BLACK & VEATCH

Climate Modeling Considerations for Utilities

Introduction

Climate change is making severe weather events increasingly unpredictable and more costly as they escalate in both frequency and magnitude.

That's why we're turning to climate modeling and other tools to help our utility clients better prepare for their future. This analysis contains three key considerations.

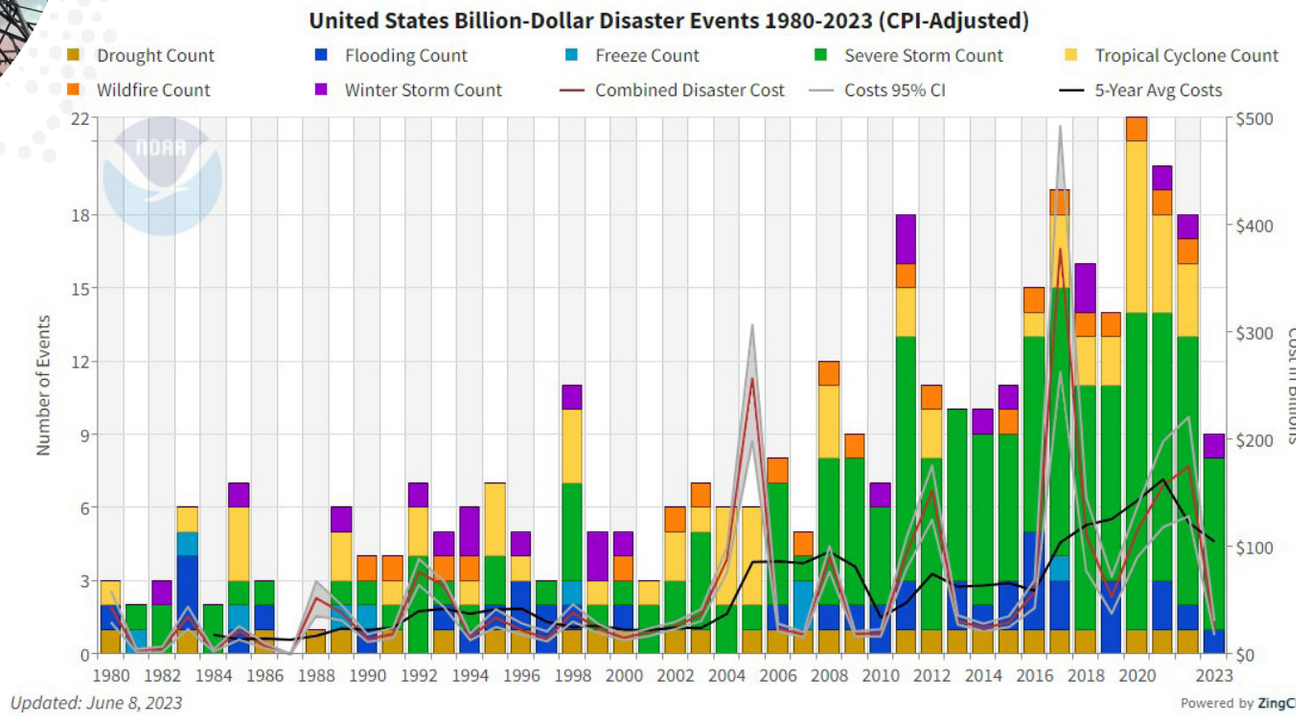
1. Location

2. Past Weather Event History

3. Climate Change Models

The image below shows the (Consumer Price Index-adjusted) billion-dollar disaster storm events in the United States from 1980-2023. The graph demonstrates that while the type and amount of these disasters varies from year to year, the overall trend is a gradual increase. While the graph shows small increases in winter storms, and freeze events; there is a notable increase in droughts, flooding, and wildfires; along with a large increase in severe thunderstorm damage since 1980.

The National Centers for Environmental Information (NCEI) reports that billion-dollar disasters from 2020-2022 totaled more than **$1.4 Trillion**



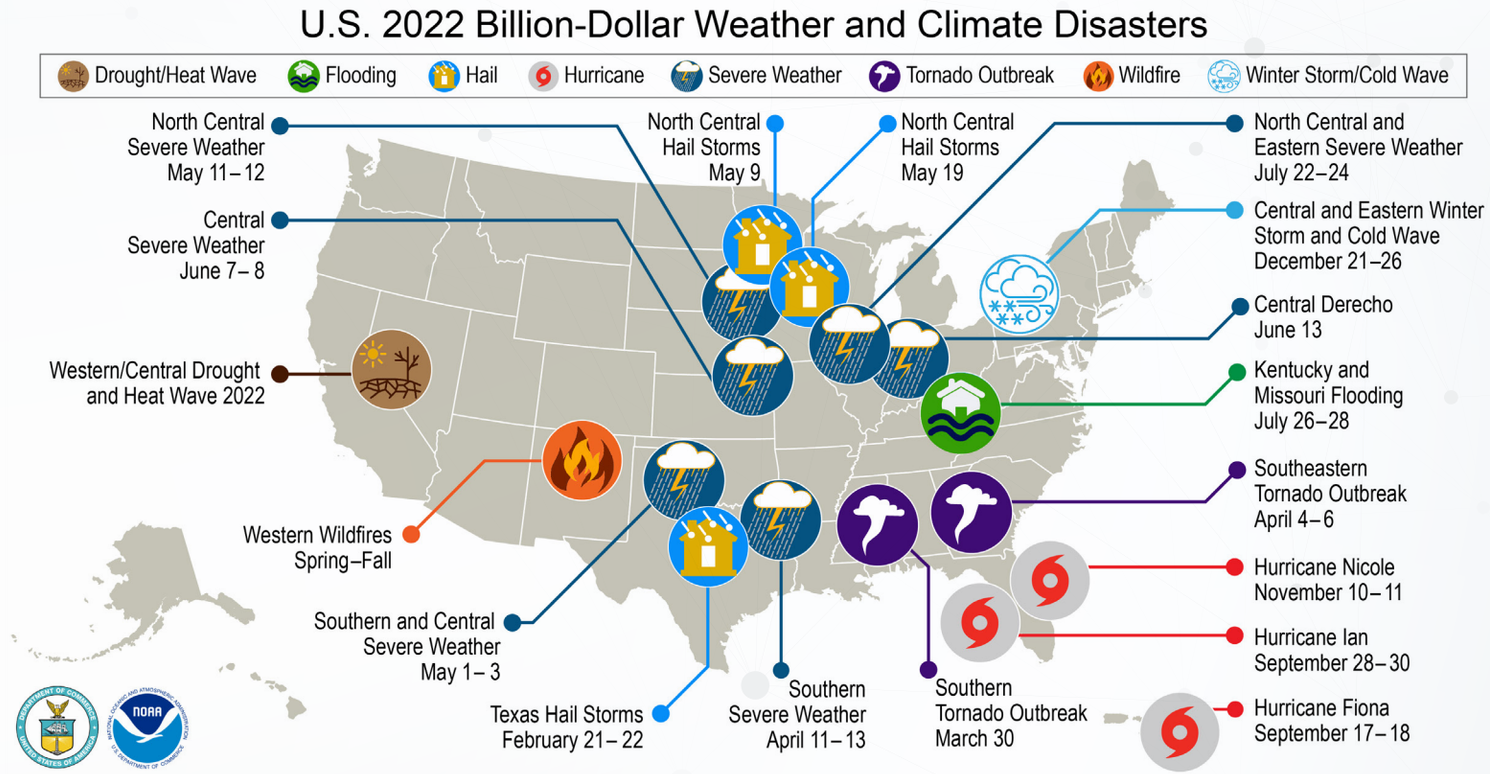
NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2023). https://www.ncei.noaa.gov/access/billions/, DOI: 10.25921/stkw-7w73

Location, Location, Location

The effects of climate change often affect different regions unproportionally and are centered on population centers and agricultural regions. The most important consideration of a climate modeling exercise is to look at the specific location and region of interest. Once that is determined, it is important to focus in as much as possible to get the best picture of the potential future at distinct locations.

The regionality of these disasters can be further broken down by each hazard on both a state-wide and even a county-wide basis. Different areas of the United States have very different profiles when it comes to disaster vulnerability. An analysis of the past five years reveals several key trends:

- **Increasing hailstorms, tornadoes, floods, and thunderstorm damage** have been occurring across the Central United States. Areas in the Central region can expect more widespread flooding during flood events along with increased heat and severe drought. Higher wind speeds and damaging hail are also likely to increase when storms occur.
- **Wildfires, drought, and flooding** have dominated the Western United States. Periods of severe drought are likely to become more common due to increased temperatures. Winter floods along with wildfire threat in the summer and early fall are also likely to increase some.
- **Cold outbreaks, thunderstorms, and flooding** have been the primary weather disasters in the Ohio Valley and Northeastern United States. Flooding is expected to increase in the Ohio Valley and Northeastern United States.
- **Hurricanes, tornadoes, and thunderstorms** have caused most of the damage in the Southeastern United States. The last couple of decades have featured an increase in winter and early spring tornadoes in the Southeastern United States. Climate change is likely to support this trend along with the potential for more devastating hurricanes.

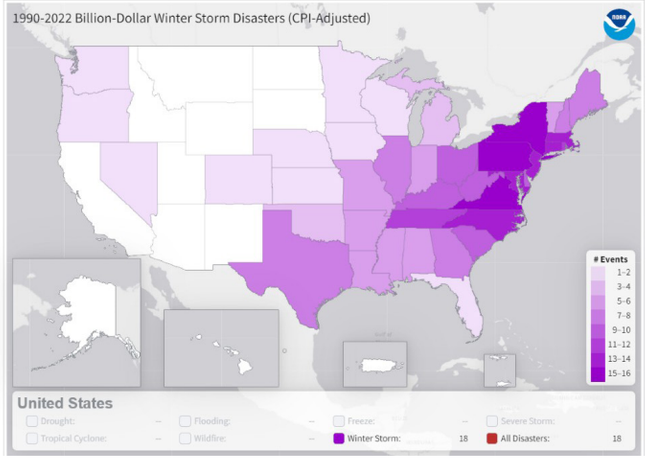


*This map denotes the approximate location for each of the **18 separate billion-dollar weather and climate disasters that impacted the United States in 2022.***

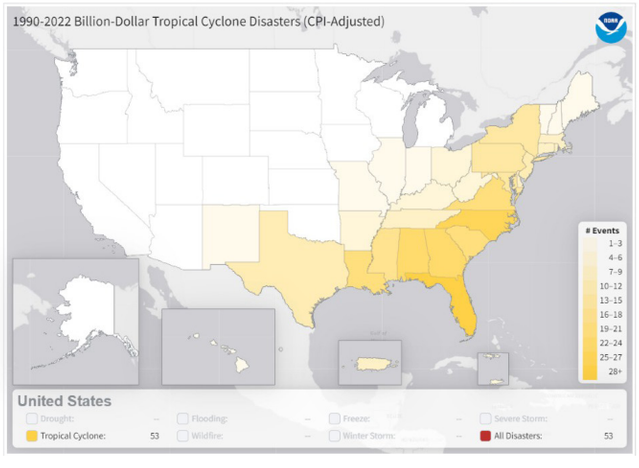
NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2023). https://www.ncei.noaa.gov/access/billions/, DOI: 10.25921/stkw-7w73

Past Weather Event Trends and Images

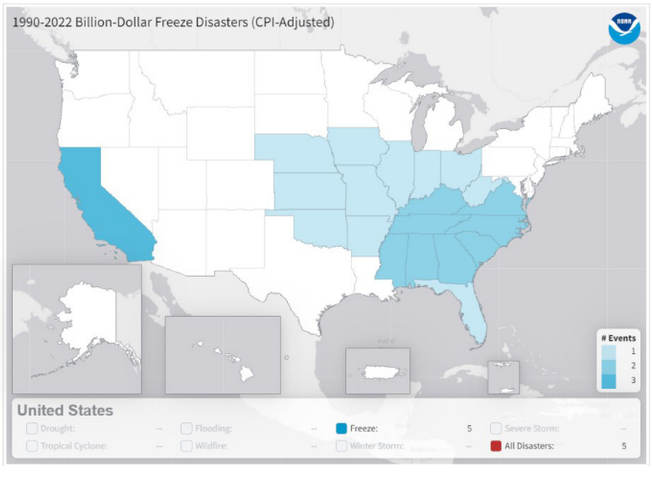
It’s important to look at historic weather events by category, on both a national and regional basis. Analyzing weather damage over a fixed time period by event type helps build the picture of what is most relevant for your region. Not all will be relevant for your area, but there are several to consider. The images on this page depict billion-dollar disasters on a state-wide basis from 1990-2022 and are provided by the National Centers for Environmental Information (NCEI) and the National Oceanic and Atmospheric Administration (NOAA).



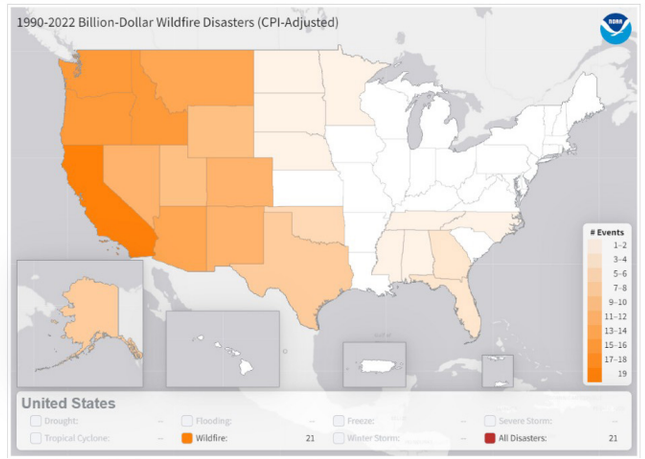
Winter Storms: As seen previously, higher population areas tend to be more susceptible to higher damage costs. This can be seen in the Central and Eastern United States damage from winter storms.



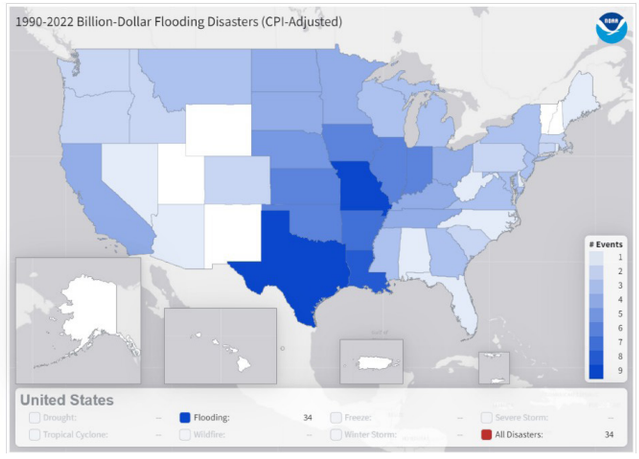
Tropical Cyclones: As expected, these area are mainly confined to areas near the gulf and East Coast, however damage can and does spread into areas along and east of the Mississippi River in the Midwest sections of the United States.



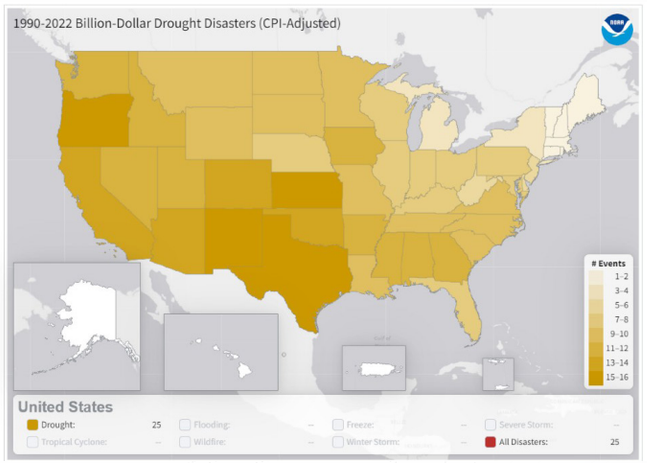
Freeze Events: Freeze events of this magnitude are associated with agriculture, which is why this large impact area is confined to California, the Midwest, and the Southeastern United States.



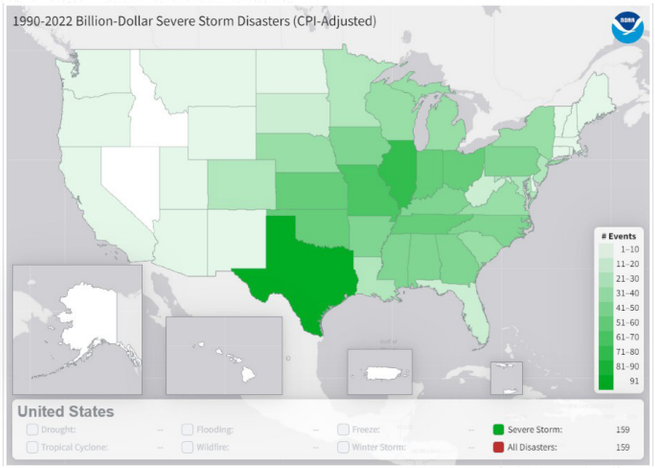
Wildfires: Unlike winter storms, the majority of these areas are located in the western half of the United States, with another area located in the Southeastern United States.



Flooding Events: Flooding events occur at different times of the year in the United States. Flooding along the West Coast is primarily attributed to large scale storm systems in the wintertime and early spring. However flooding events in the Midwest and Eastern United States are associated with spring-time snow melt combined with heavy larger scale rain events. Flooding can also occur in the Central and Eastern United States in the summertime when repeated complexes of thunderstorms can occur (these are associated with stalled frontal systems).



Droughts: Droughts can occur anywhere in the United States and are attributed to large scale weather patterns. Droughts can stress infrastructure, animal farming and agriculture. The greatest effect from drought often occurs in the summer and early fall period when agriculture and animal farming use high amounts ground water. The Southern and Western United States have been the most susceptible areas for drought.



Severe Storms: The majority of these events are in the Central and Eastern United States. This is due to the availability of moisture from the Gulf of Mexico, which helps to fuel large storm complexes.

Future Climate Predictions

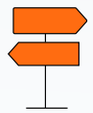
Climate models can be both global and regional, and different climate models are also based on predicted emission levels.

Global - The Coupled Model Intercomparison Project (CMIP6) is the latest Global Climate Model. The CMIP6 is a culmination of multiple global climate models that includes the Shared Socioeconomic Pathways (SSPs).

SPPs have five subsets based on societal choices that will affect greenhouse gas emissions through the year 2100.

SSP1 - Taking the Green Road – *(A world of sustainability-focused growth and equality.)* Everyone works together to shift gradually but quickly toward a more sustainable path.

SSP2 - Middle of the Road – *(A world where trends follow historical patterns.)* Historical patterns are followed to a path in which social, economic, and technological trends do not shift markedly.



SSP3 - A Rocky Road – *(A fragmented world of resurgent nationalism.)* Concerns about competitiveness, security, and regional conflicts lead to a slow transition to green energy.

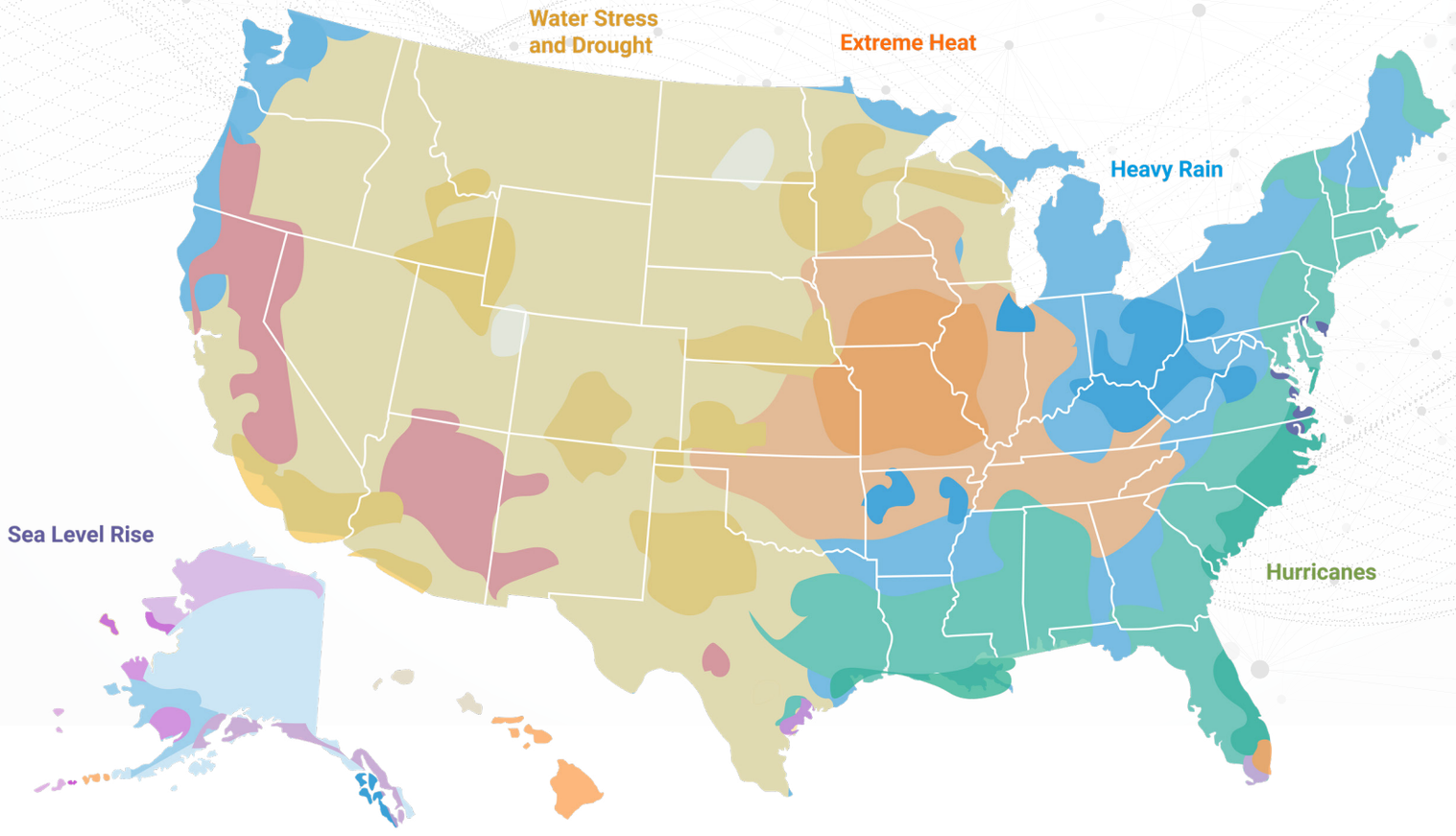
SSP4 - A Road Divided – (*A world of ever-increasing inequality.)* High unequal values in human capital, combined with increasing disparities in economic opportunity and political power lead to increasing inequalities and stratification both across and within countries leading to a continued increase in emissions.

SPP5 - Fossil-fueled Development – (*A world of rapid and unconstrained growth in economic output and energy use.)* Competitive markets, innovation, and participatory societies produce rapid technological progress and development of human capital as the path to sustainable development. This will lead to a continued increase on the reliance of fossil-fuels.

Regional Climate Models - These (CORDEX) models take the larger global climate models and break them down into a much smaller grid spacing - instead of hundreds of kilometers the spacing is reduced to 50 X 50-kilometers, or even 12 X 12-kilometers in some aspects of resolution. This leads to a better breakdown of climate change in smaller regions and areas.

Climate Modeling at a Glance:

Here is a simplified summary map of the most significant climate concerns by region, as well as a list of key acronyms to know when reviewing climate models.



Key acronyms to know:

- **IPCC** - Intergovernmental Panel on Climate Change
- **GCM** - Global Climate Models, which are a culmination of 100's of climate models
- **SSPs** - Shared Socioeconomic Pathways - Reflect projected global changes that feed the CMIP6 climate model. SSPs examine how global society, demographics and economics may change in the future.
- **CMIP6** - Coupled Model Intercomparison Project (CMIP6-latest) Consists of 100 distinct global climate models. The CMIP models are created with a resolution that averages just over 100 X 200-kilometers
- **CORDEX** - Coordinated Regional Downscaling to between 50 X 50-kilometers and 12 X 12-kilometers of resolution

How Can This Climate Modeling and Analysis Be Used?

Practical results to help utilities prepare for their future.

Climate science will continue to be phased into both the planning and maintenance of infrastructure. By utilizing it to its fullest, utilities can prepare budgets that will help them to successfully prepare for and recover from the storms they will weather. These potential uses include:

1. To determine Storm Budget Reserves. The storm budget reserves are based on historical storm spending with expected effect of climate change added to the historical storm reserve. The future storm reserve would then be bounded by the different SSP's to help show the upper and lower bounds associated with the storm reserve budget.

2. To decide what steps to take to approach climate change in your region. Climate modeling can be used to prioritize storm hardening. The goal is to minimize future damage and outages that may arise due to climate change. Some examples include:

a. Storm hardening of substations and transmission lines from stronger hurricanes and high winds

b. Flood mitigation to combat a higher frequency of severe flooding events

c. Protection from wildfires as well as mitigation of potential wildfires caused from sparking power lines

Below are some examples of work Black & Veatch has done for our clients.

Utility client in the Southeastern United States:

Client wanted to calculate a storm reserve on a yearly basis for 30 years, based on historical storm damage, inflation, and climate change. We helped them determine this number, considering the following factors:

- Tropical activity was the main cause of damage to the grid, based on 70 years of activity. Climate change was evaluated using the CMIP global and CORDEX regional climate models.
- Winter storms, thunderstorms, wind events were also evaluated historically, but had a smaller impact.
- The Consumer Price Index was used to adjust values.

Utility client in Southeastern Asia:

Client wanted to gauge the effects of climate change on three charging stations in various locations in the country over the stations' 30-year lifespan. Black & Veatch:

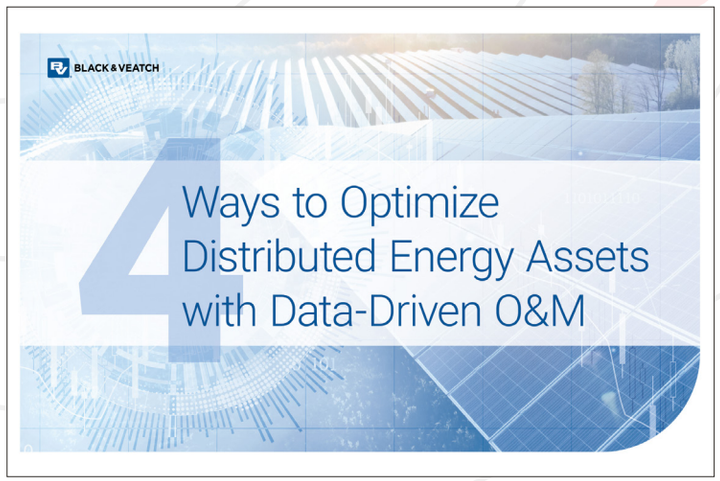
- Used secondary vendor information to evaluate the effects of heat, river flooding, heavy localized rain flooding, sea level rise, high wind, and soil subsidence on the charging stations.
- Created a report based on this information to evaluate the failure and monetary risks on the charging stations.

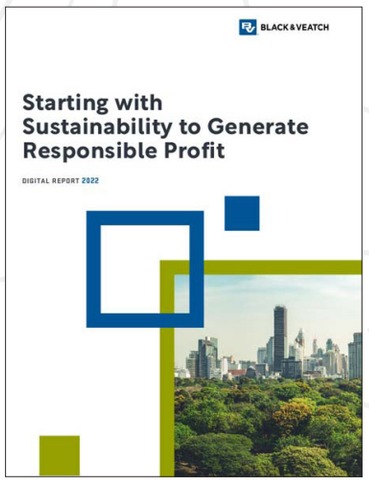
Let’s Talk

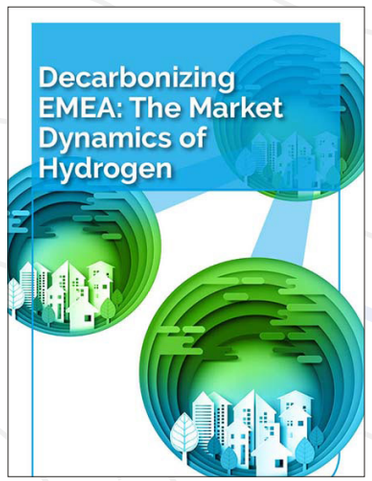
Learn more about Black & Veatch’s climate analysis expertise and connect with us about your reliability goals.

Visit Black & Veatch at bv.com

Read Our Other eBooks to Stay Ahead of the Net-Zero Curve







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