# FEMP
## Federal Energy Management Program

# Understand the Costs of an Energy or Water Outage with the Customer Damage Function Calculator

The Customer Damage Function (CDF) Calculator is a free, publicly available web tool that helps users estimate the costs incurred at their site due to an electric grid or water service outage. Developed by the National Renewable Energy Laboratory (NREL) with support from the Federal Energy Management Program (FEMP), the tool is designed to help federal facility owners, building energy managers, and resilience planners understand and quantify the value of resilience to justify investments that would prevent or lessen the impact of a disruption.



Figure 1. The Customer Damage Function (CDF) Calculator helps users quantify the costs of a grid outage at their site and estimate the potential value of resilience investments—whether the outage is caused by a storm, a flood, a fire, or other grid damage. *Photo from iStock 1034313518.*

## Value of Resilience

The costs associated with an electric grid outage or water service interruption can range from lost data to spoilage of perishable food, as well as damaged equipment, diminished worker productivity, disruption to critical services, and suspension of output and sales. Information from the CDF Calculator can help facility teams quantify these costs and estimate the potential value of resilience investments. Understanding these values allows sites to conduct cost-benefit analyses for resilience upgrades, provide justifications for enhancing resilience, and inform decision-making based on the cost of inaction.

The CDF Calculator quantifies how costs vary with different outage durations,

which can highlight unique risks a facility faces from power outages and support the optimal type of mitigation strategies to use. For example, a battery system that protects against short-duration outages could provide substantial savings to a facility that experiences most of its outage costs from the initial disruption in power. However, the same battery system may offer little benefit to another facility that is most at risk once an outage exceeds 4 hours, when expensive refrigerated materials begin to spoil.

## How the CDF Calculator Works

Users start by **entering facility data**, including location and type of property, annual electrical load, critical load, and peak demand.

Then users **estimate outage costs** incurred by the facility for power outages of various durations. Outage costs include the following:

- **Fixed costs**, which occur immediately when power is lost and are independent of outage duration (e.g., computer data loss, damage to machinery, or process interruption resulting in failed output).

- **Spoilage costs**, which include food spoilage or steel cooling in a manufacturing process. These costs are distinguished by the fact that once an item spoils, it will not spoil again in later periods.

- **Incremental costs**, which are incurred due to the value of lost opportunities and additional costs resulting from a lack of power which accumulate for each hour the power is out (e.g., lost staff productivity, loss of manufacturing production, backup generator fuel costs, or lost communications).

Finally, users **review CDF results**. The calculator automatically populates results and allows for the adjustment of outage durations and outage frequencies based on the facility location. Calculations are based on average outage costs by time of day and time of year, which reduces the input burden on the user. In addition, calculations are hazard agnostic, meaning they do not depend on the underlying causes of outages.

The CDF Calculator is designed to be used without registering or logging into a user account. Data entered while using the application is not stored on NREL servers, and for the duration of
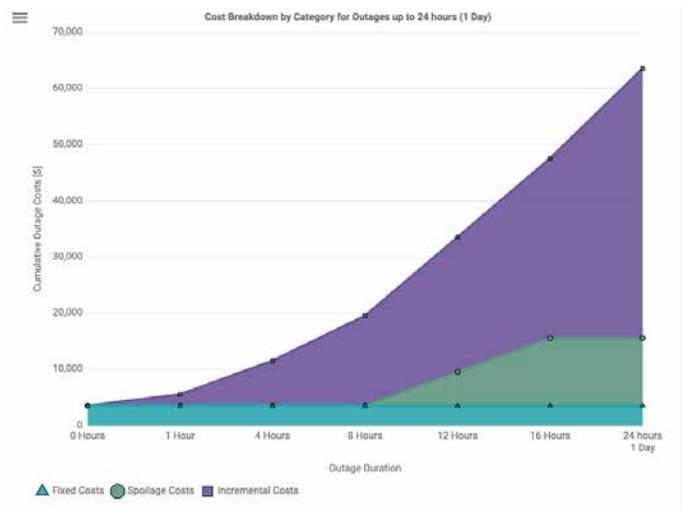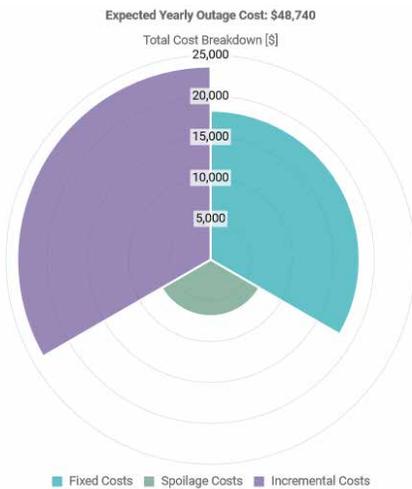
Figure 2. The CDF Calculator estimates expected yearly outage costs for a site, separated into fixed costs, spoilage costs, and incremental costs.



Figure 3. CDF Calculator results include an hourly view of outage costs by category and allows a user to adjust the outage durations and frequencies.

## CDF Calculator Users and Use Cases

The CDF Calculator web tool can be used by:

- Federal agency building owners, government and private sector energy managers, and energy consultants seeking insights into the costs associated with a power or water outage at their site

- Utilities seeking to understand the costs of outages at customer or agency sites

- Insurance industry experts estimating compounded costs of outages over time

- Researchers investigating the economics and benefits of resilience investments.

the session, the browser is encrypted using SSL. Users can download their CDF report as a PDF file or export their outage cost data to their local system and adjust outage inputs again later by loading the saved file into the calculator.

## Applications of the Tool

The CDF Calculator is primarily designed to address federal facility decision support and can also be applied as a screening tool. Using the calculator to illustrate the cost and impact of an outage, agencies can generate monetary values to justify investments in mitigation and resilience solutions that can help prevent or lessen the impact of an outage. The calculator is the first step in determining the potential avoided costs associated with resilience investments. Once a baseline of outage costs is identified, an organization can look to other tools such as REopt®[1] or the Technical Resilience Navigator[2] to further understand the cost of inaction or to build out a distributed energy or microgrid solution.

## Learn More

FEMP develops tools to help federal agencies and other organizations create a baseline of grid outage costs at their site and guide them through the process of assessing and implementing distributed energy projects to enhance site resilience. Learn more about FEMP resilience planning and valuation support at energy.gov/femp/resilience-planning-and-valuation. For questions about FEMP technical assistance, contact Ethan Epstein at Ethan.Epstein@hq.doe.gov.

Use the free, publicly available CDF Calculator web tool to evaluate and understand costs associated with an electric grid or water service outage at your site. Learn more at cdfc.nrel.gov.

Contact the CDF Calculator development team at cdf.calc@nrel.gov.

**For more information, visit:**
energy.gov/femp

DOE/GO-102023-5909 · May 2023