

# *Impacts of Extreme Weather Events on Electricity Grid Resilience*



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# EPRI

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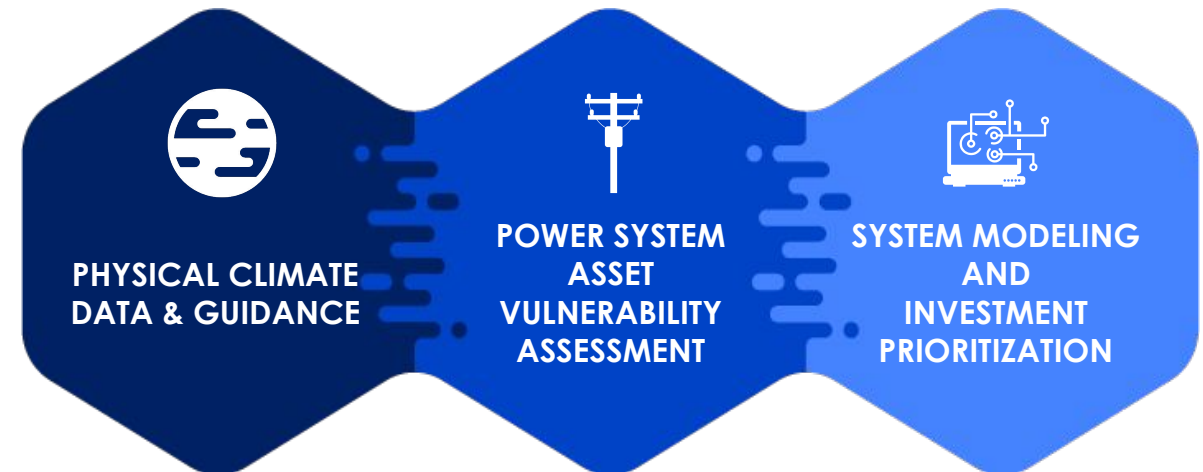
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# EPRI Climate Resilience and Adaptation Initiative (**READi**)

- **COMPREHENSIVE:** Develop a *Common Framework* addressing the entirety of the power system, planning through operations
- **CONSISTENT:** Provide an informed approach to climate risk assessment and strategic resilience planning that can be replicated
- **COLLABORATIVE:** Drive stakeholder alignment on adaptation strategies for efficient and effective investment



## Final Product: A Common Framework

- Climate data assessment and application guidance
- Vulnerability assessment
- Risk mitigation investment
- Hardening technologies

• Adaptation strategies

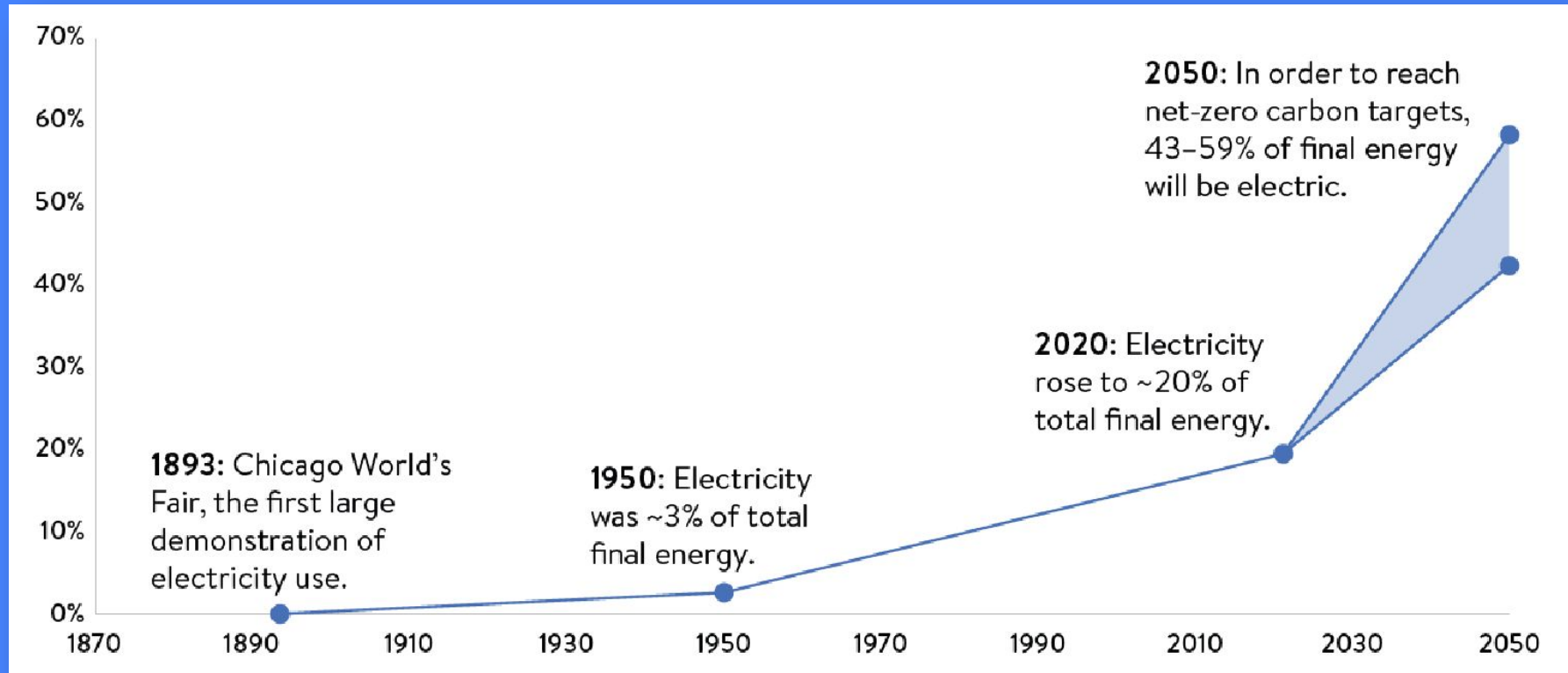
Access all results,  
story maps, and the  
framework at:

[epri.com/readi](http://epri.com/readi)



# A Growing Dependency on Electricity as Final Energy

Electricity as a fraction of total energy consumption in the U.S.



Source: EPRI, "LCRI Net-Zero 2050," 2022: <https://lcric-netzero.epri.com/>

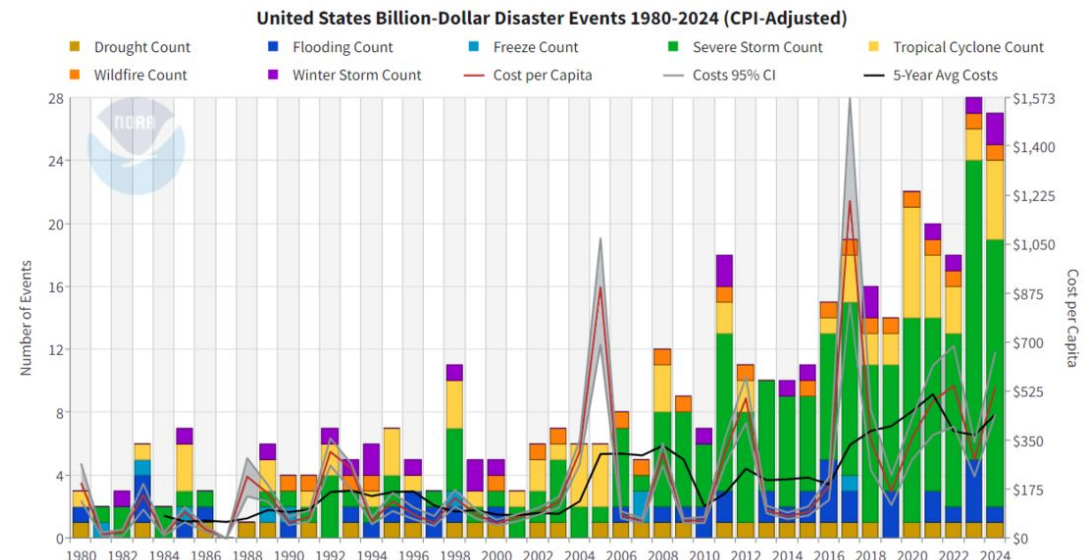
## The Power System of the Future will be both more Weather Dependent & Operating in a Changing Climate



# The Costs of Extreme Events

Billion-dollar disasters are growing in cost and increasing in frequency

Without informed and timely adaptation, costs from climate disasters are likely to increase.



Billion-dollar disaster events in the U.S. from 1980 through 2024.  
Source: [NOAA](https://www.noaa.gov)

Canadian Insured Catastrophic Losses-  
2022 Source: *Insurance Bureau of Canada, 2023*

# Potential energy system impacts from extreme weather and climate change



## Energy Demand

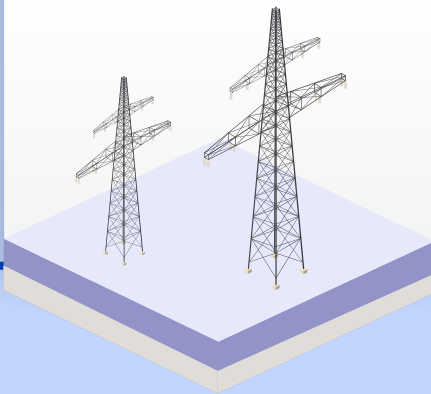
Extreme temperatures increase electricity and fuel demands beyond capacity



## Electric Grid

Wind, ice, floods and wildfires damage power lines and other infrastructure

Extreme heat decreases transmission/distribution capacity

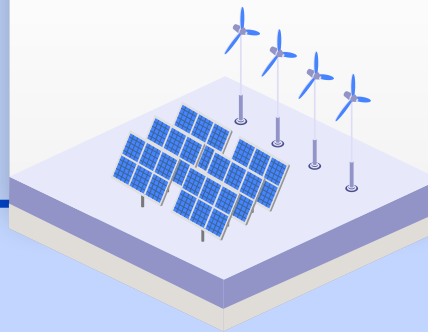


## Wind, Solar, Hydropower, and Geothermal

Extreme weather damages on and offshore facilities

Cloudy or stagnant conditions reduce solar and wind production

Drought limits water-intensive geothermal and hydro production

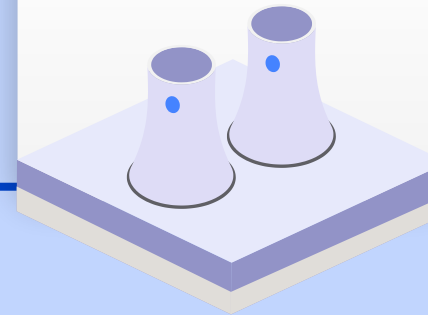


## Thermoelectric Power

Flooding damages facilities and disrupts operations

Higher air and water temperatures decrease power plant efficiency and limit cooling water discharges

Limit ed cooling water availability reduces production and siting of new plants



## Oil, Gas, and Coal

Extreme winds damage on and offshore platforms

Flooding damages production and storage facilities

Drought and severe storms constrain drilling, refining, fracking, mining and transport

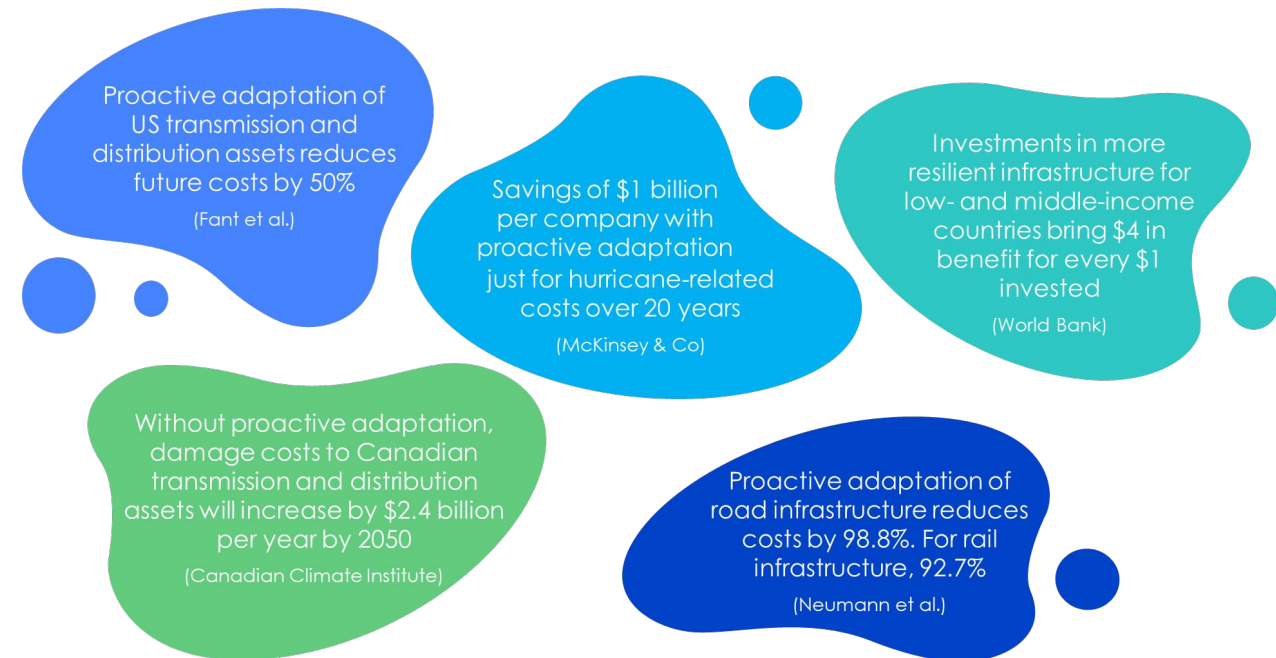


Climate change impacts all aspects of the energy system

# Cost and Benefits of Proactive Climate Adaptation in the Electric Sector



- Outlines and quantifies the benefits of proactively implementing climate adaptation strategies
- Explores costs of recent disasters and recovery, and comparisons to proactive hardening costs



Proactive adaptation is consistently less expensive than respond & repair

# Grid Impacts – Extreme Heat

Asset Class	Vulnerability	Consequence	Adaptation?
BESS	Reduction in service life of batteries	Accelerated aging	None
Overhead Lines	Sagging	Outage; fire danger	Low-sag lines
Overhead Lines	Overutilization	Accelerated aging	Reconductor, re-tension
Transformers	Increase transformer loading	Derate	Additional capacity, NBS
Metal Assets	Higher Corrosion	Accelerated aging	Less corrosive materials, coating

**Both acute and chronic heat increase risk of outage and shorten asset lifetime**



# Grid Impacts – High Precipitation, Flooding, Typhoons

Asset Class	Vulnerability	Consequence	Adaptation?
DERs	Equipment damage; electrical failure	Damage, outage	Proper siting
T&D Assets	Pole instability	Damage, outage	Stormwater management techniques; gabions
T&D Assets	Erosion leading to falling trees	Damage, outage	
Substations	Inundation	Damage, outage	Elevation, stormwater control
T&D Assets	High winds down lines	Damage, outage	Vegetation management

Increased extreme weather increases likelihood of physical damage

# Where Do We Begin?

## 01 Data Is Critical

- Having access to robust climate data – in a format relevant for power system analysis – is essential
- Gathering and sharing asset/system specific data is a challenge
- It's important for power system engineers and climate scientists to be able to speak the same

## 02 You're Only as Strong As Your Neighbor

- *Integrated* planning requires *integration*, coordination, and shared assumptions
- Integration happens within a utility, across multiple utilities, across sectors, and across regions
- Study scoping, communication, and coordination are critical

## 03 Prioritization is a Pivotal Challenge

- We have the adaptation strategies needed available to us today
- Cost-benefit and multi-criteria decision-making can aid justification and selection
- Benefits remain a challenge to quantify and inform investment decisions

## 04 Uncertainties Should Not Limit Action

- Robust and flexible decisions can be made despite uncertainty
- Uncertainties about climate and impacts are important to communicate
- We needed a 'Gold Standard' for risk assessment because we can't gold plate the power system



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# Climate READi Compass:

## Navigating Physical Climate Risk Assessments for the Electric Power Sector

Compass provides practitioners with a single resource for navigating the Climate READi Framework and identifying the elements of the Framework best suited to their current implementation needs.



Access Compass here!

