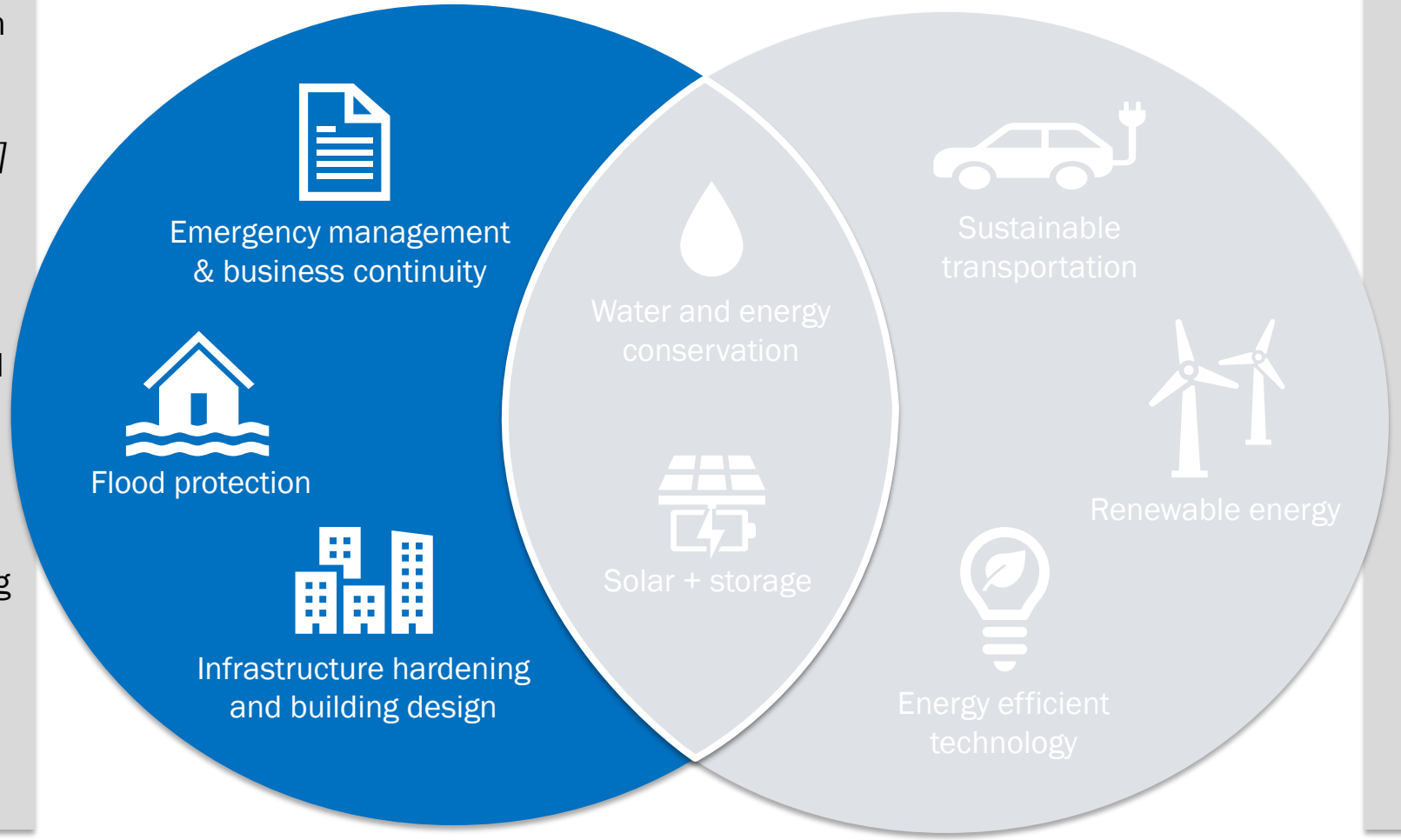

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High impact hazards occurring more frequently over time

- NOAA analysis of “billion-dollar disasters” demonstrates an increase in hazards that are likely to be impacted by climate change over time

- Increasing cost of natural hazards is likely a combination of increasing population and climate change effects

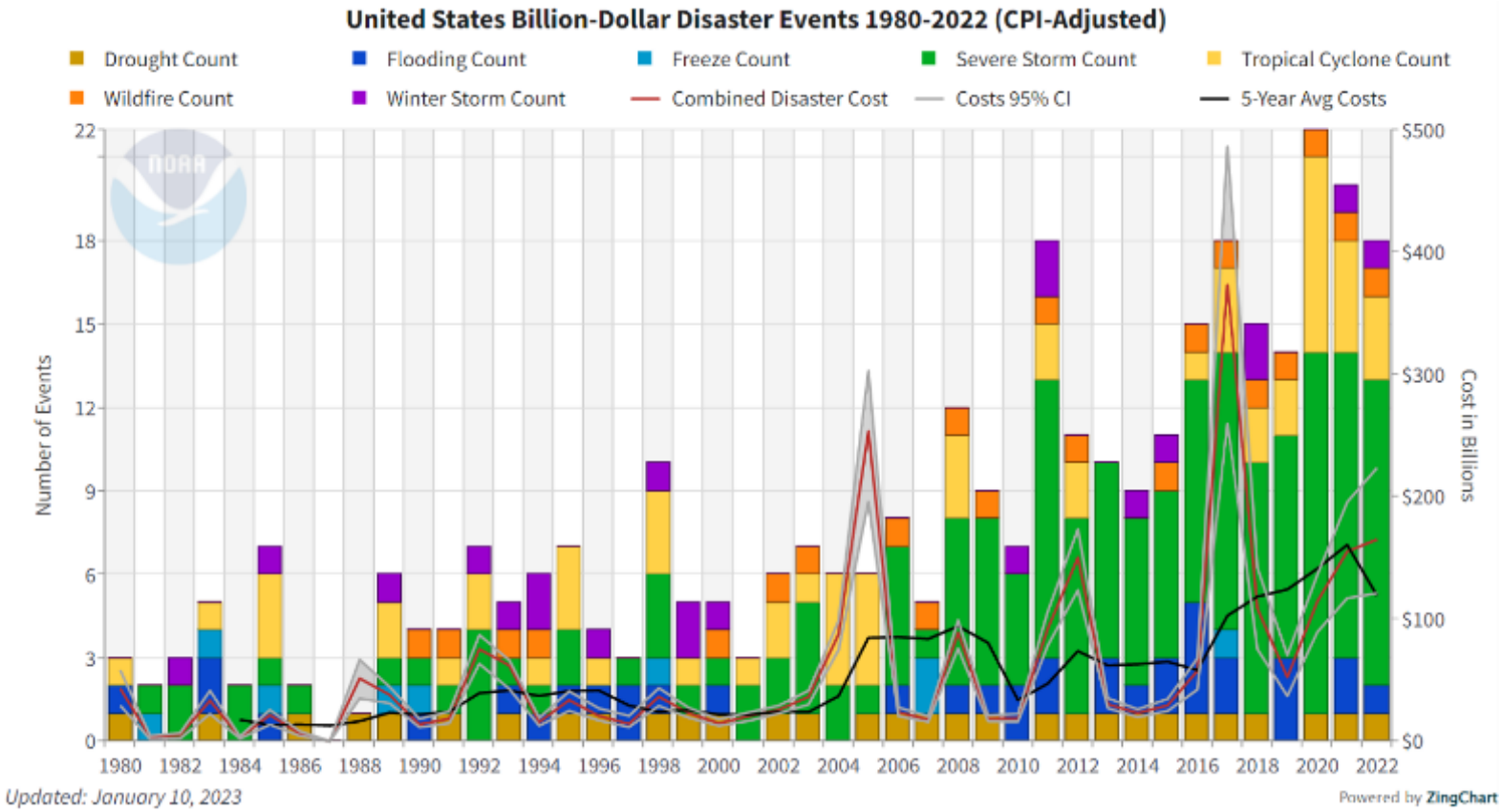


Figure Source: NOAA/NCEI, https://www.climate.gov/news-features/blogs/2022-us-billion-dollar-weather-and-climate-disasters-historical-context

Climate change: scenarios & projections

- **Projections are models that *simulate* changes in the earth's climate**

- **Scenarios describe possible future outcomes of climate change *impacts***
  - RCP = Representative Concentration Pathways
  - RCP 4.5 and RCP 8.5 are two different climate futures considered to be plausible

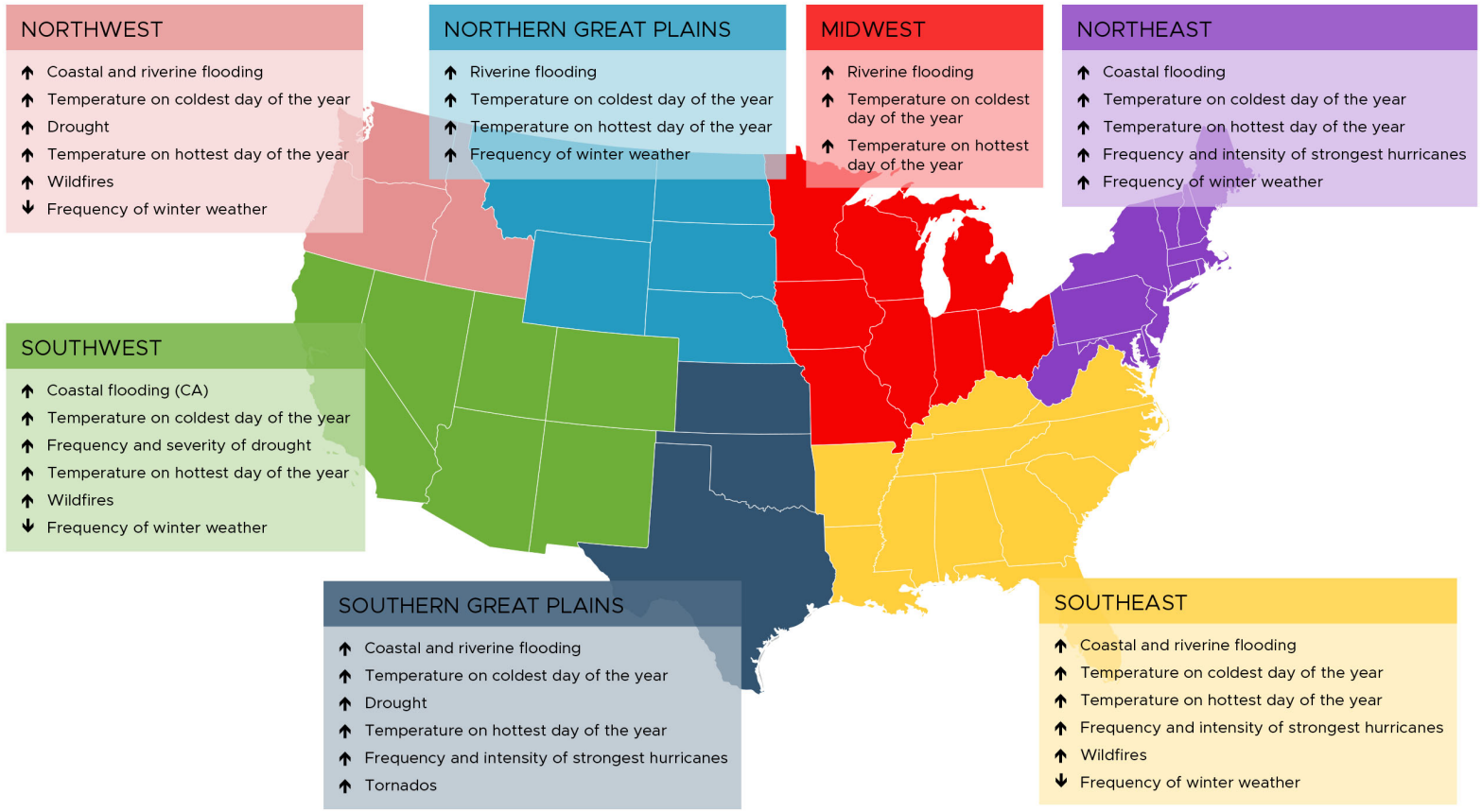


Figure Source: Delgado, A., and Rabinowitz, H.S. Considering Climate Change Scenarios in Site Resilience Planning. 2021. doi:10.2172/1833511. (After 4th NCA 2018, note 5th NCA anticipated to be released in 2023)

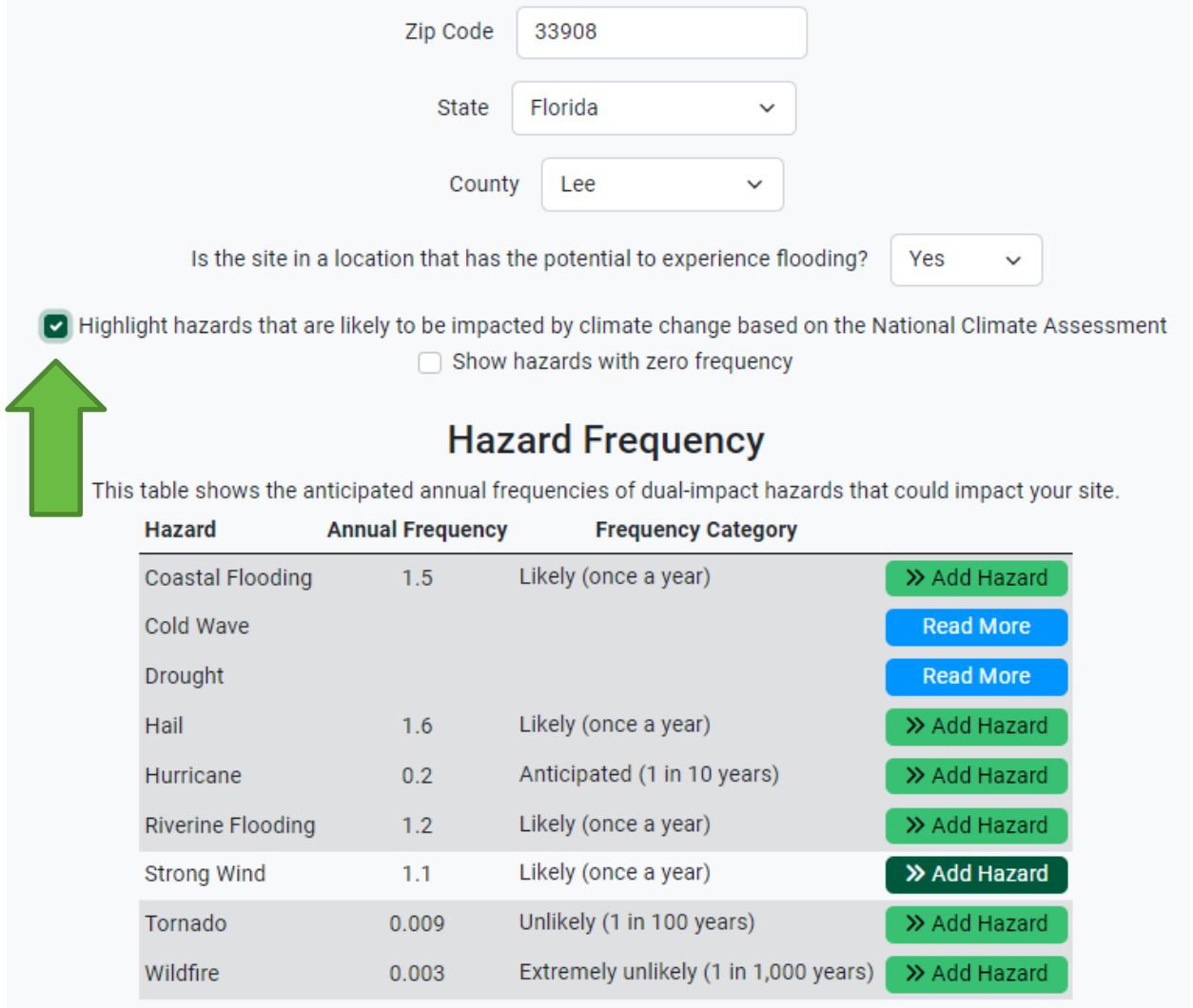
TRN Toolkit Provides Resources for Assessing Hazard Exposure

TRN Toolkit includes two tools to help users characterize hazards for their risk assessment:

- Identify Potential Hazards
- Climate Change Resources

https://trn.pnnl.gov/toolkit

Identifying hazard characteristics for resilience planning

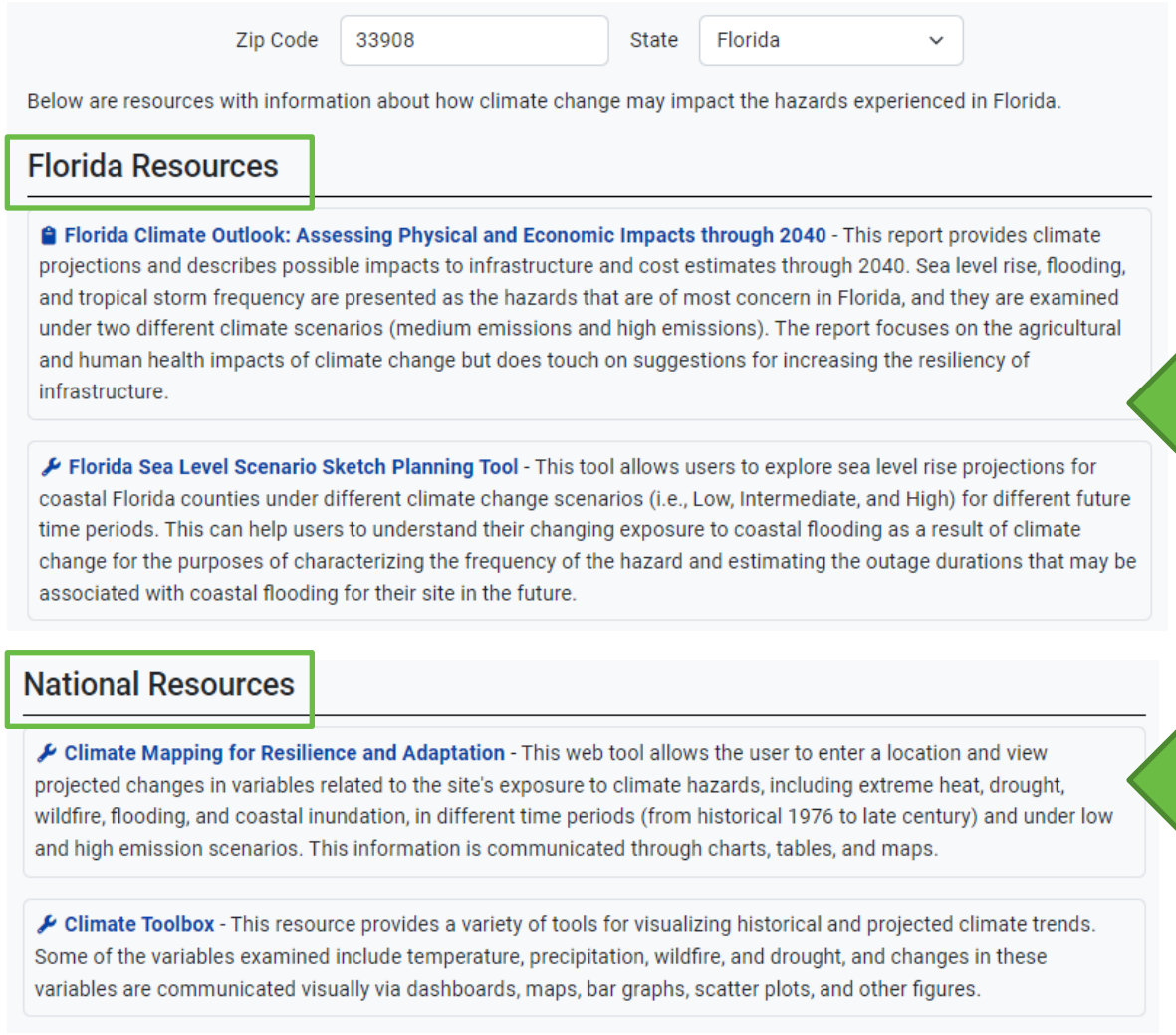


Technical Resilience Navigator (TRN) Identify Potential Hazards Tool

- Tool identifies potential range of hazards and how frequently they may impact a site
- Uses historic data from FEMA's National Risk Index (NRI), modified to display the likely annual frequency of a hazard at a site
- Highlights which hazards are likely to change as a result of climate change (per the NCA)
- **Limitation: The 'highlighted' hazards might be impacted by climate change; however, without state or regional-level context or information, this table does not show impact at the specific location**

Available outside TRN log-in at: *https://trn.pnnl.gov/potential-hazards*

Incorporating climate change considerations into resilience planning



TRN Climate Change Resources Tool

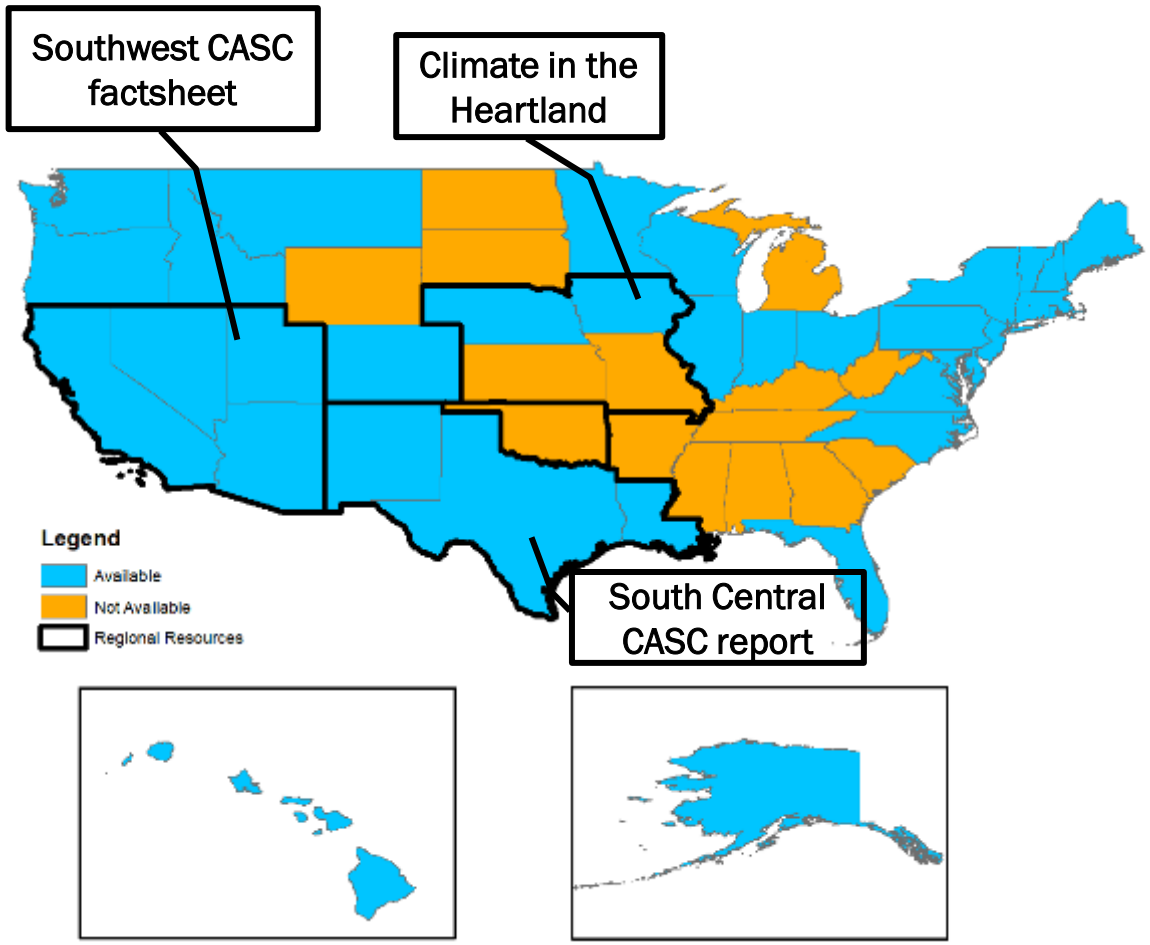
- Tool identifies relevant climate change resources (assessments, reports, and web tools) for a zip code or state entry

State resources are provided, as available, for state-level information on how climate change may affect specific hazards. National tools may not account for state-level heterogeneity in hazards

National resources are provided for every state, including those lacking state-level resources, and include the NCA state summaries, climate and sea level-rise mapping tools, and other resources

Available outside TRN log-in at: *https://trn.pnnl.gov/toolkit/climate-change-resources*

Availability of state-level resources



- **71 percent (35 states and DC, 36 in total) have state-level plans, assessments, analyses, tools or other resources**
  - An additional 3 states are included in non-NCA regional assessments, for a total of 38 states (plus DC) that have regional or state resources
- States that do not have state-level resources still have information available via the NCA and other national resources

Figure Source: Rabinowitz, H.S., S. Dahodwala, S. Baur, A. Delgado. *Availability of state-level climate change projection resources for use in site-level risk assessment*. (in review)

State-level reports & assessments

- **Reports/assessments, at the state level, generally discuss:**
  - Anticipated changes in hazard frequency and severity as a result of climate change (for hazards of particular concern to stakeholders)
  - The expected impacts of changing hazards (though generally not at the site-level)
  - Potential mitigation and adaptation strategies (usually at the regional or community-level)
- **Example:** New York state's *Responding to Climate Change in New York State (ClimAID)* report investigates projected changes in multiple hazards (such as flooding, ice storms, and coastal storms) and the impacts on eight different sectors, including energy and water resources
- **As these resources are often extensive, users may need to search for hazard names or other keywords within their state's report to more easily find relevant information**

State-level tools

Web Tool: Future Rainfall Change Factors for Flood Resiliency Planning in South Florida

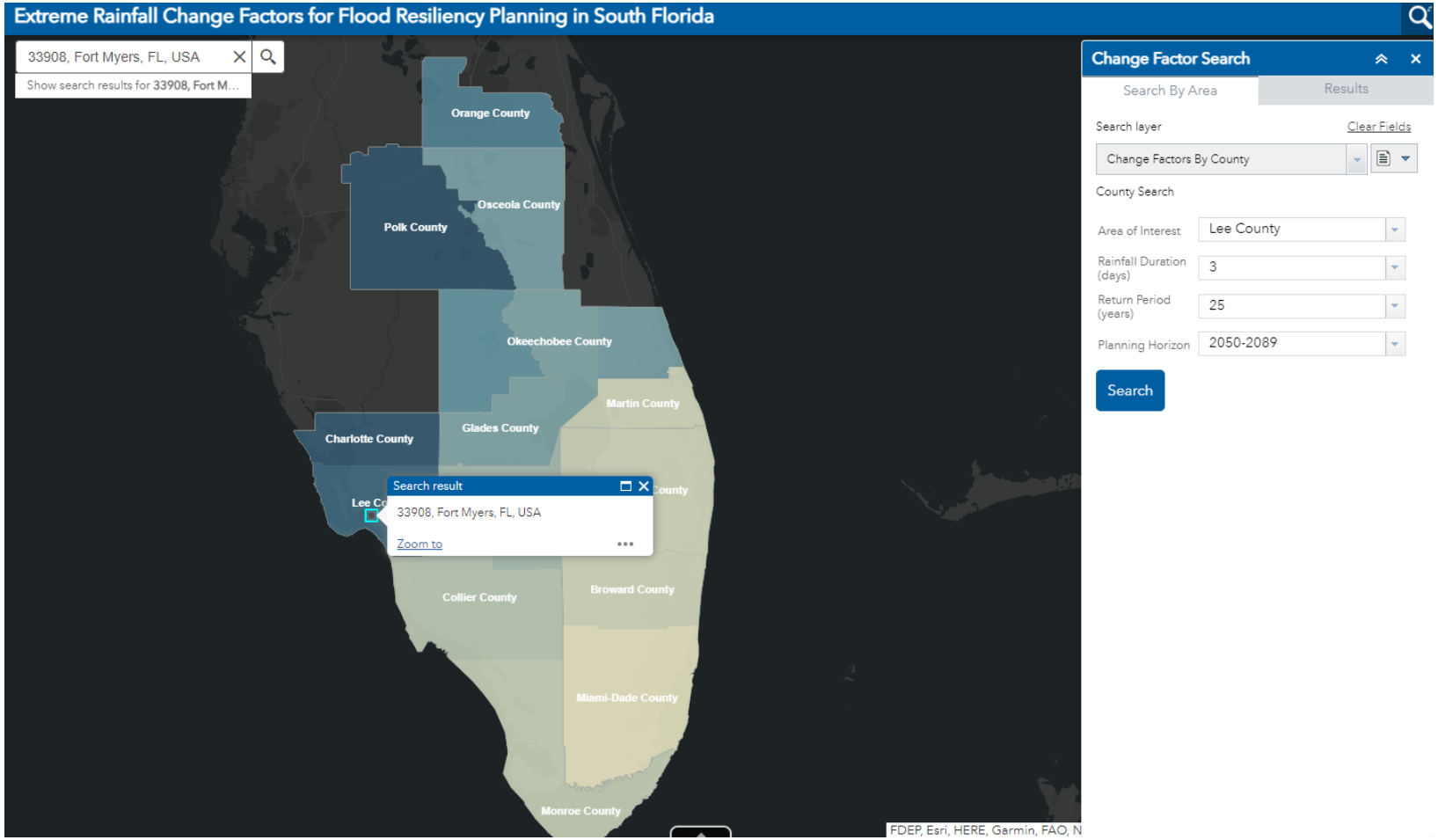


Figure Source: South Florida Water Management District. Resilience Metrics Hub. Future Rainfall Change Factors for Flood Resiliency Planning in South Florida.

Several states have **web tools** to assist users in understanding climate change impacts on hazard frequency/severity. Most of the available web tools have mapping features or other capabilities to **visualize changes in hazard characteristics and/or their impacts.**

TRN Overview

Risk-informed resilience planning

What can go wrong?
(A *scenario*)

How likely is it?
(A probability or frequency)

How bad would it be?
(A consequence severity)

Risk =

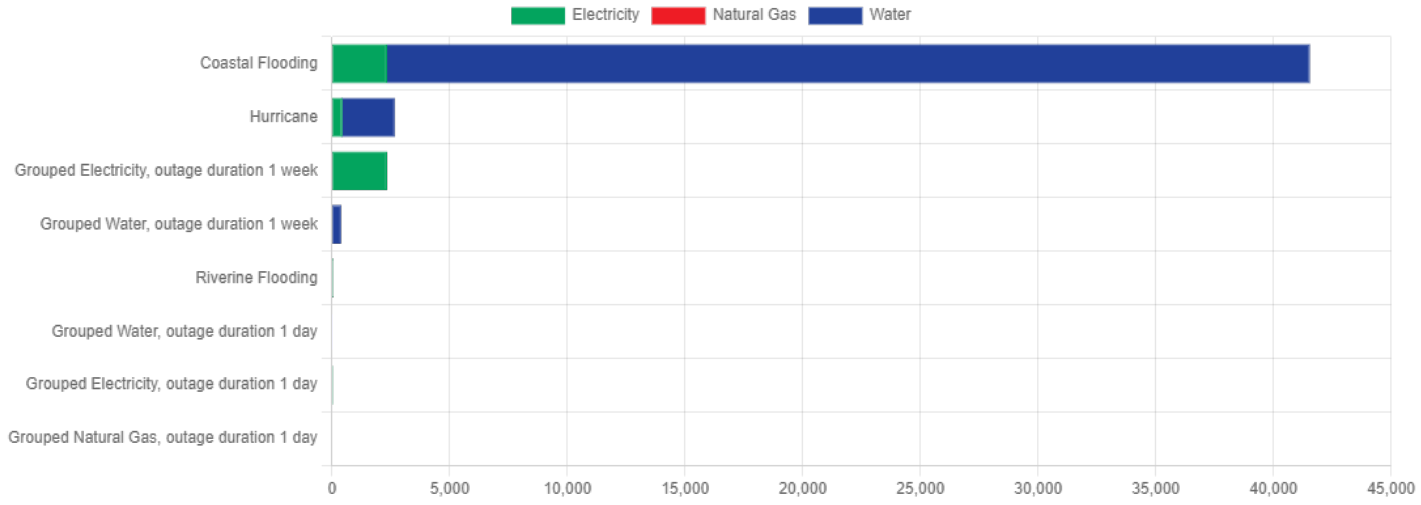
Hazard x Vulnerability x Consequence x Criticality

The TRN follows best practices in risk assessment.

By identifying drivers of risk, users can focus on creating solutions in areas likely to have the biggest impact.

Risk Insights Based On Best Estimate Inputs

- TRN risk assessment allows users to identify the critical loads and hazards that are driving outage risk at their site
- Typical user likely to base hazard characterization on historical data
- In order to account for climate change, conduct sensitivity analysis



Calculating Risk in the TRN

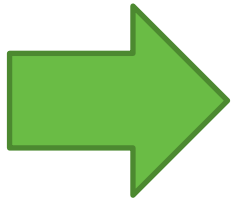
Key Inputs

- Hazard
- Vulnerability
- Consequence
- Criticality Weighting Factor

Applying Information From Climate Resources for Sensitivity Analysis

- Information on projected changes in hazards obtained from state-level (and national) resources can be used to build sensitivity cases in the TRN that represent different potential climate futures
- For example, Florida is expected to have…
  - Sea level rise likely to contribute to increased contamination of groundwater reservoirs
  - Increased rainfall in hurricanes (so damaging hurricanes may be more frequent)
  - Increased rainfall for 1-week rain events (potentially impacting riverine flooding)

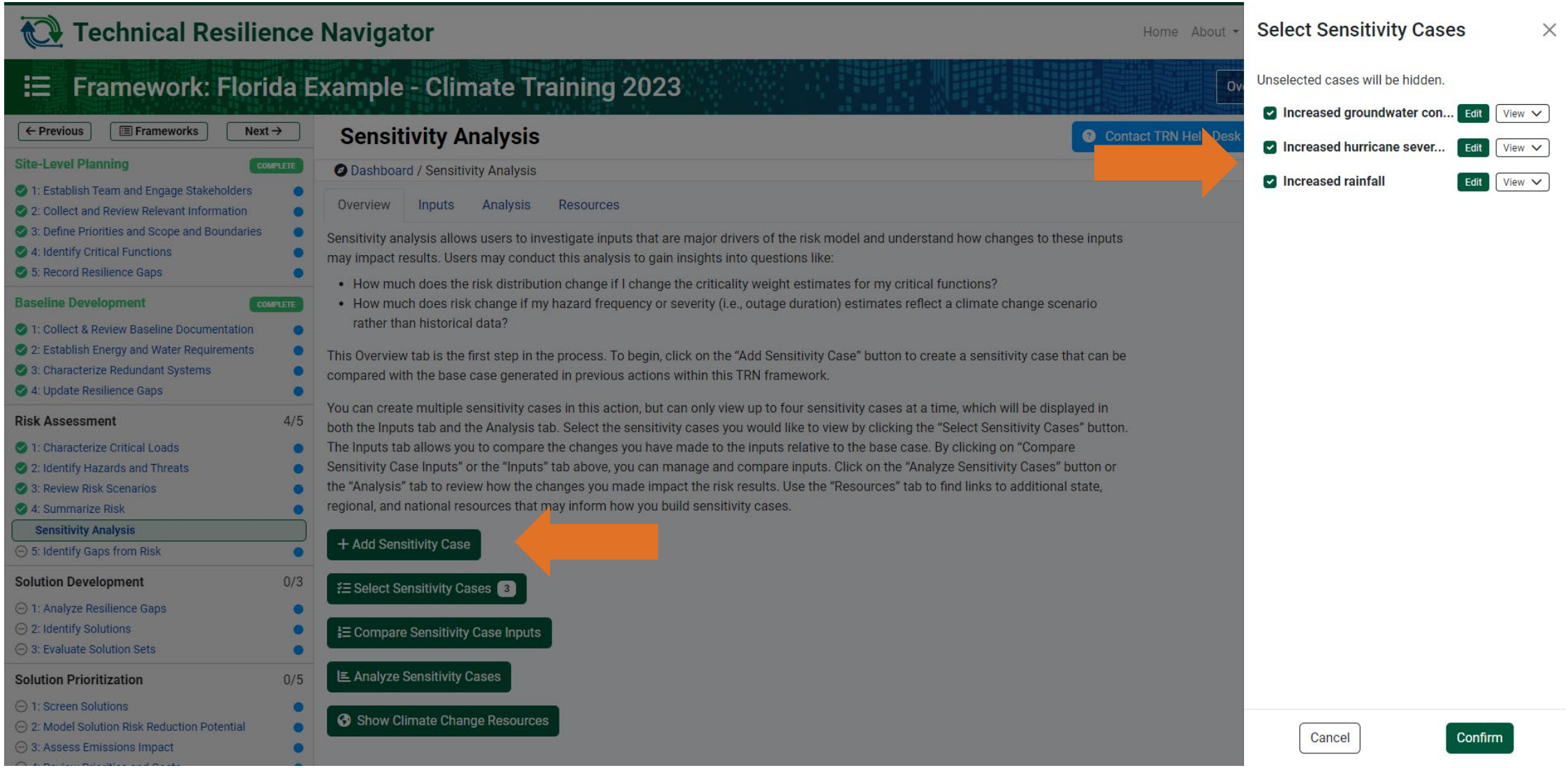
- Change annual frequency
- Change outage duration



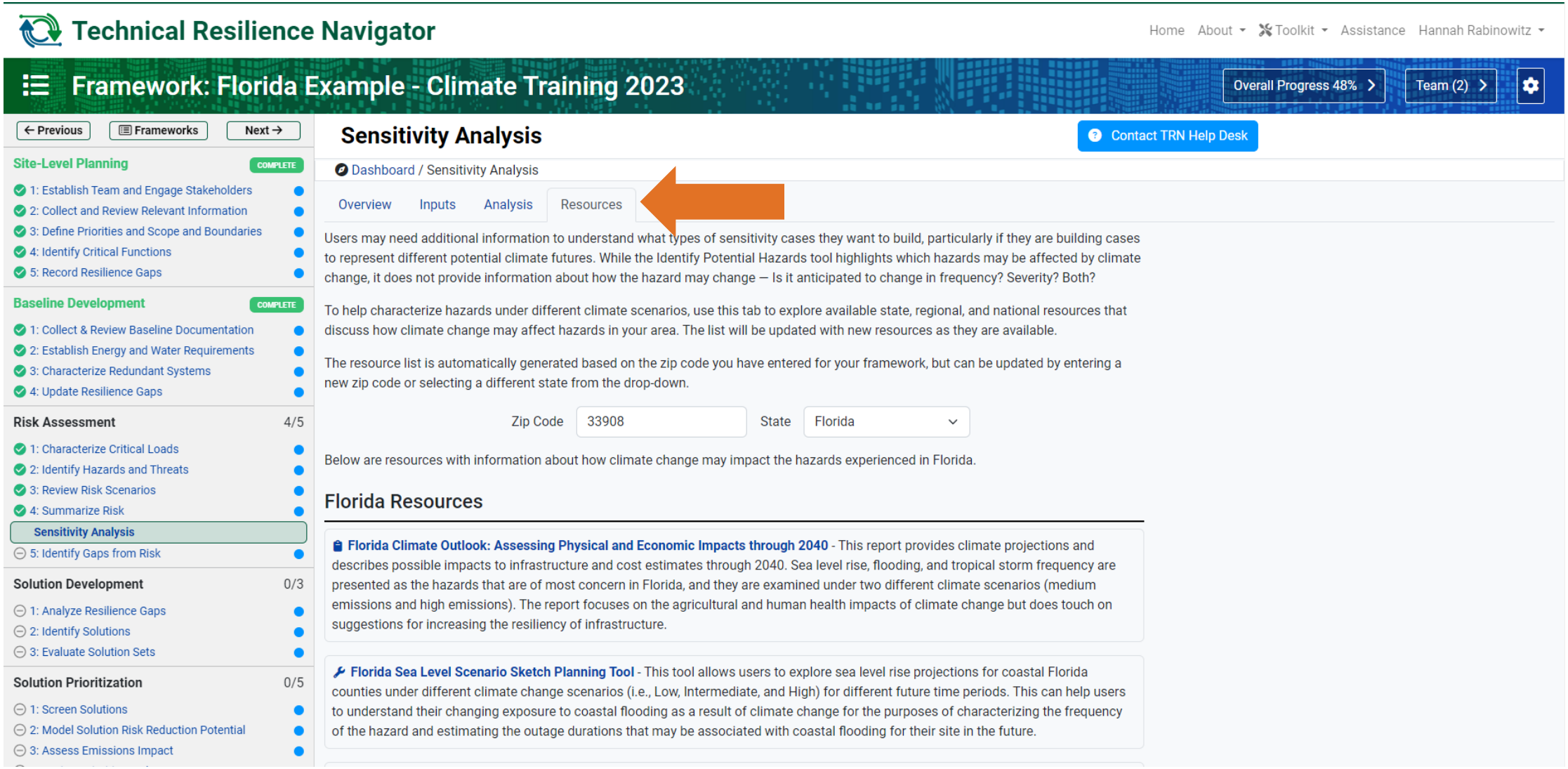
Grouped Hazard	Outage Duration	Frequency	Increased groundwater contamination by salt water	Increased hurricane severity	Increased rainfall
Electricity	1 day	Almost certain (3 times/year)	Almost certain (3 times/year)	Almost certain (3 times/year)	Almost certain (3 times/year)
Electricity	1 week	Anticipated (1 in 10 years)	Anticipated (1 in 10 years)	Anticipated (1 in 10 years)	Anticipated (1 in 10 years)
Natural Gas	1 day	Anticipated (1 in 10 years)	Anticipated (1 in 10 years)	Anticipated (1 in 10 years)	Anticipated (1 in 10 years)
Water	1 day	Unlikely (1 in 100 years)	**Likely (once a year)**	Unlikely (1 in 100 years)	Unlikely (1 in 100 years)
Water	1 week	Unlikely (1 in 100 years)	**Anticipated (1 in 10 years)**	Unlikely (1 in 100 years)	Unlikely (1 in 100 years)

Dual-Impact Hazard		Base Case	Increased groundwater contamination by salt water	Increased hurricane severity	Increased rainfall
Coastal Flooding - Electricity	Outage Duration (hrs)	1 week	1 week	1 week	1 week
	Frequency (hrs)	Anticipated (1 in 10 years)	Anticipated (1 in 10 years)	Anticipated (1 in 10 years)	Anticipated (1 in 10 years)
Coastal Flooding - Water	Outage Duration (hrs)	1 week	1 week	1 week	1 week
	Frequency (hrs)	Likely (once a year)	Likely (once a year)	Likely (once a year)	Likely (once a year)
Hurricane - Electricity	Outage Duration (hrs)	1 week	1 week	1 week	1 week
	Frequency (hrs)	Unlikely (1 in 100 years)	Unlikely (1 in 100 years)	**Anticipated (1 in 10 years)**	Unlikely (1 in 100 years)
Hurricane - Water	Outage Duration (hrs)	1 month	1 month	1 month	1 month
	Frequency (hrs)	Unlikely (1 in 100 years)	Unlikely (1 in 100 years)	**Anticipated (1 in 10 years)**	Unlikely (1 in 100 years)
Riverine Flooding - Electricity	Outage Duration (hrs)	1 day	1 day	1 day	**1 week**
	Frequency (hrs)	Anticipated (1 in 10 years)	Anticipated (1 in 10 years)	Anticipated (1 in 10 years)	Anticipated (1 in 10 years)

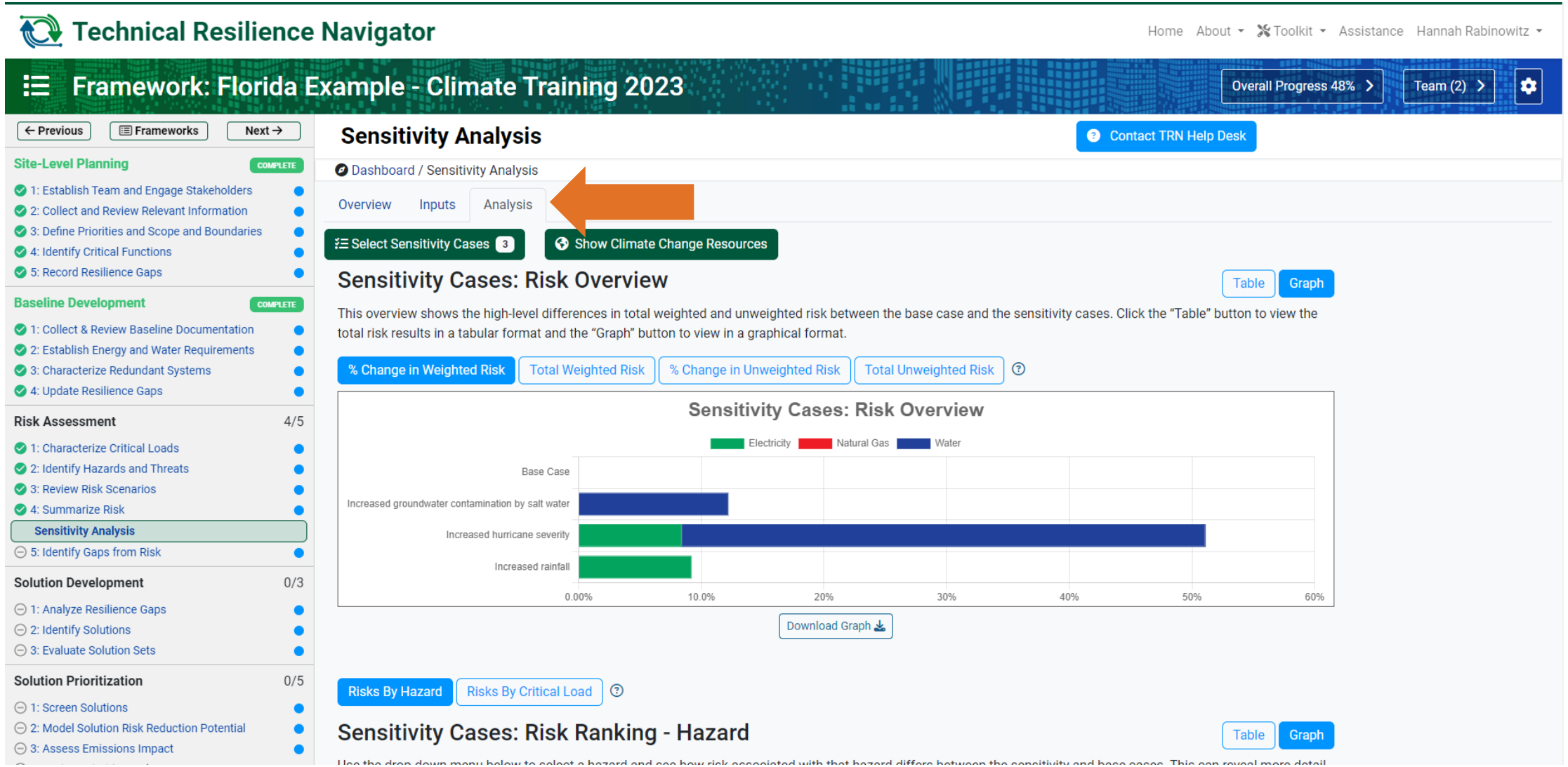
Add Sensitivity Cases and Choose Which to Analyze



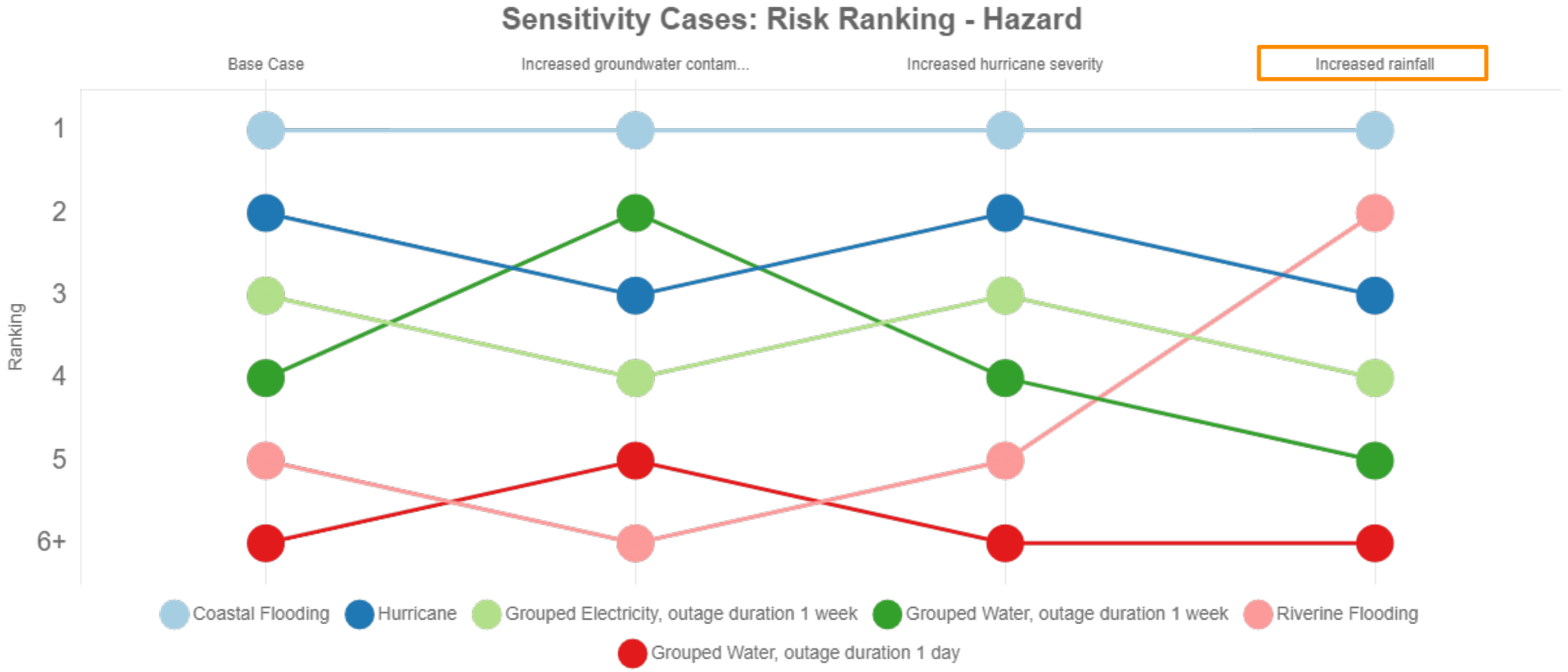
Check out Climate Resources for Background Information



Compare Risk in Sensitivity Cases to Base Case



Use Sensitivity Analysis to Explore Potential Changes



Sensitivity cases can explore potential impact from changes to hazards impacting the site and how that impacts which hazards are driving risk and should be addressed via resilience solutions. In this example, for a climate change scenario where there is increased rainfall leading to longer riverine flooding events, riverine flooding becomes the second biggest risk driver.

Climate Change Adaptation Solutions

Climate adaptation actions focus on mitigating the risks of climate change impacts, such as the increasing frequency and severity of natural hazards.

BBC. "Welney flood barrier: Norfolk road disruption for weeks." https://www.bbc.com/news/uk-england-norfolk-61526512

Climate Adaptation

- Implement flood hardening, such as elevating systems above flood and storm surge levels, installing enclosures or barriers to protect against inundation, and installing drainage
- Use natural infrastructure to control riverine flooding, such as planting trees to control stormwater runoff, building swales, controlling steam bank erosion, and protecting and enhancing riparian buffers and floodplains
- Implement wildfire hardening, such as installing a built-in fire suppression system around systems and managing vegetation

Achieving climate resilience

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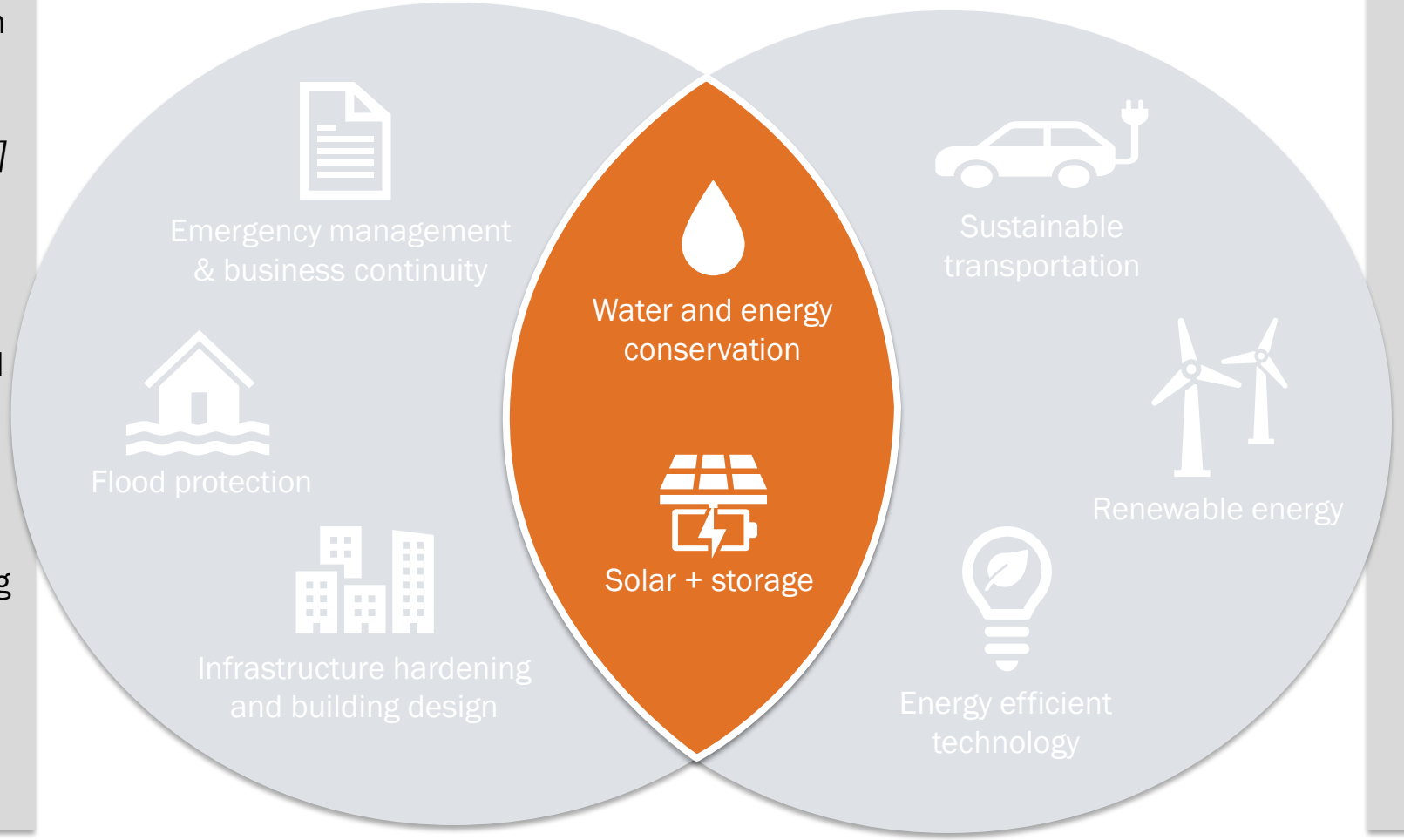

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Importance of considering adaptation and mitigation together

Climate resilience planning requires a holistic approach

- Opportunities and trade-offs in meeting energy and water performance goals, mitigation goals, and climate adaptation goals
- In the example on the right, lower reliability of the electric grid leads to higher risk associated with the geothermal heat pump (GHP) solution relative to the initial natural gas heating system
- Consider resilience implications in development of climate mitigation solutions to avoid increasing risk

Example of the effect of electrification on risk using the TRN risk assessment methodology

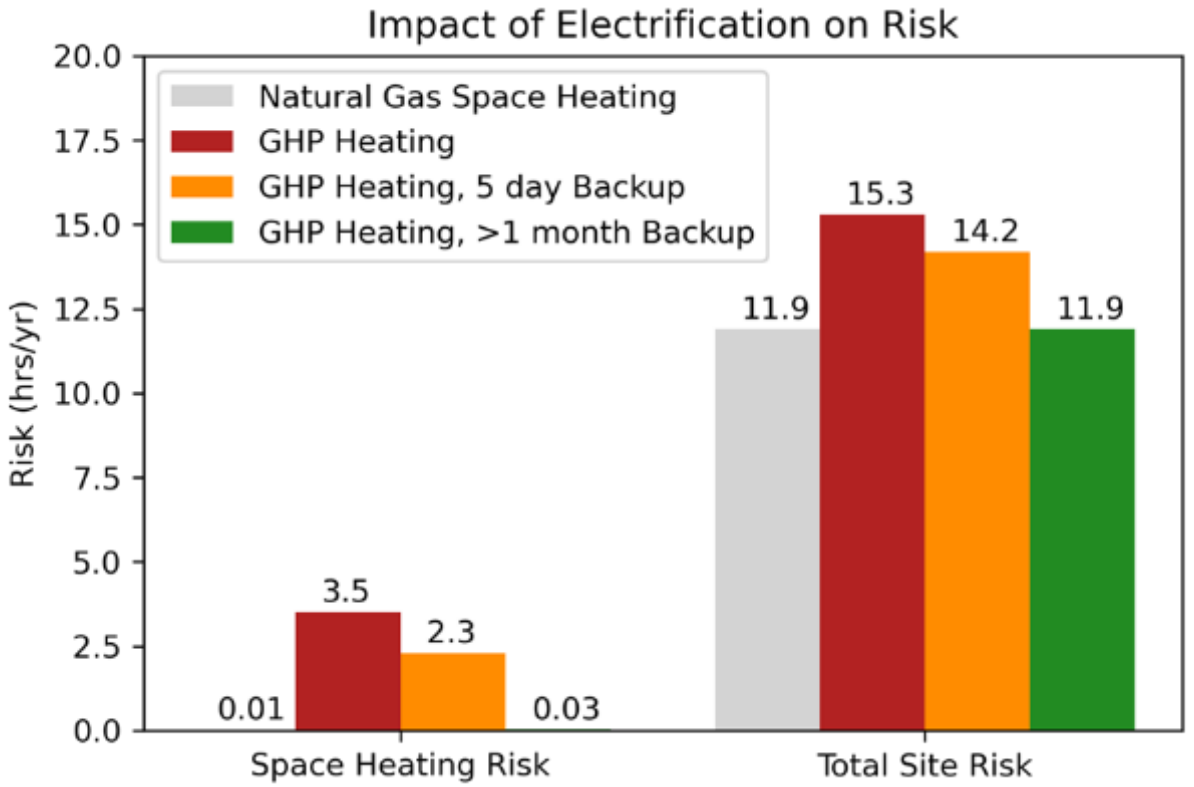


Figure Source: Elliot, D.B., H.S. Rabinowitz, A. Delgado, and J. Rotondo. 2022. "Decarbonization in Climate Resilience Planning." In 2022 ACEEE Summer Study on Energy Efficiency in Buildings, August 21-26, 2022, Pacific Grove, CA: American Council for an Energy Efficient Economy. PNNL-SA-176563.

FEMP Resilience Program Offerings

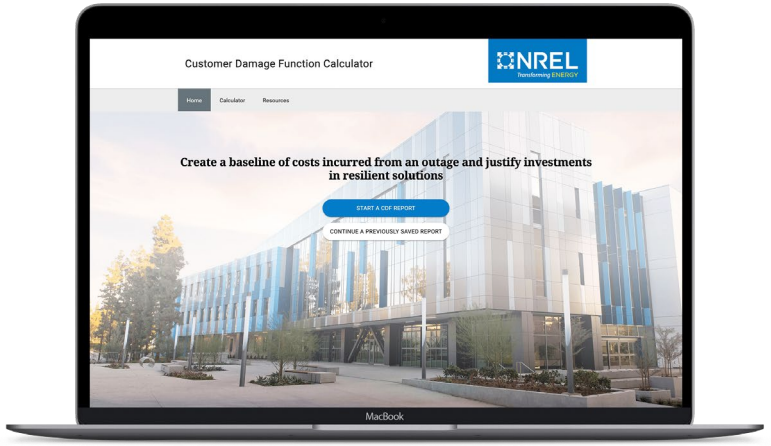
Resilience Planning

- Agency agnostic tools and resources to guide stakeholders through the process of assessing and implementing projects that enhance site resilience

https://trn.pnnl.gov/

Resilience Valuation

- Tools and frameworks to help stakeholders better quantify the benefits from resilience projects or measures



https://cdfc.nrel.gov/

TRN Toolkit

Tools to support resilience planning can be used outside of a TRN framework.

TRN Toolkit includes:

- Climate Change Resources
- Identify Potential Hazards
- Generator Runtime Calculator
- Water Supply Runtime Calculator

https://trn.pnnl.gov/toolkit

Find Out More – Visit TRN Today

- View TRN action text
- Check out FAQs
- Create & verify account
- Take TRN Accredited Training
- Explore Identify Potential Hazards Tool

TRN
TECHNICAL RESILIENCE NAVIGATOR

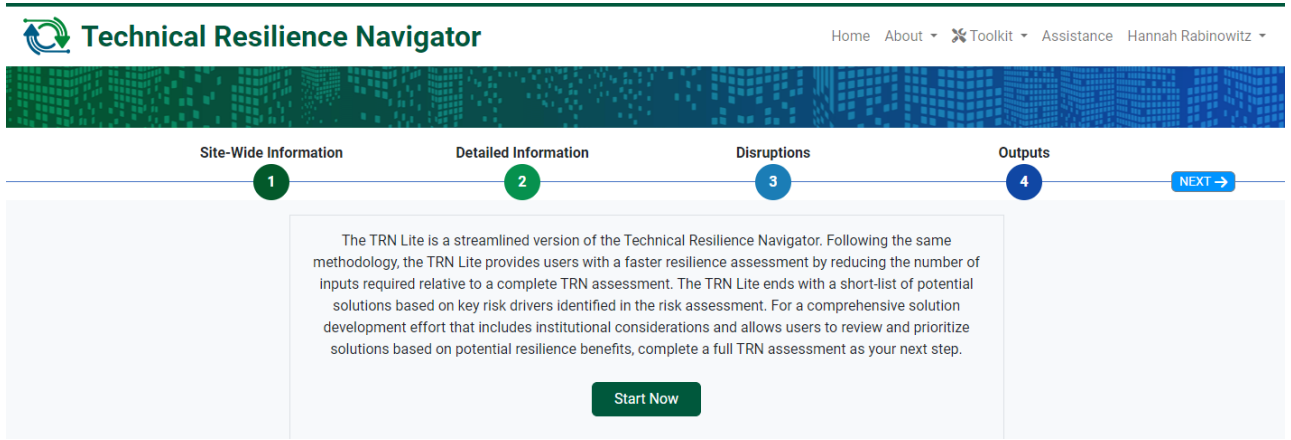
Visit: https://trn.pnnl.gov/

Join us next month for the interactive TRN Lite training!

Learn how you can use FEMP's new, streamlined version of the TRN, to kickstart resilience planning efforts at your site!

Key features:

- Streamlined inputs
- Quick identification of risk drivers
- Auto-generated solutions for reducing risk and improving resilience
- Expanded data visualizations



Tuesday, August 15th at 1:30pm ET

Register today:
https://wbdg.org/continuing-education/femp-courses/femplw08152023

FEMP 50 – A Celebration of Federal Energy Management

- Celebrate 50 years of Federal Energy Management with a week of accredited training, collaborating, and celebrating success!
- Training sessions focus on FEMP successes, current programs, historic retrospective
- Registration will be required and limited for in person

Tuesday September 12	
9:30 – 10:45 AM	Welcome (In-person & Virtual)
11:00 – 12:00 PM	Tools and Resources to Meet Agency Goals (In-person & Virtual)
12:00 – 12:30 PM	Break
12:30 – 2:00 PM	Concurrent Workshops & Meet-Ups
2:30 – 4:00 PM	Advancing Federal Energy and Water in a Changing Climate (Virtual)
5:00 – 7:00 PM	No Host Networking
Wednesday September 13 (Virtual)	
10:00 – 11:30 PM	Decarbonization, Electrification, and CFE
11:30 – 12:30 PM	Break
12:30 – 2:00 PM	Concurrent Workshops & Meet-Ups (In-person)
2:30 – 3:30 PM	Building Design, Data, and Performance
3:30 – 4:30 PM	Utility Engagement & Performance Contracting for Decarbonization and CFE Goals
5:00 – 7:00 PM	No Host Networking
Thursday September 14	
10:00 – 12:00 PM	Leadership Remarks & FEDS Spotlight
12:00 – 1:00 PM	DOE Atrium Reception

September 12 – 14, 2023, Washington, D.C. and Virtual

Energy Exchange℠

March 26 - 28 2024
Pittsburgh, Pennsylvania

At Energy Exchange 2024, you will:

- Hear federal leadership's key priorities and insightful solutions
- Attend agency-driven trainings to understand and address dynamic and growing challenges
- Collaborate with peers and agencies during dedicated networking opportunities
- Explore new and innovative technologies from industry experts at the Trade Show

Registration opens soon!

For more information, visit
Energy-Exchange.com

Questions?