

**WHY CHOOSE
A VACUFUSE®
SELF-RESETTING
INTERRUPTER
FOR YOUR SYSTEM?**



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YOUR UNSOLVED MYSTERY

Every utility deals with blown fuses where the cause of the fault is unknown. Crews may guess at the reason, but often it's just that: a guess.

For the thousands to millions of overhead distribution transformers on your system, **that's one big, unsolved mystery.**

Yet when there's no evidence, that's actually a clue the cause of the fault was temporary. In fact, 70% of overhead distribution transformer fuses incur nuisance operations, where there was no evident cause and no other repair work was needed.

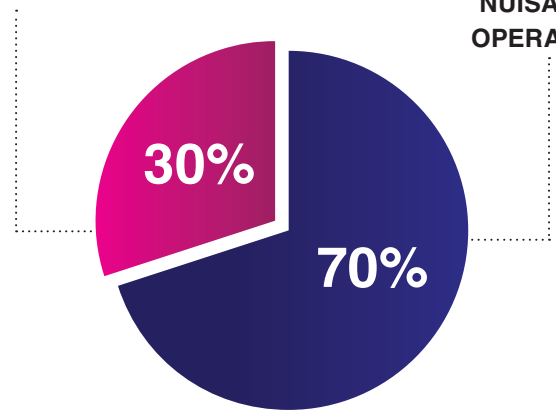
Not only might your crews have stopped their assigned jobs partway through their work, but these overhead distribution transformer fuses are often in remote or difficult-to-access locations, making a simple fuse replacement take hours.

BUT 'NUISANCE' IS AN UNDERSTATEMENT.

While frustrating to crews, it's wasteful to your company. That 70% of nuisance operations equates to 70% of wasted maintenance expenses—and the opportunity cost of crews focusing on reactive re-fusing instead of proactive projects to modernize your system.

REPAIR WORK
NEEDED

NUISANCE
OPERATION



THE RISING INFLUENCE OF CUSTOMER SATISFACTION

When considering system-performance metrics, most utilities think of SAIDI and SAIFI. While these two indices have largely defined the quality of power delivery for decades, a variety of factors, including the growing importance of additional indices, are forcing the industry to take a more well-rounded look at reliability.

One is a rising emphasis on customer satisfaction. Today's utility customers are not satisfied with yesterday's reliability standards. This is largely fueled by increasing customer expectations in a connected and power-dependent society, as well as by a shifting regulatory landscape. Here are a few examples of recent industry trends in the response to improving the customer experience:

UNITED KINGDOM

The United Kingdom's RIIO-1 regulatory framework rewards utilities for meeting the adapting expectations of end-customers.



RIIO-1 **financially incentivizes utilities** to deliver quality customer service, scoring utilities on overall customer satisfaction, complaints-handling, and stakeholder engagement.^①

Results from RIIO-1 show all electricity-distribution utilities met or surpassed mandated customer-satisfaction targets, **averaging 8.9 out of 10** in the customer-satisfaction survey.^②



The U.K. is transitioning toward its second iteration, RIIO-2. Customer value remains a key facet of RIIO-2, as **customers will be given a stronger voice** through internal customer engagement and user groups.^③

CANADA

In 2014, Canadian utilities implemented new criteria to evaluate performance based on a variety of outcomes, including customer satisfaction.



Since this shift in measurement, the top 5 largest utilities in Ontario all reported increased overall customer satisfaction.^④

① Ofgem: *Customer satisfaction with network operators: Electricity distribution (RIIO-ED1)*, March 2019
<https://www.ofgem.gov.uk/data-portal/customer-satisfaction-network-operators-electricity-distribution-riio-ed1>

② Rocky Mountain Institute/AEE: *UK's RIIO – A Performance-Based Framework for Driving Innovation and Delivering Value*

③ Utility Dive: *UK RIIO sets out to demonstrate how a performance-based regulatory model can deliver value*, May 30, 2019
<https://www.utilitydive.com/news/uk-riio-sets-out-to-demonstrate-how-a-performance-based-regulatory-model-ca/555761/>

④ Ontario Energy Board Scorecards

UNITED STATES

In the U.S., 20 states and federal districts have seen recent regulatory developments related to performance-based ratemaking, a 46% increase from the prior year.^⑤

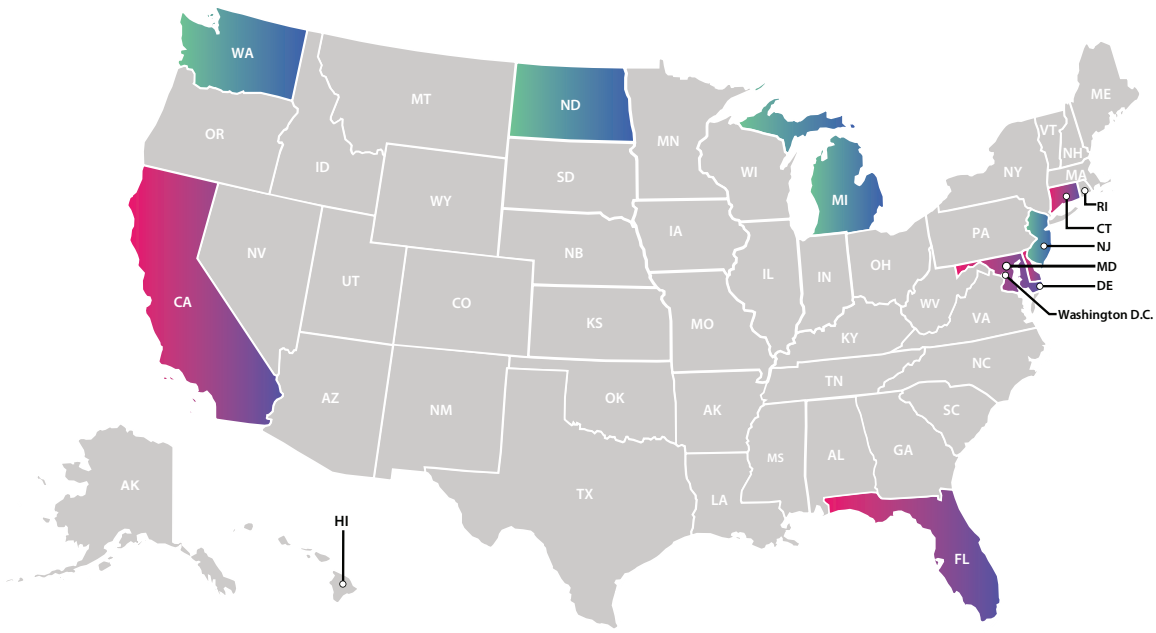
Also, in the U.S., six states and federal districts are now required to report Customers Experiencing Multiple Interruptions (CEMI), a reliability index that focuses on individual customers.

An increase in utility customer satisfaction is associated with an increase in shareholder Return on Equity (ROE), suggesting utilities benefit directly from investing in customer satisfaction improvement programs.^⑥

⑤ Wood Mackenzie: *Regulatory evolution for a future electric grid: State of performance-based ratemaking in the U.S.*, June 2019

⑥ J.D. Power Electric Utility Residential Customer Satisfaction Study, 2001-2014, and Regulatory Research Associates, a division of SNL Energy

U.S. CEMI ADOPTION



■ States that require utilities to track CEMI ■ States with utilities that voluntarily track CEMI



DOES YOUR UTILITY TRACK CUSTOMER-BASED METRICS?

Several utilities in additional states are taking customer-based metric reporting into their own hands, tracking these metrics even though it is not required by regulators.

CUSTOMER SATISFACTION INSPIRING UTILITY ACTION

Regardless of whether utilities have formal metrics around customer satisfaction or more casual, internalized priorities, utilities are paying attention to their customers' needs and opinions in various ways:

CUSTOMERS EXPERIENCING MULTIPLE INTERRUPTIONS (CEMI)

CEMI is an index that tallies whether individual customers have experienced multiple interruptions within a 12-month period. Often CEMI includes a threshold for below-average experiences (e.g., CEMI-5 indicates customers that have experienced 5 or more interruptions a year).

QUESTIONS TO CONSIDER:

- Do your regulators require you to measure customer satisfaction?
- Are you aware of regulatory changes that may soon be on the horizon?
- Do you have less formalized ways to track the same issue?

TROUBLESOME SPOTS

Often issues on the grid tend to bubble up into troublesome pockets—despite best efforts to resolve them. This is often evidence of nuisance outages where causes can't be found or because solutions you've already attempted only address one potential cause (e.g., animal guards can't combat lightning surges).

QUESTIONS TO CONSIDER:

- Are there locations on your system that crews need to routinely visit?
- How much money have you wasted in repeat truck rolls?
- Are your arresters and animal guards solving 100% of your problems?

VOCAL CUSTOMERS

With a growing dependency on power, customers have become less tolerant of outages. You likely have some customers who won't hesitate to call and complain or blast you on social media. Additionally, crews who need to fix issues at the grid edge often must go into customers' yards, so if these customers are unhappy, crews deal with these complaints face to face.

QUESTIONS TO CONSIDER:

- How inundated is your call center with complaints?
- How often do you fear or experience highly public backlash on social media?
- How often are your crews left to handle complaints face to face with customers while they're trying to do their job?



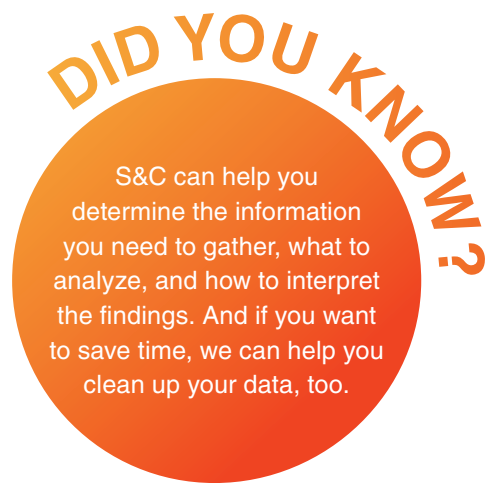
WHAT DOES THIS MEAN FOR UTILITIES?

Whether to follow mandates, to quiet criticism, or to mitigate repeated truck rolls to the same areas, utilities must take customer satisfaction into account. While utilities often take a systemwide look at improving performance, addressing customer satisfaction may be a matter of looking at critical or troublesome spots on the grid.

INVESTIGATING YOUR DATA

Utilities are known for conducting thorough due diligence before implementing change. They perform study after study and test after test, and they dig through their own system and outage data to corroborate their decisions.

But what if...the data aren't 100% accurate? There are understandable situations every utility crew encounters that can create misleading information:



ENVIRONMENTAL

- Outage occurred at night, and it was too dark to see well
- Outage occurred during a storm, and rain, wind, or snow made it difficult to see
- Trees, vines, and other obstacles interfered with getting close enough to investigate properly

THE HUMAN FACTOR

- Crews forget to record cause of fault
- Crew members have different interpretations of situations, causing variance
- Crews couldn't determine a definitive cause, so selected the best guess

CIRCUMSTANTIAL

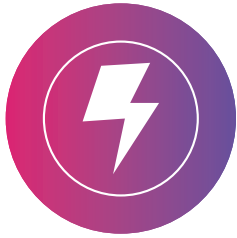
- Juggling many jobs for the day, crews rushed away without providing notes
- Residents don't want crews trampling backyards, forcing crews to leave quickly
- There's no standard for recording data, especially for marking what might have been a transient fault

But data drive the action—or inaction—you plan to take. If you have a suspicion your data-collection practices aren't as rigorous as they should be, be sure you carry that signature due diligence all the way through to data-scrubbing and analysis. Investigate the information you do have because, without thoroughly doing so, that data may lead you down the wrong path.

PRO TIP

If you need to go a step further to prove you have a problem, S&C offers communication sensors or a modified TripSaver® II Cutout-Mounted Recloser to collect data on nuisance operations that occur on your system. Our team can help you target trouble areas to collect strategic data and analyze the findings.

GETTING TO KNOW THE VACUFUSE SELF-RESETTING INTERRUPTER



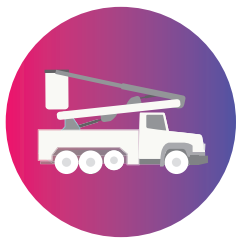
THE GAP

Other approaches to solve the problem of temporary faults and transformer protection only address individual causes. Animal-guarding has limitations and often can't guarantee a solution. Pole-construction standards will continue to require larger clearances and space. Fusing is plagued with fuse-replacement errors, oversizing or miscoordination, stresses from system age, and lightning surges. None of these strategies address the entirety of the problem, resulting in needless outages and millions of dollars in unnecessary repair. The VacuFuse interrupter is the first holistic solution tackling all sources of the problem.



THE STRATEGY

Outage mitigation, including for momentary outages, is most effective when positioned closest to faults. For decades, utilities have been using reclosing strategies to break feeders and laterals into smaller, more manageable zones to mitigate and isolate temporary faults from the rest of the system. VacuFuse interrupters bring fault-testing further toward the edge of the grid than it has ever been—the areas most vulnerable and toughest to reach. They round out the utilities' suite of lateral outage-mitigation technologies and provide them with end-to-end lateral protection.



THE HISTORY

Familiar with S&C's TripSaver® II Cutout-Mounted Reclosers that use reclosing on laterals to improve reliability and avoid unnecessary truck roll costs, utilities approached S&C seeking help to solve a persistent problem with nuisance outages on the primary side of overhead distribution transformers. They complained about spending too much labor time and expense repairing these faults, but because the cause of the fault often couldn't be found, they couldn't eliminate the outages. Diving into utilities' data, S&C discovered the root cause was temporary faults. S&C worked hand in hand with these utilities to develop the VacuFuse interrupter concept, iterate designs, and test it to prove it will function successfully and reliably.



THE FUNCTIONALITY

VacuFuse interrupters replace the fuses above overhead distribution transformers and test once for a fault. If the fault is temporary, the device will restore power. If the fault is permanent, the device will interrupt the fault current and deenergize the line. This prevents temporary faults from becoming permanent outages—and saves your utility significant annual maintenance expenses otherwise spent on re-fusing and restoration. With its compact design, a wide library of available configurations, and installation into several manufacturers' approved cutouts, VacuFuse interrupters can easily be placed above any single-phase transformer 75 kVA and below and up to 27 kV.

FUSES VERSUS VACUFUSE INTERRUPTERS

While it may feel uncomfortable to move away from fuses, which have been used on the grid since the beginning of electricity distribution, compare the pros and cons between fuses and implementing new technologies on your system:

FUSES FOR OVERHEAD DISTRIBUTION TRANSFORMERS

PROS

- Inexpensive up-front cost
- Crews know how to interact with them and how to replace them
- No changes needed to standards, operations, and teams' day-to-day work

CONS

- All faults become permanent outages, even if the cause is temporary
- Hidden cost of wasted and avoidable company maintenance expenses
- Time wasted for very simple re-fusing tasks
- Sneakouts or weakening can occur over time

QUESTIONS TO CONSIDER:

- If we want to stick with the status quo, have we done our due diligence to know how much fuse replacement costs us in O&M expenses?
- Will we be able to keep up with O&M needs as our system continues to age and as we'll likely see more outages?
- How much will our operation costs increase in the future as team member costs increase?

VACUFUSE INTERRUPTERS

PROS

- Temporary faults that make up 70% of overhead distribution transformer faults no longer become permanent
- A significant amount of maintenance cost is saved by avoiding unnecessary truck rolls
- New equipment can be capitalized
- A set-it-and-forget-it solution on your system
- Teams can work on more proactive, valuable tasks versus reactive re-fusing from nuisance operations
- Don't need to worry about blanketing the system with animal guards or tree wire, or ensure surge arresters are functional and phase spacing is adequate

CONS

- Higher up-front cost than fuses
- Require new standards, operations, and training within your utility

QUESTIONS TO CONSIDER:

- How do we convince others within the company this change is a good idea?
- Who will be affected by using a new device?
- What standards and processes will be affected by a new device?
- How will we deploy a new device across our system?

The VacuFuse interrupter is a compact temporary-fault protection solution fit specifically for the transformer application.

COMMON MISSTEPS AND MISTAKES

Daily routines make it easy to fall into complacency or overlook the obvious, which can lead to accepting the status quo or tripping up over the smallest details. Look out for these common misconceptions or issues so you can avoid them:



Not looking into your data. It may be easy to dismiss the idea overhead distribution transformer fuses aren't a problem. But have you really looked into it? Every lineworker can relate to seeing a blown fuse but not being able to identify why it happened. This is a mystery that will remain unsolved and will persist unless you investigate and decide to do something different.



Not rallying your team. Before proceeding with a new device on your system, it is critical to gain buy-in from key groups or individuals at your utility. Operations, engineering, and line-crew stakeholders will need to orient themselves to the new solution. Convincing key stakeholders early on will smooth the path forward from pilot to deployment.



Underestimating the cost of a truck roll. There's the cost of the truck to consider, including the gas and insurance, plus the wages for your crews. These wages might spike into hazard or overtime pay brackets (including unused time for overtime minimums) because truck rolls often occur during severe weather. Moreover, there's the opportunity cost of what your crews could have been working on instead.



Not thoroughly training crews. Lack of training can lead to your teams' dissatisfaction and frustration with the devices. Thorough and repeated training is critical for all team members who will be configuring, installing, and working with the devices.



Confusing the VacuFuse interrupters for similar devices. While this device has similarities to other solutions, there are significant differences between them. For example, if you have TripSaver II reclosers, another reason to train your teams thoroughly is to clearly delineate how the standards and operations practices are distinct from each other.



Handling devices incorrectly. Although VacuFuse interrupters are designed to withstand the brutal outdoors, they're not indestructible. If the installer doesn't follow installation and handling recommendations, they could damage the VacuFuse interrupter, resulting in improper or unsafe operation.



Using improper cutouts. VacuFuse interrupters can be installed in several cutout options, but S&C has provided an approved list of which cutouts to use. Using unapproved or untested cutouts could result in misoperations or safety hazards for your crews.

NEXT STEPS

YOU THINK YOU HAVE A PROBLEM. WHAT'S NEXT?

Now that you are prepared to further examine trouble areas on your grid, it's important to keep next phases in mind. As the grid and regulatory landscapes move forward, you may need to investigate details you haven't previously had to prove. Determining which new metrics to pursue will equip you with the information you need to move toward next steps that will bring positive change to your system.

If this sounds challenging and you aren't sure where to start, our team can help you scrub and organize your data to identify where nuisance operations detrimentally impact your system, as well as provide recommendations on the customer-centric metrics and regulatory shifts you should be tracking.

Understanding the scope of your problem and how to analyze it will pave the way toward gaining support for system modernization. If you aren't sure where to start in developing a plan and explaining the value of making a change with the VacuFuse Self-Resetting Interrupter, S&C is here as a resource to build a justification for you, prepare a plan to present to key decision-makers, and guide you through each step of the process.





S&C ELECTRIC COMPANY

Excellence Through Innovation

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