The Power of Grid Monitoring
From Challenge to Solution

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EVERY CONNECTION COUNTS

Agenda

1 The Evolution from **Conventional to Smart Grids**

2 **Overhead** Distribution Lines: Challenges and Solutions

3 **Underground** Distribution Lines: Challenges and Solutions

4 Underground **Safety and Asset Management**

5 Q&A

Emerging Challenges in Distribution Grids

In 2030, 20% of our global energy will rely on wind power, and the demand for solar power continues to grow.

As the emergence of points of power generation multiples, the **increased power flow is adding pressure on grids** that have already been running for decades.

With the demand for energy growing exponentially, it is essential that grids can manage the increased electrical stress, in order to **avoid disruption to your network**.

Relying on a **smart grid** can help you:

- Improve safety for operators and people
- Improve the reliability of your grid
- Achieve network automation and remote control

From Conventional to Smart Grids

CONVENTIONAL GRIDS

- No monitoring or remote control
- Uni-directional power flow from large power plants to end consumer

WHAT IS CHANGING?

- Distributed power generation
- Rising expectations for power quality and power availability
- Increased demand on electricity (eg: charging stations)
- Aging infrastructures

CONSEQUENCES

- Unstable power supply
- More frequent and longer duration of unpredicted faults

Resulting in:

- Economic consequences of power loss
- Occupational risk and safety

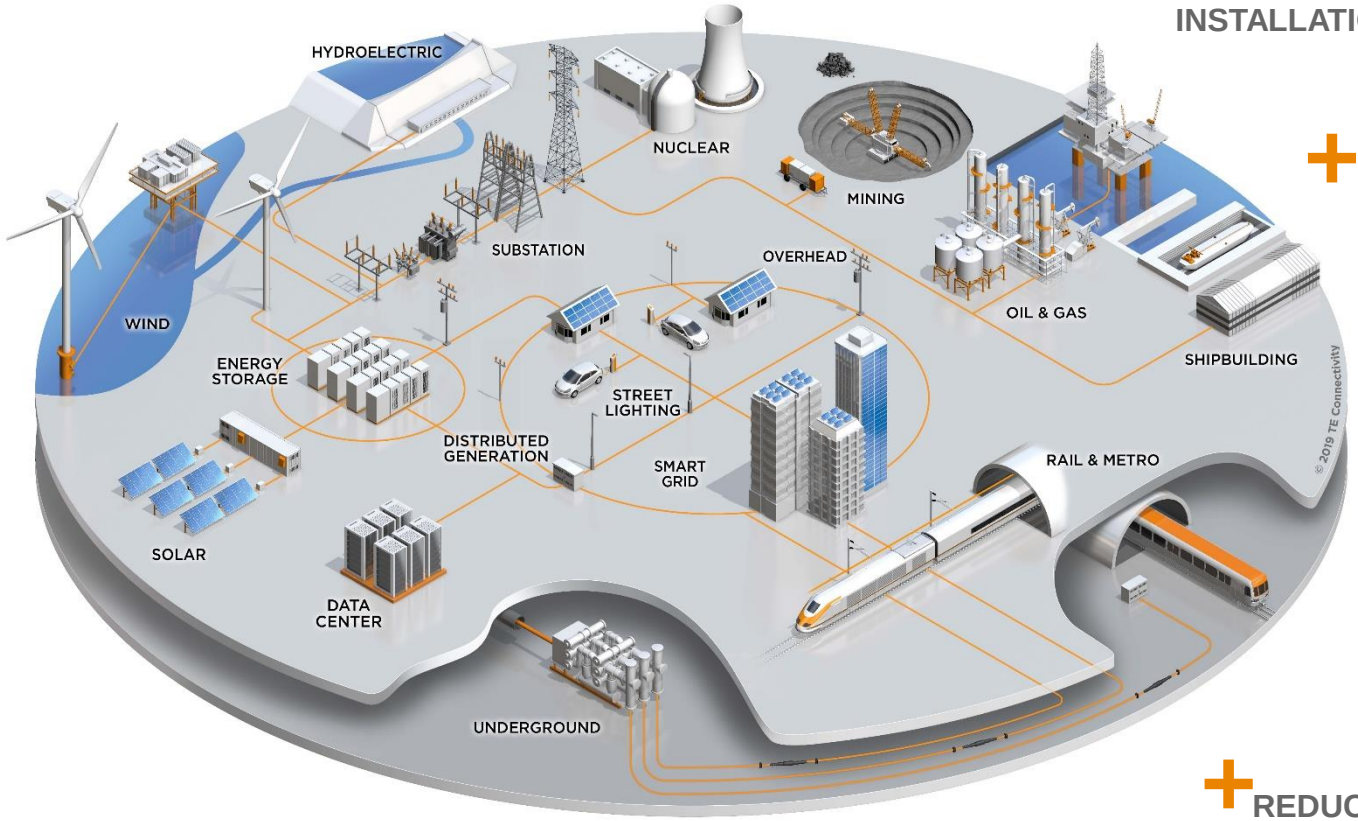
THE SOLUTION: INCREASE NETWORK VISIBILITY AND TRANSPARENCY

- Power presence monitoring
- Fault monitoring
- Power flow monitoring

Evolving Needs Require Evolving Solutions

As the grid evolves more complex and the energy flow increases, it is even more critical to:

- **Prevent outages** before they happen
- When outage happen, **quickly act at the source**
- Keep **maintenance costs** as low as possible



+ EASY, FAST, SAFE INSTALLATIONS

+ WILDLIFE & ASSET PROTECTION

+ GRID MONITORING

+ GRID RELIABILITY

+ REDUCED COST OF OWNERSHIP

+ INSTALLER & ENGINEERING SUPPORT

Unplanned Outages for Utilities

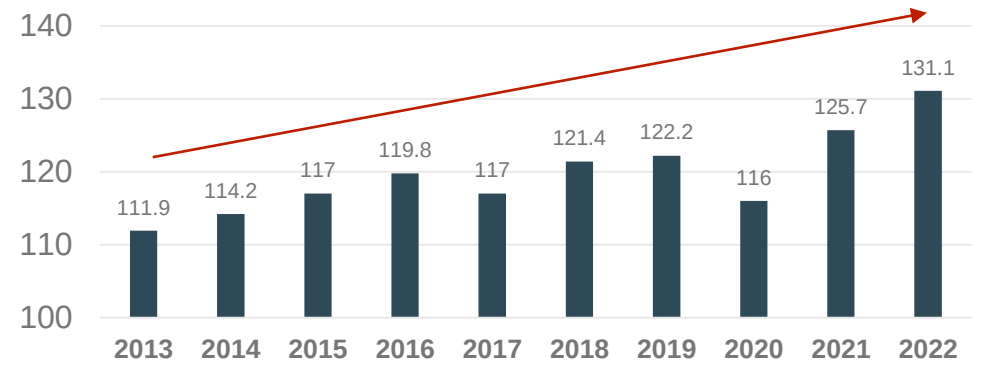
With more than 150,000 miles of power lines, the US power grid is one of the largest worldwide. Overhead lines are key to connect the network: from generation, to transmission and distribution. They are **also the most vulnerable when it comes to weather and animal-related challenges**.

A common way to track down time for utilities is **System Average Interruption Duration Index (SAIDI)**. Being able to efficiently restore power reduces the impact of unplanned faults.

Grid monitoring solutions can help you **locate faults** on underground and overhead distribution power lines **increasing grid reliability and safety.**

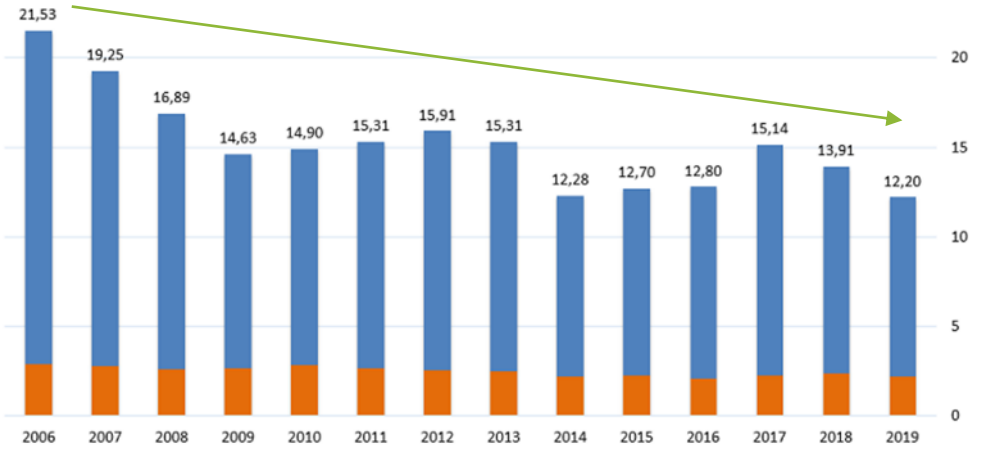
CONVENTIONAL GRID

Average duration of total annual interruptions in electricity service in the United States (largely overhead lines) - minutes per year*



SMART GRID

Average duration of total annual interruptions in electricity service in Germany (largely underground networks) - minutes per customer



**Source: US Energy Information Administration, Annual Electric Power Industry Report*

Unplanned Outages for Data Centers

With an ever-evolving landscape in computing and the increasing need for cloud storage, there is one thing that must remain constant: your power supply.

To achieve the **industry's standard uptime of Five-9s** (99.999%), reliable power delivery is essential. As a result, data centers have always had monitoring and control in place, however, it is possible to make improvements in personal safety and facility awareness by increasing power monitoring.

To achieve that, you will need:

- **Connections** that are reliable and high-performing
- **Voltage monitoring** devices, for personal safety
- **To detect and locate faults** as quickly as possible

The average cost of an outage in a data center is estimated to **$9k** in lost revenue per minute*

*Source: https://www.vertiv.com/globalassets/documents/reports/2016-cost-of-data-center-outages-11-11_51190_1.pdf

The Real Cost of Power Outages

4.7 hours

The average total annual interruption in electricity service hours per customer in the US

~2 hours

The average interruption per customer annually excluding major events

100,000 USD

The average cost of an outage for a Utility per hour

Overhead Distribution Lines

Challenges and Solutions

EVERY CONNECTION COUNTS

Outages Cannot Be Completely Eliminated

Yes, outages will keep happening.

All overhead lines are exposed to:

- Forces of nature (wind, lightning, ice)
- Vegetation contact
- Wildlife intrusion
- Vehicle collisions
- Wildfires
- Equipment failures / aging infrastructure

Outages be reduced with protective equipment or practices, **but <u>not</u> completely eliminated.**

An Outage Happened. What Now?

Time is money!

You must aim at **FLISR**, safely and quickly

- **F** ault
- **L** ocation
- **I** solation &
- **S** ervice
- **R** estoration

What tools are available?

SCADA systems

Advanced meter systems

Relay event records

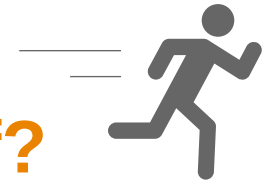
CHALLENGE: Vast areas are unmonitored, require visual inspection.

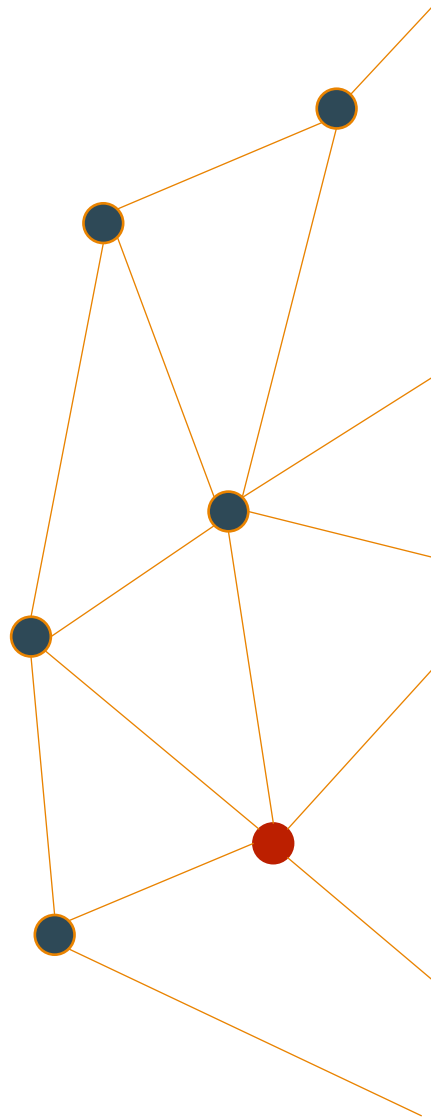
How do Grid Operators Find Faults?

Conventional grids require a troubleshooter to "ride out" the circuit… BUT

- **Circuits** may be less than a mile to **over 40 miles long**
- Some parts **not street accessible**
- Circuits likely have **multiple branches**
- The process can take an hour, **4 hours or more!**

What if... that time could be cut in half?





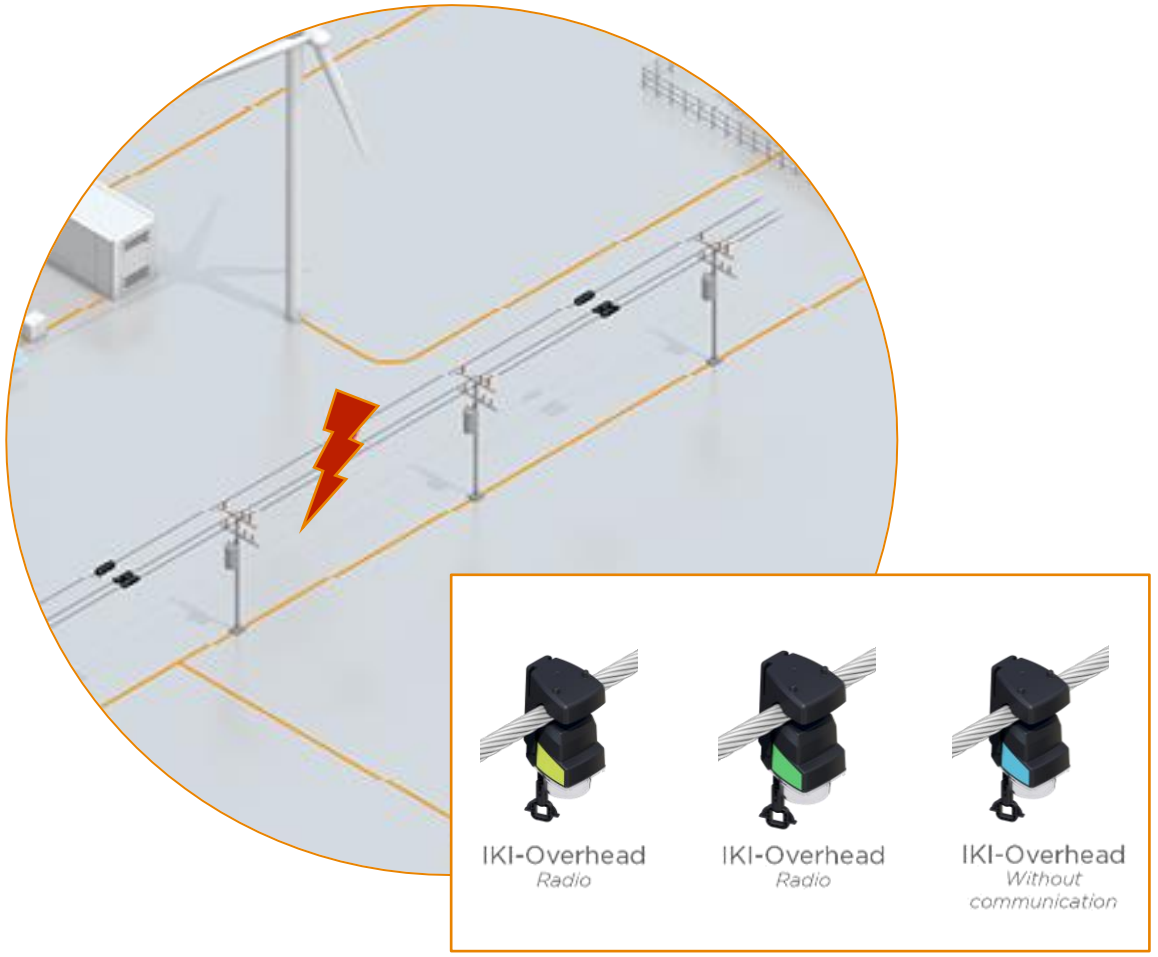
Benefits of Fault Current Indicators

A **fault indicator** is a device placed directly on the overhead conductor which provides **visual or remote indication of a fault on the electric power system**.

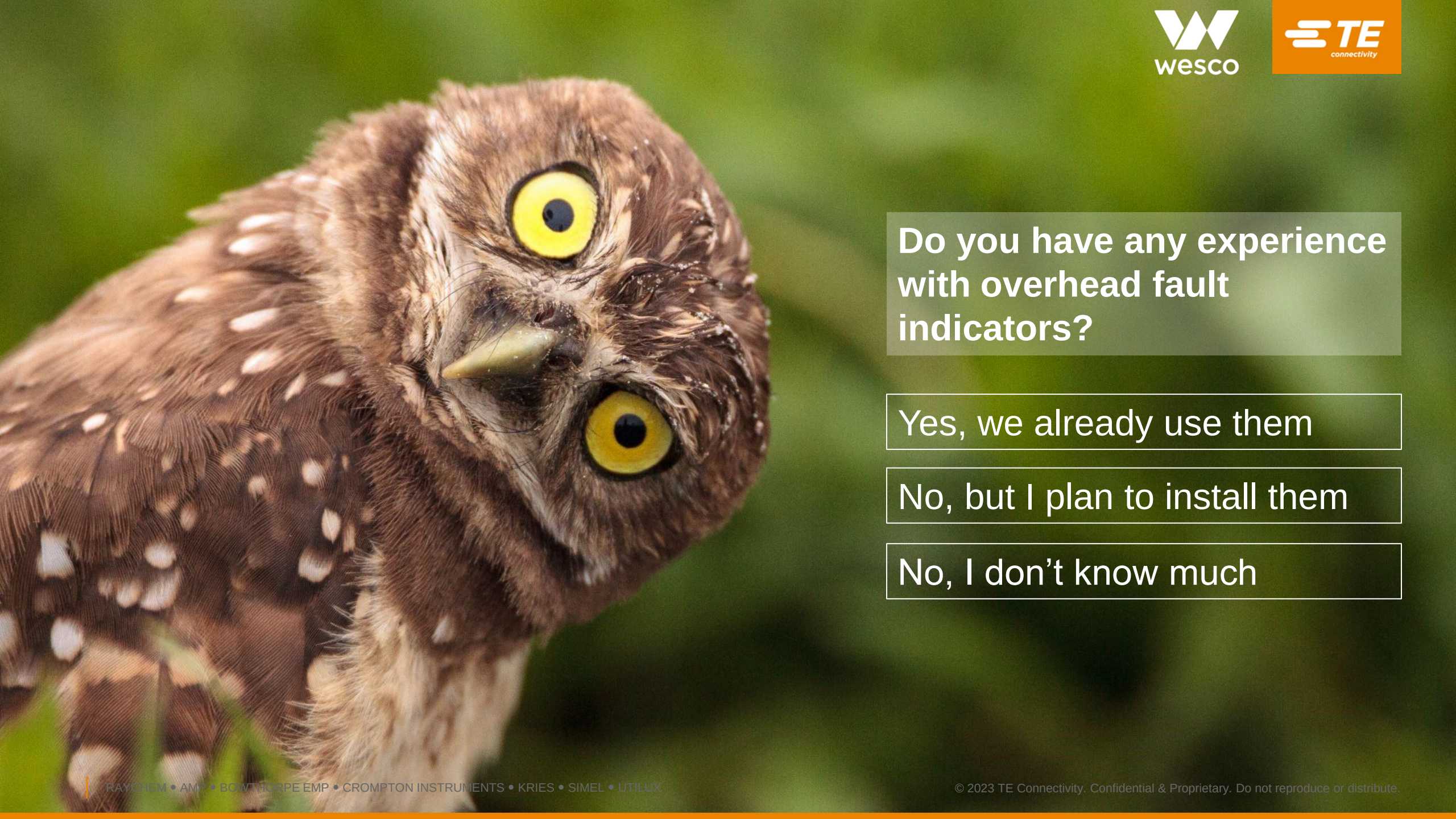
Fault is located between the last indicating and the first non-indicating fault indicator.

How is a fault indicator used?

- Troubleshooters will see if the **fault indicator is flashing.**
- **Communicating fault indicators** can also notify Operations, Engineering, or SCADA master system.



Overhead Fault Detection



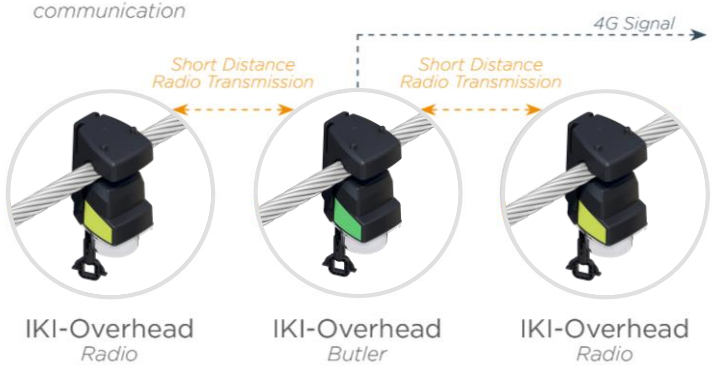
Do you have any experience with overhead fault indicators?

- Yes, we already use them
- No, but I plan to install them
- No, I don’t know much

Local and Remote Indication Systems

IKI-Overhead
Without communication

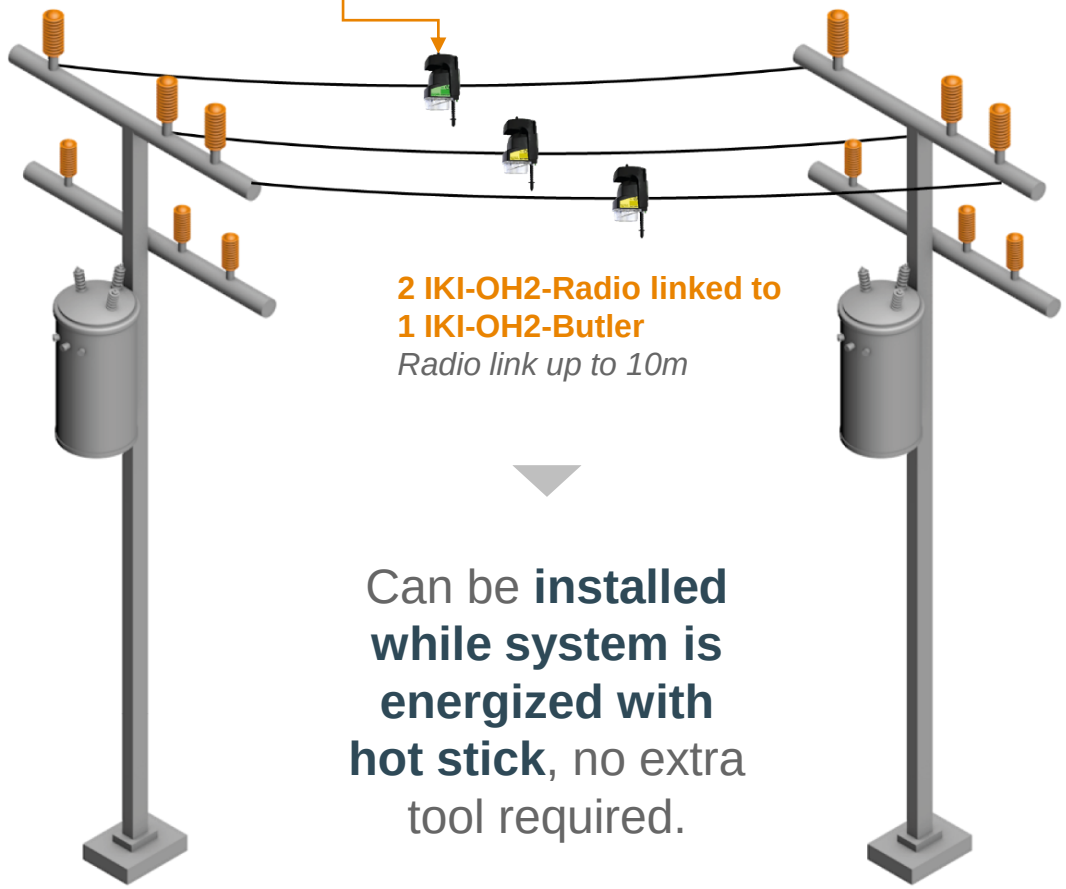
1. LED strobe-only devices, for local visual indication.



2. Communicating devices, with SMS over 4G for SCADA integration.

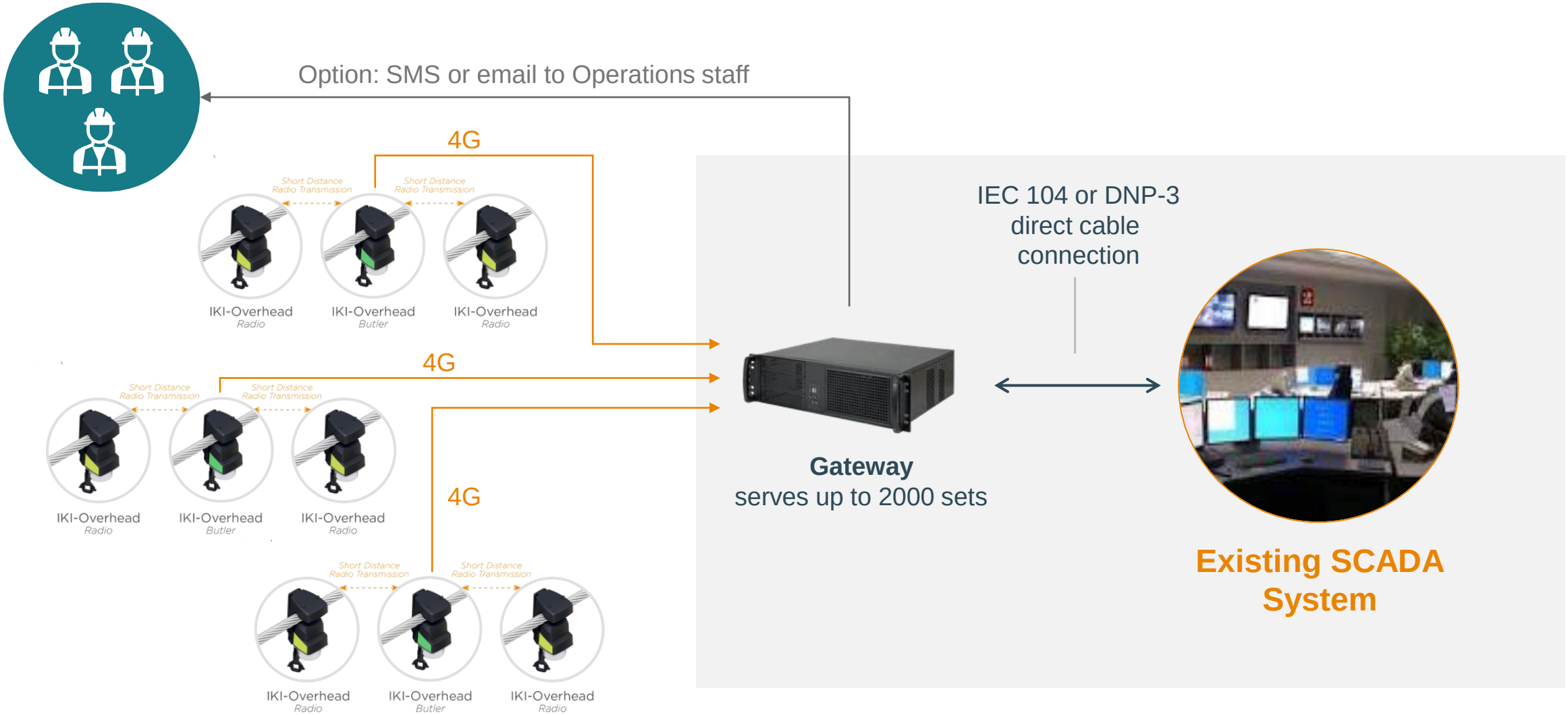
FEATURES

- Voltage: 1 - 35 kV
- Cross sections covered: #4 AWG – 1000 kcmil
- Fault current adjustable to 900A
- Sends alerts over 4G (SMS)



Can be **installed while system is energized with hot stick**, no extra tool required.

Device Integration with SCADA



Use Case: Long Circuits

Challenges

May take **hours to find fault**: time is money!

May have **multiple branches**.

Solution

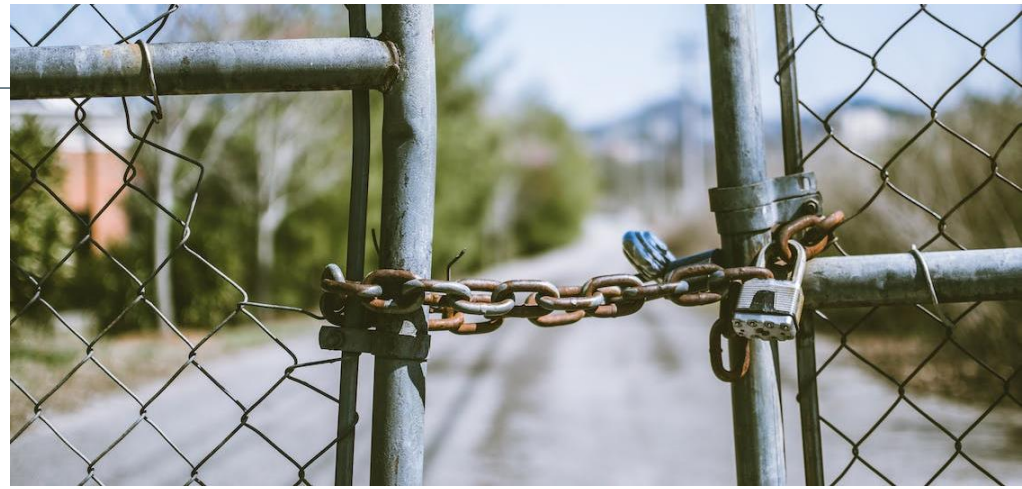
- **Segment circuit into smaller parts** with fault indicators.
- **One set breaks circuit in half**, cutting inspection time in half.
- **Add more fault indicators** to further reduce time to find fault proportionally.

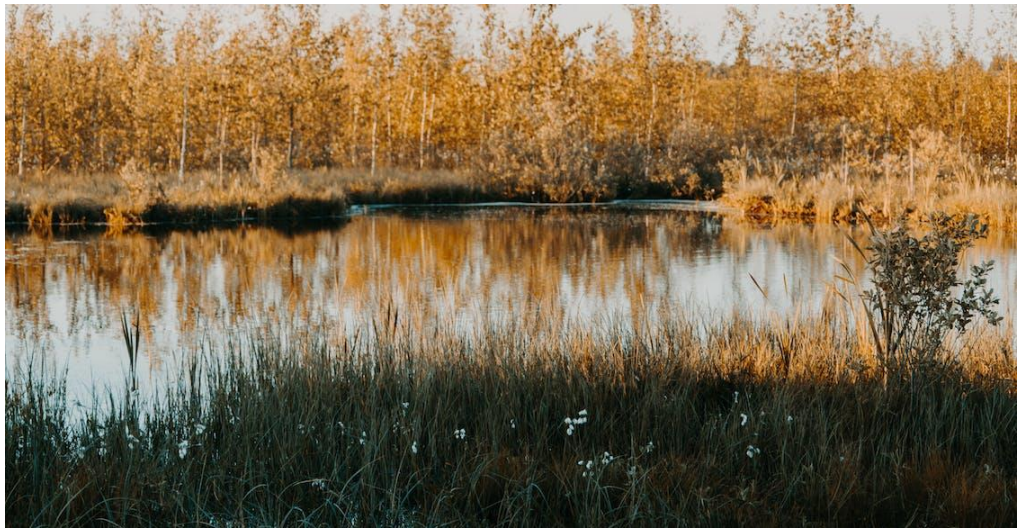
Pole Fault indicator

Use Case: Difficult to Access Areas

Challenges

- May require **walking out circuit**
- May require **special vehicle** or boat
- May require **long drive** to access
- Rivers, swamps, rear easements, fenced property





Solution

- Place **fault indicators on source edge** of difficult area.
- If fault indicators **not flashing**, no need to enter.

Pole Fault indicator

Use case: Underground Substation Feeder Getaways

Challenges

Circuit **lockout and restoration** require **different response**

Need to rule out **fault in the underground getaway**

- Close-in fault would damage substation transformer
- Specialized crews/equipment needed to test getaway
- Adds time to the restoration process, could be hours

Solution

- Place **fault indicators on transition point.**
- If fault indicators **flashing**, fault is <u>not</u> in the underground getaway.

Pole Fault indicator

Use Case: Problematic Circuits

Challenges

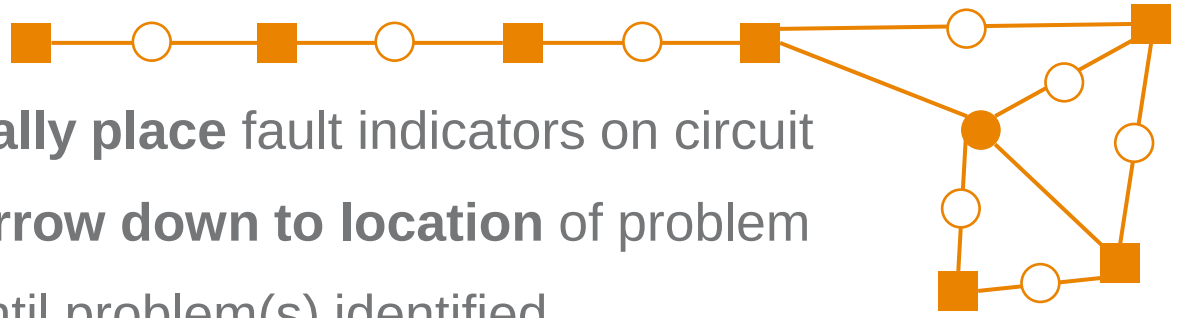
Root cause difficult to locate, may be multiple root causes.

May have **chronic momentary outages.**

May cause **regulatory risk.**

Solution

- **Strategically place** fault indicators on circuit
- Use to **narrow down to location** of problem
- **Repeat** until problem(s) identified



Pole Fault indicator

Underground Distribution Lines

Challenges and Solutions

EVERY CONNECTION COUNTS

Do you have any experience with fault indicators for Underground Residential Distribution (URD) Transformers?

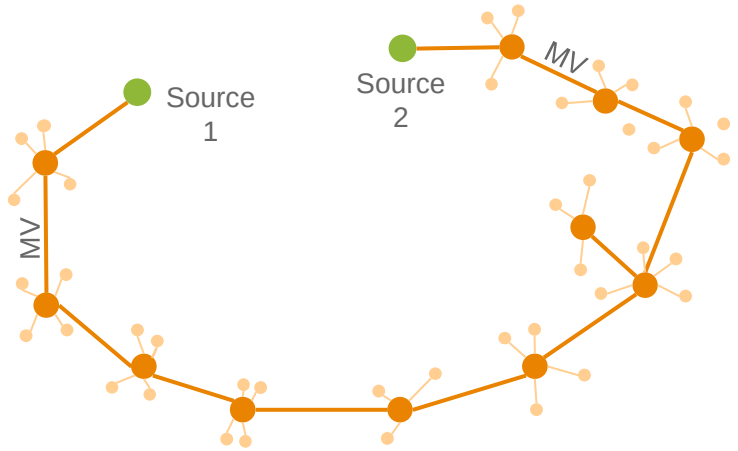
- Yes, we already use them
- No, but I plan to install them
- No, I don’t know much

Underground Residential Distribution (URD)

Single Phase circuits

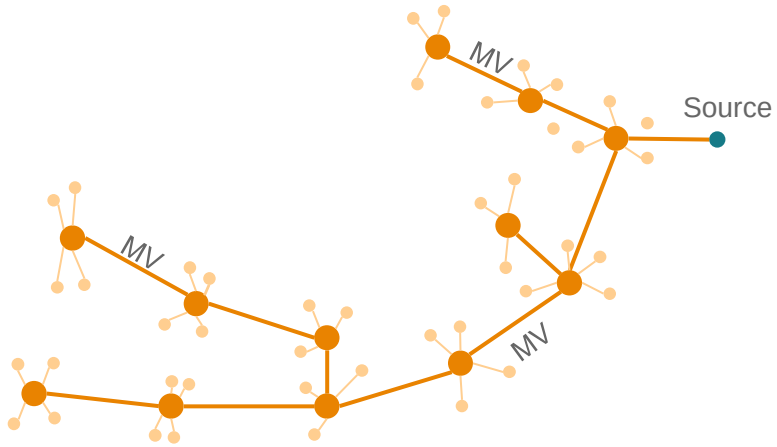
Underground cables connect to **pad-mounted transformers**
Easement will be in the front or rear of homes

Configurations



Loops

- Will have a "normally open" point to isolate the two sources
- Loop sources protected by fuses



Radial

- No redundancy
- Source protected by fuse

Locating Faults in URDs

Fault condition occurs...

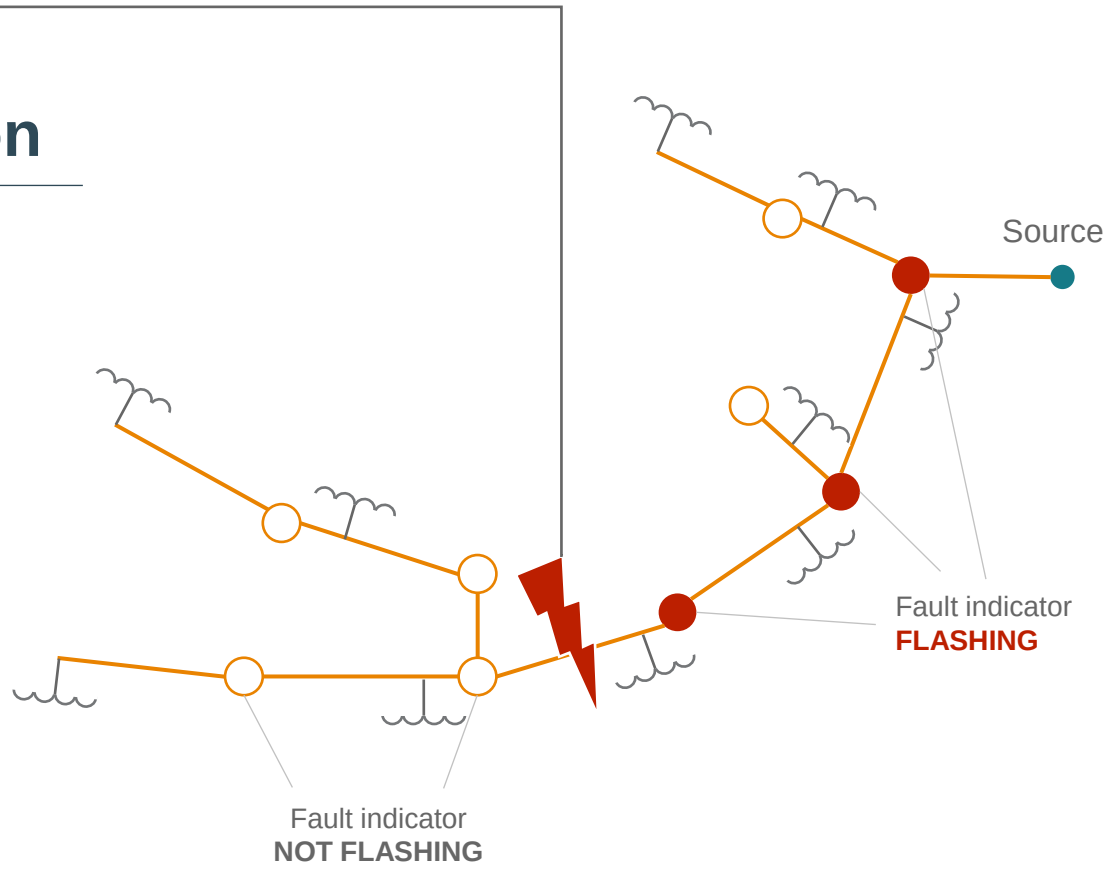
Fuse protection for loop or radial circuit will open

Challenge: Little knowledge of fault location

- Troubleshooting and repairs are **time-consuming**
  - Transformer vs. cable restoration requires different crews/equipment
  - Typical outage is **4+ hours**
- **Rear easement URD especially difficult**

Solution: Equip pad-mounted transformers with fault indicators

- Fault located **between last indicating and first non-indicating**
- Add more indicators to make segments small

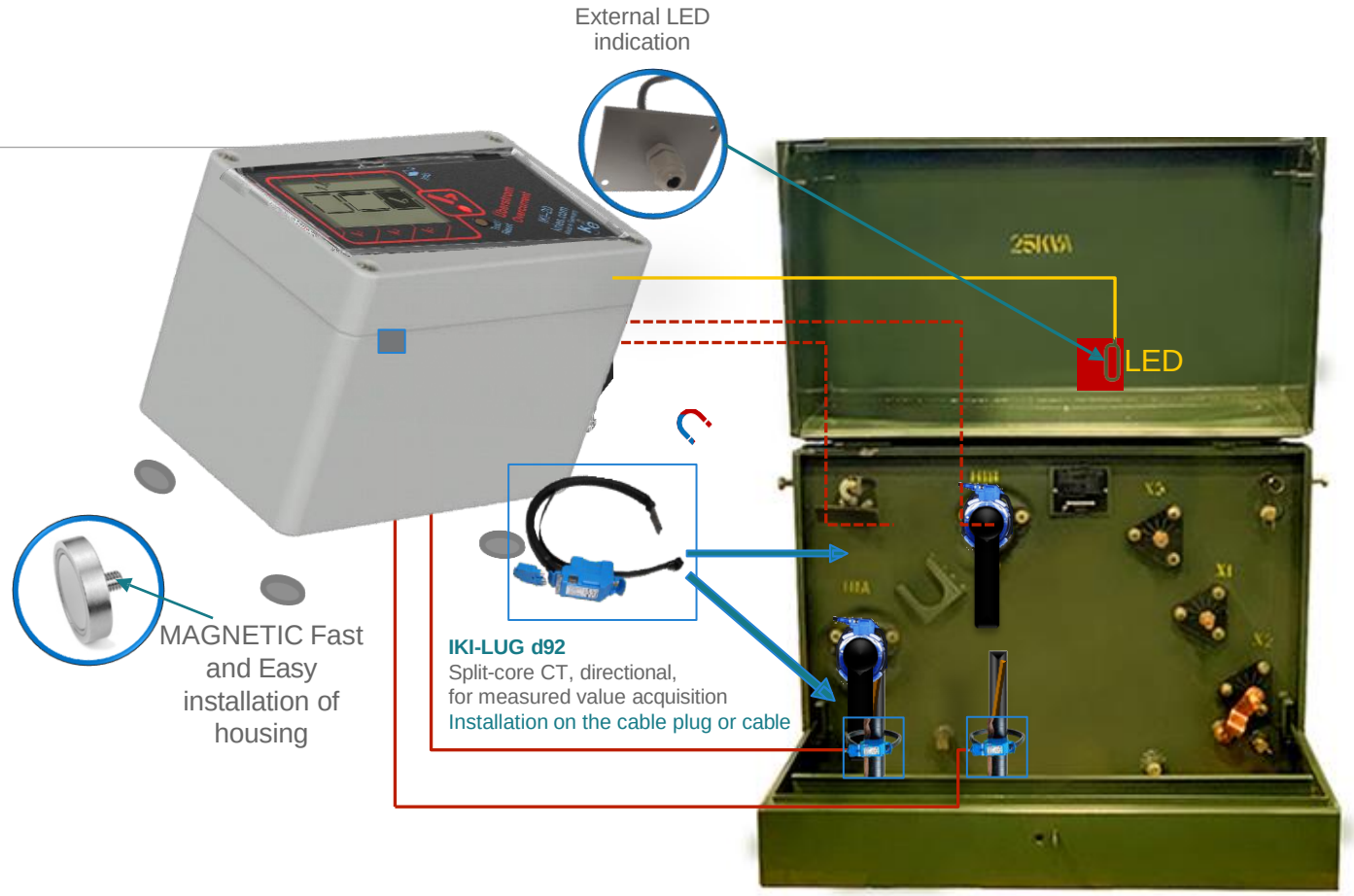


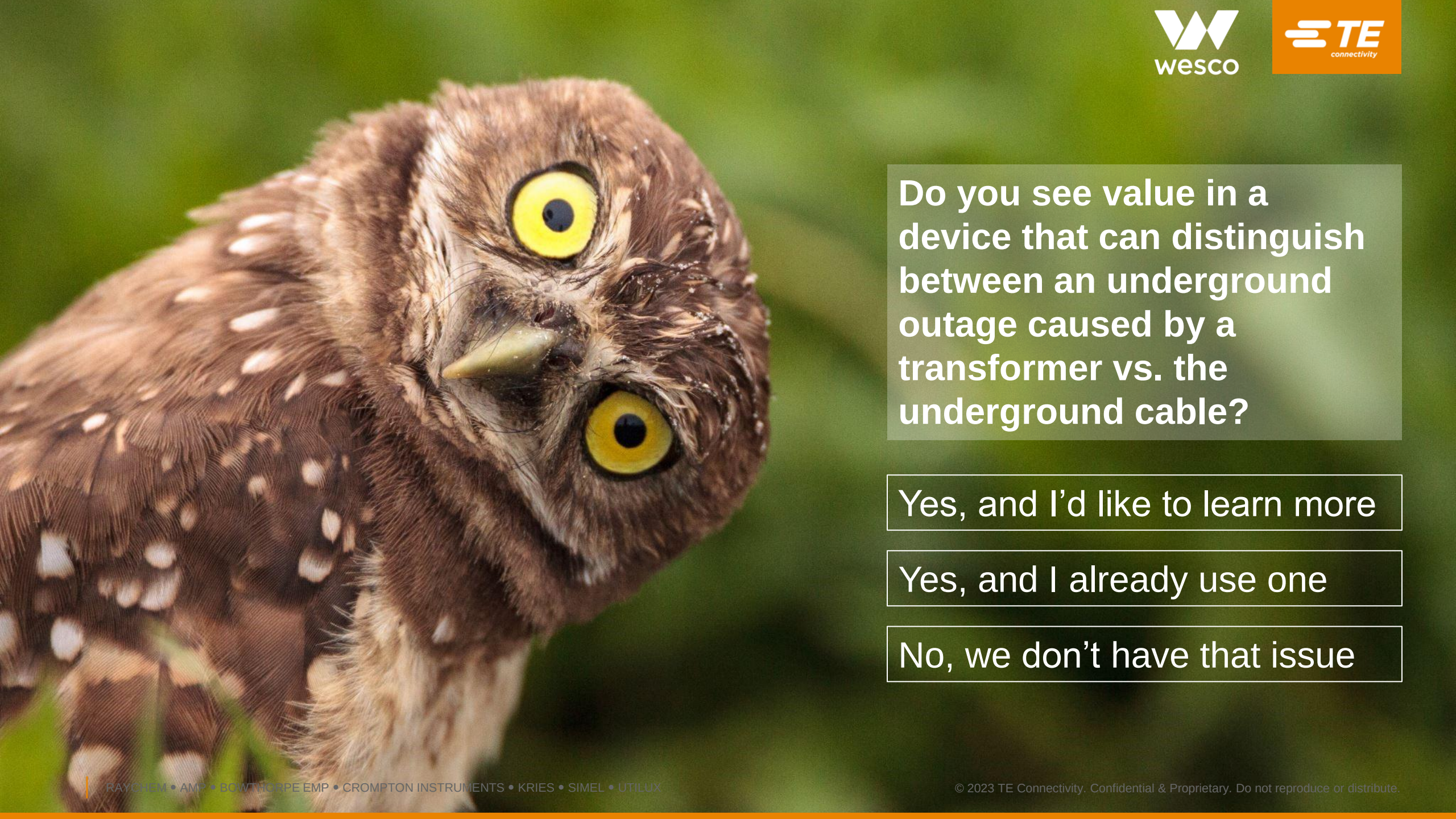
URD Radial Design Example

Fault Current Indicators for for URD Pad-mount Transformers

Benefits

1. Find faults more quickly, reduce SAIDI
2. **Distinguish between transformer fault and cable fault**
   Enables you to bring right crew, right equipment. Significant time savings!
3. Self-powered device
4. Field configurable
5. No minimum load current needed
6. Coordinated with fuse curves





Do you see value in a device that can distinguish between an underground outage caused by a transformer vs. the underground cable?

- Yes, and I'd like to learn more
- Yes, and I already use one
- No, we don't have that issue

Underground Safety and Asset Management

Challenges and Solutions

EVERY CONNECTION COUNTS

Improving Safety for Operators

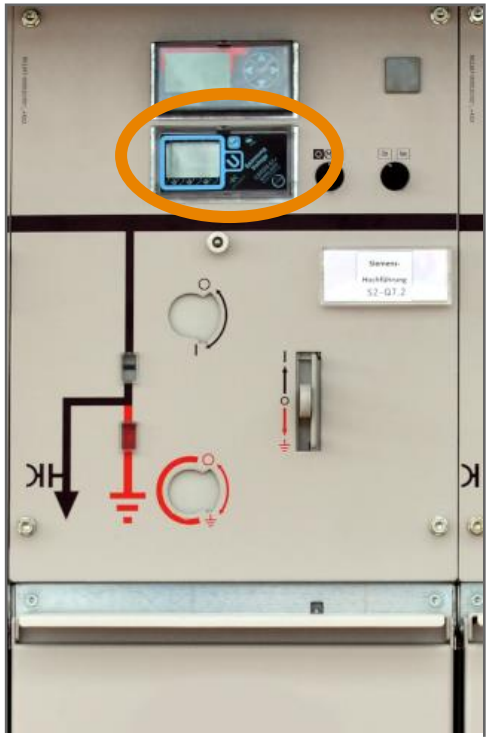
Permanently installed Voltage Detection and Indicating Systems (VDIS) offer improvement over current procedures for confirming proper de-energization.

Today, the operator needs to use a **hot stick with a voltage detector**. It is the most common method today, and yet very dangerous as the **operator is potentially exposed to an immediate arc flash hazard**.

VDIS can bring:

- **Improved safety**: eliminating the operator's exposure to potential hazards
- **Confidence**: permanently installed device vs. handheld device
- **Ability to check for voltage presence** and phasing at included test points.

Operator using a hot stick with a voltage detector



Permanent Voltage Detection and Indicating System

Voltage Detection System – Easily Retrofitable

Gas Insulated Switchgear

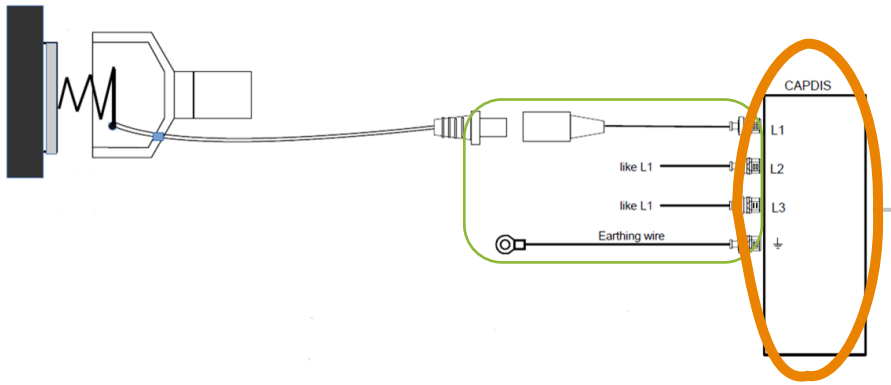
Bushing with capacitive tap

C1 – 250A elbow

Air Insulated Switchgear

C1 - Insulator

Retrofittable C1 for terminations



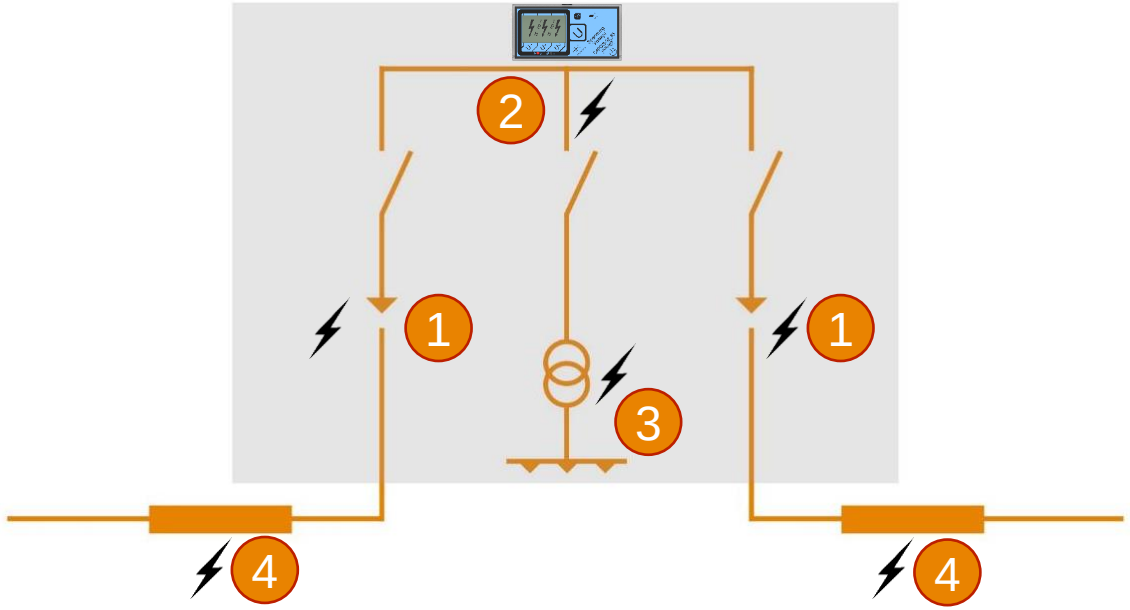
TE Kries CAPDIS Features

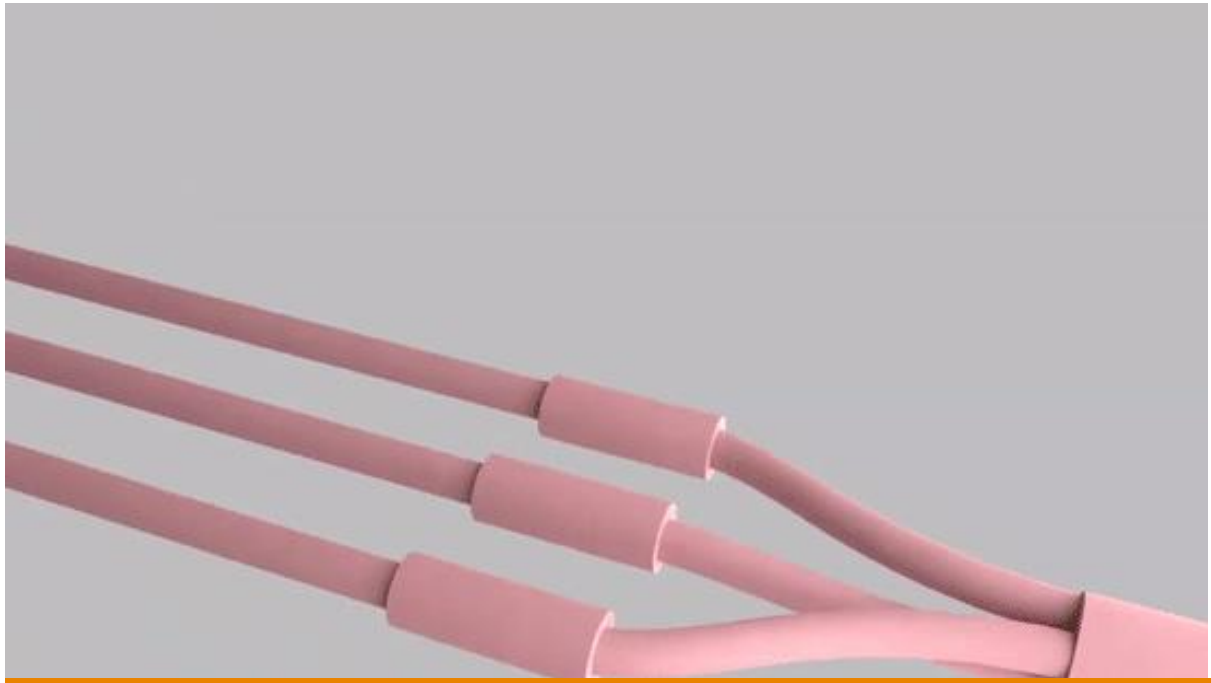
- MV 1–52KV;
  HV 53-480KV
- Integrated self-test
- Front display with LED
- Relay contacts for interlock, remote indication and SCADA input
- **Live Partial Discharge Detection**

Voltage Detection and Partial Discharge Indication

TE Kries CAPDIS R5 can detect partial discharges within switchgears in:

1. Cable terminations / elbows
2. Busbars
3. Transformer
4. Adjacent splices





“TE PD !” appears when Partial Discharge threshold is exceeded (not phase selective)

Key Takeaways from Today's Webinar

We have looked at both **overhead** and **underground** challenges and solutions.

CAPDIS allows for **live monitoring of asset health**, such as transformers and switchgear serving critical customers.

Fault indicators can save you hours of downtime by quickly highlighting outage sources.

By implementing the right **VDIS**, we can also enhance safety for operators.

But there is a lot more we can do to make your grid more reliable!

Q&A

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EVERY CONNECTION COUNTS

wesco

TE connectivity