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JUPITER INTELLIGENCE SPECIAL REPORT

# Grids Turn to High-Resolution Climate Analytics as a Strategic Tool for Resiliency Planning

**State-of-the-art Earth and data science enable forward-thinking utilities like Hawaiian Electric to prepare for climate-change-driven extreme weather**

## Executive summary

As climate change causes more frequent and more extreme weather events—storm surges, hurricanes, high winds, prolonged precipitation, extremes of heat and cold, wildfires, and drought—major electric utilities worldwide are collaborating with private industry, academia, and stakeholders (especially their customers) to improve grid resiliency and optimize the safe and reliable delivery of electric energy.

Some have moved ahead of the pack by incorporating state-of-the-art climate science and data analytics into critical investment planning and risk management processes.

> *"The climate is changing so much and so fast that historical weather data does not necessarily reflect new realities."*
>
> *—Utility Dive, April 2020*

Hawaiian Electric is one such visionary utility. It is using data, climate modeling, and analytics from Jupiter Intelligence in its efforts to:

- **Identify climate-vulnerable assets**
- **Develop a targeted, risk-based resilience plan**
- **Harden its infrastructure against weather-related perils**
- **Meet the dynamic needs of its customers,** as well as other stakeholders and regulatory authorities
- **Develop disclosures in line with guidance** set by organizations such as the Sustainability Accounting Standards Board (SASB) and the Task Force on Climate-related Financial Disclosures (TCFD).

This Jupiter Intelligence special report, part one in a series, examines the urgency behind climate resiliency initiatives in the electric utilities industry; the essential role that high-resolution risk modeling, based on novel data sources and best-in-science climate analytics, can play in these efforts; and the noteworthy efforts being undertaken by Hawaiian Electric and other pioneers among utilities.

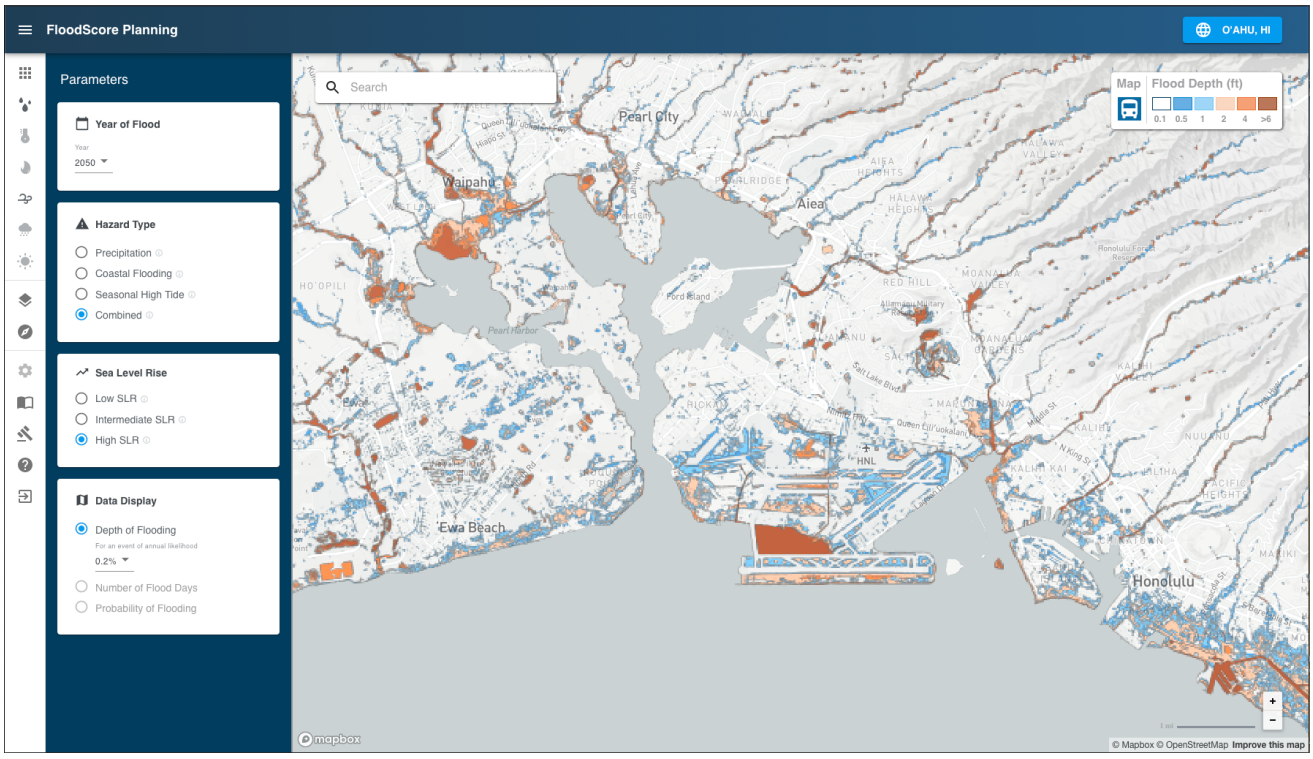


**Figure 1** A Jupiter FloodScore Planning™ model of a potential flood scenario for Oahu's Māmala Bay, near the entrance to Pearl Harbor. Hawaiian Electric's Waiau generation facility lies on the shore of the East Loch, southeast of Pearl City. FloodScore Planning probabilistically predicts long-term flood hazards from six months to 50-plus years in advance, at very high resolutions.

## Grid resiliency: The time to act is now

Climate change is making severe weather events more extreme, frequent, erratic in behavior, and costly. The electric utilities industry is highly vulnerable to the massive impacts of hurricanes, storm surges, high winds, wildfires, prolonged rainfall, and extremes of heat and cold.

That vulnerability is expected to increase over time, and electric utilities are in the crosshairs. The USA's Fourth National Climate Assessment warns:

> *Due to climate change, [the energy system] is projected to be increasingly threatened by more frequent and longer-lasting power outages affecting critical energy infrastructure and creating fuel availability and demand imbalances … [Extreme weather] can interrupt energy generation, damage energy resources and infrastructure, and interfere with fuel production and distribution systems … Extreme weather can damage energy assets—a broad suite of equipment used in the production, generation, transmission, and distribution of energy—and can cause widespread disruption that takes weeks to fully resolve, at sizeable economic cost.*[1]

How costly? The Lawrence Berkeley National Laboratory estimates that extreme weather currently costs electrical utilities US $44 billion in business interruptions each year. For individual utilities, the financial calamities can be catastrophic, and even legendary. California's most devastating recent wildfire, the Camp Fire of 2018—sparked by a PG&E transmission line—drove that utility into bankruptcy proceedings; its settlement entailed PG&E pleading guilty to 84 counts of involuntary manslaughter.[2] PG&E's filing "has widely been called the first climate change bankruptcy," wrote Columbia University's Center for Global Energy Policy in August 2019. "It will likely not be the last, as climate change exacerbates natural disasters…"[3]

Despite this urgent and immediate crisis, "many utilities are not yet ready," wrote McKinsey and Company in April 2019. Thousands of generation facilities, traditionally located on or near shorelines to have ready access to water, are at risk from storms; nine U.S. nuclear power stations are located within two miles (3.2 km) of the ocean.[4] They're also at risk from drought-caused reduced water supplies. Transmission and distribution lines cross millions of square miles of terrain that exposes them to high winds, extreme temperatures, and wildfires. Vulnerable substations, at risk of riverine flooding and protracted and heavy precipitation, dot the landscape.

> *"Extreme weather can damage energy assets…and can cause widespread disruption that takes weeks to fully resolve, at sizeable economic cost."*
>
> *—The Fourth National Climate Assessment*

## The massive cost of doing nothing—or too little

"The cost of extreme weather is already high, and the cost to life and property of extreme weather events has increased in recent years," McKinsey advises. "If such events become more common or intense, as the [National Climate] Assessment predicts, the price will be even higher. Even now, some utilities are making investments in long-lived assets in risky locations, increasing system vulnerability and balance-sheet risk."[5]

> *"Climate risk is investment risk."*
>
> *—Laurence Fink, BlackRock CEO, 2020*

Asset managers have taken notice. BlackRock CEO Laurence Fink wrote in January 2020: "Climate change has become a defining factor in companies' long-term prospects … Investors are asking how they should modify their portfolios. They are seeking to understand both the physical risks associated with climate change, as well as the ways in which climate policy will impact prices, costs, and demand across the entire economy… Climate risk is investment risk."[6]

BlackRock followed that policy statement in July 2020 by revealing that it had identified 244 companies that "are making insufficient progress integrating climate risk into their business models or disclosures. Of these companies, we took voting action against 53, or 22 percent. We have put the remaining 191 companies 'on watch.' Those that do not make significant progress risk [BlackRock's] voting action against management in 2021."[7]

For many utilities, the existential threat represented by climate change has given new impetus to adaptation and grid resiliency initiatives to protect assets, systems, and the people, communities, and economies they serve, from extreme weather impacts.

Hawaiian Electric is among the utilities who are taking a proactive approach, kicking off an innovative and interactive Integrated Grid Planning process that's designed to ensure a future of reliable and resilient electric service. In this multifaceted program, Hawaiian Electric engages closely with local stakeholders, including customers, as well as global experts and thought leaders.

Importantly, it is integrating best-in-science climate modeling analysis from Jupiter Intelligence to optimize its grid resiliency planning. Jupiter will help Hawaiian Electric assess risk to its critical infrastructure on a 30-year time horizon at high resolutions—down to the individual asset level—from perils like wind and flooding driven by changing climate conditions. By harnessing AI-enabled climate models and the work of its world-class scientists, Jupiter provides high-resolution projections of flooding and wind risk with unprecedented precision.

## A future climate that doesn't resemble the past

The emergence of services such as Jupiter's are changing the game in resilience planning. The models and scenarios used in the past traditionally relied upon historical data. However, the very essence of climate change—that it is constantly changing, or "non-stationary"—means that historical information cannot be trusted to project the present or future climate and its impact.

A January 2020 Jupiter Intelligence special report on the unsuitability of FEMA flood zone maps[8] for risk management warns that reliance on static, purely historical data can lead to planning assumptions that "grossly underestimate the true frequency and severity of future extreme weather events" and ignore changing climate signals like rising sea levels, increasing prolonged precipitation events, and warming sea surface temperatures—factors that drive the intensity and rate of occurrence of extreme weather.

Citing Jupiter's analysis of the vulnerability of electrical substations in Harris County, Texas, the U.S. House of Representatives Select Committee on the Climate Crisis, in its June 2020 report, noted the hidden risk to critical infrastructure from flooding that may go undetected by reliance on FEMA maps.[9]

In addition, historical data does not account for changes in the terrain and the built environment, a dynamic that can also change constantly; those factors can influence the intensity and behavior of perils like flood, high winds, and fire. Hotter, drier summer weather in traditionally wetter climates, and encroachment of property development into vulnerable geographies, like California's Wildland-Urban Interface, have amplified the devastation and property damage of wildfires.

> *"Managing [climate] risk will require not moving to a 'new normal' but preparing for a world of constant change."*
>
> *—McKinsey & Company, 2020*

There's already ample evidence that "what used to be normal isn't normal anymore." Notably, Houston and surrounding Harris County experienced three "once-every-500-year" floods in just over two years, starting in the late spring of 2015 and culminating in the devastation of August 2017's Hurricane Harvey.[10] Damage and economic losses from California wildfires from 2017 through 2019 exceeded $550 billion by some estimates.[11]

"The climate is changing so much and so fast that historical weather data does not necessarily reflect new realities," wrote Utility Dive in April 2020.[12]

As McKinsey put it, in a breakthrough January 2020 report Climate Risk and Response: Physical Hazards and Socioeconomic Impacts, "Managing [climate] risk will require not moving to a 'new normal' but preparing for a world of constant change…decision-making based on experience may no longer be reliable."[13]

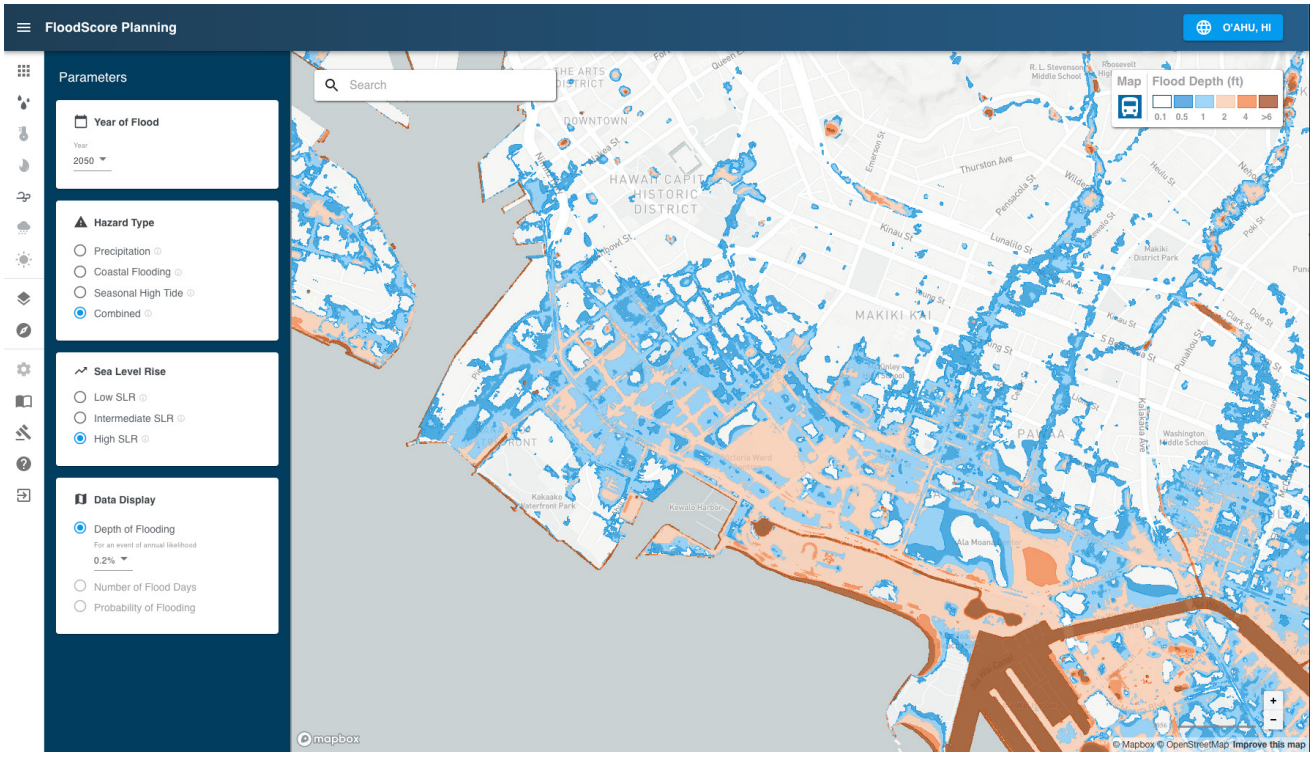


**Figure 2** A FloodScore Planning model of a 0.2% likelihood event flood in Honolulu in 2050 at street-level resolution. Jupiter services like FloodScore can model impacts at a resolution of three meters, and—in some cases—as fine as one meter.

## Toward forward-focused, high-resolution climate risk analysis

To meet this challenge, climate and data scientists have developed methodologies and forward-focused climate models built upon the principle of non-stationarity. Projections are based on rigorous climate, weather, ocean, hydrological, fire, and data science; they utilize novel data sources like satellite, air, land, and ocean-borne sensors and large-scale climate models that simulate Earth's past, present and future climate states.

Jupiter, for example, uses the Community Earth System Model (CESM)® from the National Center for Atmospheric Research (NCAR), a premier global climate model that has been tested and validated by thousands of peer reviews and re-analyses. Through a computationally intensive process powered by cloud computing and artificial intelligence, Jupiter dynamically down-scales the global model to project the probable impacts of extreme weather perils on specific assets down to resolutions of three meters—in some cases, one meter—over time horizons that range from hours to 50 years into the future.

High-resolution climate risk analysis, and the insights it delivers at the asset level, enables utilities to better identify the need, location, and timing of climate resilience investments. It can also be used for operations, regulatory, and community engagement purposes as part of a comprehensive Integrated Grid Planning process.

## High-resolution modeling in resilience planning: current use cases

Multiple global initiatives are underway that would strengthen grids against climate-related weather perils, and the incorporation of next-generation climate risk analytics into these plans features in many examples.

Regulatory pressures are one driver. In July 2020, the California Public Utilities Commission proposed that utilities incorporate "the best available climate science into utility infrastructure and operational planning to provide resilient and reliable service to all customers." The regulation is designed to strengthen the state's electric grid against a range of perils—"wildfires, extreme heat, extreme storms, drought, subsidence, and sea-level rise, among other climate change phenomena."[14] It would compel utilities to submit climate-vulnerability reports and mitigation plans to the CPUC every four years as part of their rate case cycles.[15]

Rather than reacting to regulatory pressures, some leading utilities are working proactively to integrate advanced climate analytics into their vulnerability assessments and grid resiliency planning. In addition to Hawaiian Electric—discussed below in detail—these include a dense, metropolitan electrical grid, Con Edison in New York City, and a transmission system operator (TSO), Terna S.p.A., in Italy. All use Jupiter climate analytics services in different ways.

Con Edison released its Climate Change Vulnerability Study in December 2019. The comprehensive report reviewed the utility's current infrastructure, design specifications, and procedures in the event of climate-related weather perils, including flooding and extremes of temperature.

Jupiter helped Con Edison map temperature differences across its complete transformer portfolio. The goals: to optimize its annual infrastructure investment, ensure no loss of capacity over a 30-40 year equipment lifecycle, and minimize maintenance costs. The utility incorporated Jupiter's analysis of the Urban Heat Island (UHI) effect within its service area to determine where variables like terrain characteristics elevate surface and atmospheric temperatures and cause heat-related impacts.

A forward-looking Jupiter analysis also found significant decreases in projected network reliability driven by increases in the frequency and duration of heat waves in the coming decades; it projected that, by 2050, 17 to 43 percent of Con Edison's networks would fail network reliability standards—absent adaptation measures.[16]

Terna manages almost 75,000 km (46,500 miles) of high-voltage transmission lines across Italy. As part of its EU €7.3 billion plan to strengthen and modernize its network, Terna is using the Jupiter WindScore™ service to model the probable impacts of high winds on its overhead power lines and infrastructure, to assess potential damage, meet regulatory requirements, and inform their capital investment strategy.

Hawaiian Electric and its subsidiaries serve 95 percent of the state's 1.4 million residents on the islands of O'ahu, Maui, Hawai'i Island, Lāna'i, and Moloka'i. In 2020, Hawaiian Electric began working with Jupiter to use its FloodScore and WindScore services to harden its infrastructure against flooding and high winds from winter storms and summer and autumn hurricanes—perils that often contribute to sustained electric power interruptions across its service area.

> *"By adding Jupiter's climate risk analytics into our integrated grid planning process, we are significantly advancing our ability to make better decisions about the need, location, and timing of resilience investments."*
>
> *—Colton Ching, Hawaiian Electric, Senior VP/Planning & Technology*

## Hawaiian Electric: using Jupiter's best-in-science analytics to strengthen infrastructure against flood and wind

Jupiter climate-risk data is integral to the utility's multi-year Integrated Grid Planning efforts. The Jupiter services assess physical climate change risks and, at the asset level and over a 30-year time horizon, are designed to help Hawaiian Electric optimize the resiliency of its generation, transmission, and distribution infrastructure. They will help the utility harden the grid across the five islands that Hawaiian Electric serves.

"We sought more sophisticated data and forecasting tools for long-term planning," says Colton Ching, Hawaiian Electric's senior vice president of planning and technology. "By adding Jupiter's climate risk analytics into our integrated grid planning process, we are significantly advancing our ability to make better decisions about the need, location, and timing of investment to cost effectively provide the level of electric system resilience our customers expect."

In its first phase, Jupiter climate risk data will help Hawaiian Electric prioritize geographic locations and assets that are most at risk. Subsequently, it will provide detailed area analyses of all assets. Potential applications of Jupiter's climate risk analyses include:

- **Prioritizing transmission and distribution system hardening.** Hawaiian Electric can use the asset-level analysis of WindScore Planning to determine the specific components of their transmission and distribution infrastructure that are at greatest risk of failure from wind load and decide which structures and poles should be replaced or reinforced first.
- **Optimizing placement of new generation sites.** Hawaiian Electric is using FloodScore Planning to determine flood-prone exclusion zones, areas to avoid when locating new generating sites such as solar panel arrays.
- **Prioritizing resources such as flood warning systems.** Hawaiian Electric is using FloodScore Planning to identify the substations that would benefit from flood-warning equipment and rank them by priority.
- **Optimizing mitigation strategies.** By modeling flood scenarios, FloodScore Planning can help Hawaiian Electric simulate impacts of extreme weather and develop more effective defense systems.
- **Estimating potential renewable generation damage.** Using WindScore and FloodScore Planning, Hawaiian Electric can assess risk and potential damage to utility-scale renewables and distributed energy resources such as roof-top solar.

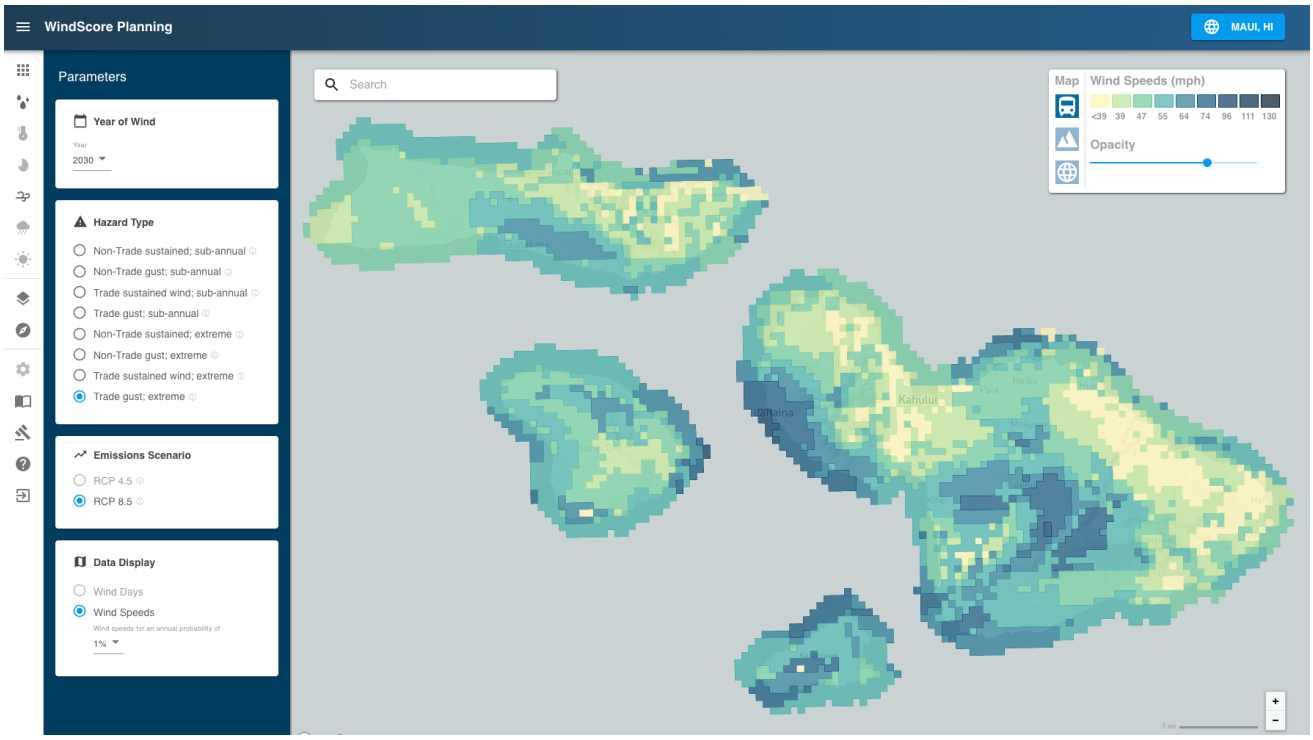


**Figure 3** A Jupiter WindScore™ Planning model of a 1% trade gust event for 2030 (RCP 8.5) impacting the islands of (clockwise from top) Molokaʻi, Maui, Kahoʻolawe, and Lānaʻi. WindScore uses best-in-science climate models and machine learning to deliver quantifiable analyses of changes in wind at very high spatial and temporal resolution—down to the asset level.

- **Prioritizing danger/hazard tree removal.** Using WindScore Planning, Hawaiian Electric can identify the most vulnerable sections of critical circuits to prioritize tree removal efforts.
- **Identifying distribution lateral undergrounding candidates.** Hawaiian Electric can use WindScore Planning to supplement efforts to identify and prioritize distribution laterals (neighborhood power lines) that are most vulnerable to wind and wind-related damage as candidates for targeted undergrounding.

Over the duration of the program, Jupiter will help Hawaiian Electric review the status of thousands of material assets.

The Jupiter services also will deliver insights that will be used for engineering, operations, regulatory, and community engagement. They will enable Hawaiian Electric to meet the dynamic needs of its customers, as well as other stakeholders, and develop disclosures in line with the guidance set by organizations such as SASB and TCFD.

“Hawaiian Electric is a pioneer in planning for climate resilience,” says Rich Sorkin, CEO and co-founder of Jupiter Intelligence. “Jupiter’s mission is to partner with companies and organizations like it to provide asset-level climate risk insights that enable them to prepare for a new and challenging reality.”

## A wave of climate risk management change is coming for utilities

Electrical utilities and risk managers are accustomed to planning for extreme weather events that may occur once every 500 years. However, the changing climate that today impacts the planet and drives our present and future is such a powerful and far-reaching phenomenon, it is a once-in-ten-millennia event. As McKinsey put it, in its breakthrough January 2020 report, "After 10,000 years of relative stability—the full span of human civilization—the Earth's climate is changing."[17]

Jupiter's work with Hawaiian Electric, Con Edison, and Terna are prominent examples of efforts being undertaken worldwide by utilities, universities, and thought leaders in private industry to quantify and mitigate physical climate risk for critical systems like the electric grid. The incorporation of non-stationary, best-in-science climate data and models, such as Jupiter's, is a crucial component of these initiatives.

The next report in this series will examine the ongoing collaboration between Hawaiian Electric and Jupiter and the key ways in which Jupiter climate-risk data is improving its integrated planning processes and informing key decisions.

For more information or to request a demo, please contact request@jupiterintel.com.

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>
> *—Rich Sorkin, Jupiter Intelligence CEO*

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