Addressing Challenges in Modern Grid Integration

Tilo Kubach
Head of Sales, Grid Monitoring
Kries Energietechnik, now part of TE Connectivity

Hamed Rezaei
Global Product Manager, Grid Monitoring
TE Connectivity

EVERY CONNECTION COUNTS

Our Experts

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Agenda

1 Introduction to TE Connectivity & Kries Energietechnik

2 Customer Challenges in Grid Integration

3 Achieve Grid Digitalization – Key Steps

4 Our Solutions for Underground and Overhead Grids

5 Key Takeaways

6 Q&A

ENERGY BUSINESS UNIT

CUSTOMERS RELY ON US TO INNOVATE SUSTAINABLE ENERGY NETWORKS AND KEEP THE POWER ON.




3100
EMPLOYEES DEDICATED TO ENERGY

$917M
ENERGY GLOBAL REVENUE FY24

PARTNERING IN
130+ COUNTRIES

WORLD's top Utilities, EPCs and OEMs

Sales figures based on actuals exchange rates.

Introduction to Kries Energietechnik

- **Founded in 1994**
- **Pioneer in smart grid** systems that help maximize uptime for power grids around the world.
- Built on **a deep culture of quality and innovation**
- **Complete offering** for automation, transparency and efficiency of distribution grids for increased uptime
- **2020: Collaboration between Kries Energietechnik & TE Connectivity**
- **2023: Acquisition of Kries Energietechnik**

Power Presence in Distribution Networks

Reliable power presence is only possible through the combination of smart components.

Distribution networks are changing:

- More intelligence in the secondary substation.
- More intelligence in the feeders.
- Intelligence through combination of VDIS, fault indicators and smart sensors.

Enhancing Grid Reliability Every Step of the Way

As your global partner, we deliver solutions to prevent faults through reliable connections, advanced insulation, smart devices, and expert training. In case of outages, our fault detection and automatic switching technologies ensure quick restoration and seamless network automation.

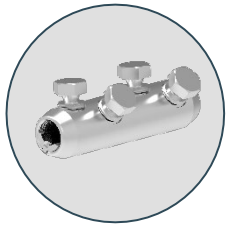
Prevent.

Professional Services

Wildlife & Asset Protection

Jointing Technologies

Switchgear Connect



Mechanical Connectors

Insulators & Arresters

Detect & Locate.

Overhad Fault Current Indicators

Local Underground Fault Indicators

Substation Feeder Control Units

Advanced Substation Feeder Control Units

Predict.

Voltage Detectors CAPDIS

Voltage & Current Detectors KFDI

Customer Challenges in Grid Integration

EVERY CONNECTION COUNTS

Challenges of Today's Distribution Networks

Digitalization in distribution networks → **Digital Substations**

Distribution Networks are Changing:

- *Distributed generation (**Renewables**)*
- *Complex/Interconnected grids (**Urbanization**)*
- *Increased demand on electricity (**Electrification***

Consequences:

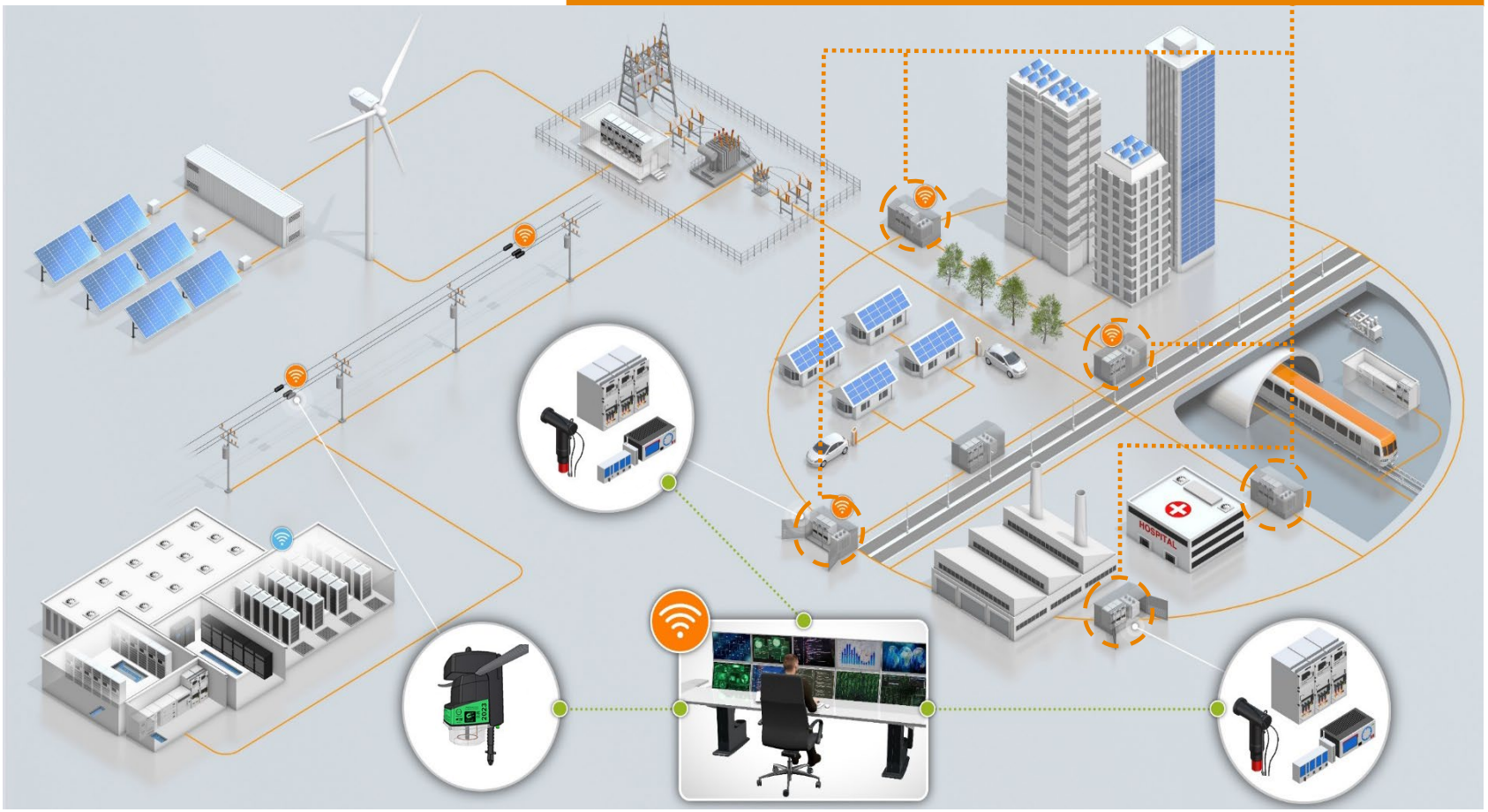
- **System stability**
- **More frequent faults**

Possible Solutions:

1. More copper → Network expansion
2. More intelligence → **Digitalization**

Visibility (Monitoring):

1. Presence of Power
2. Detection of Faults
3. Monitoring of Power flow (U/I/P/etc.)



DIGITALIZATION PROVIDES THE RIGHT TOOL TO MANAGE TODAYS AND TOMORROW'S DISTRIBUTION NETWORKS

Unplanned Outages for Utilities

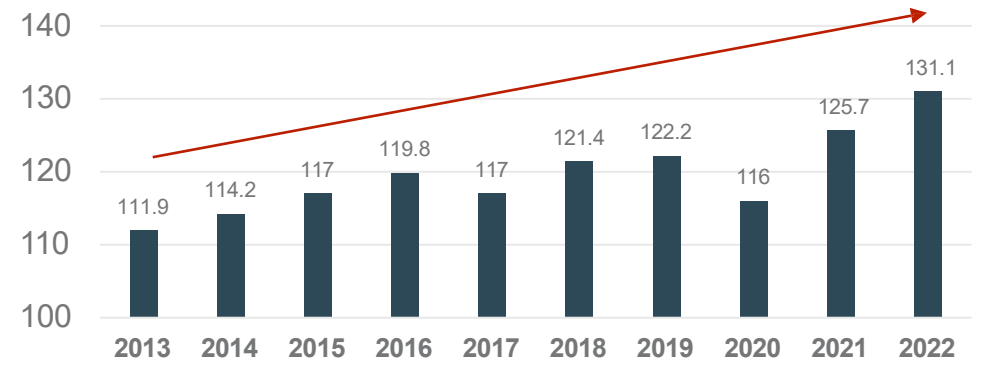
Overhead lines are vital for connecting the network, facilitating power flow from generation to transmission and distribution.

However, these lines remain highly susceptible to weather conditions and animal-related disruptions, making reliability a constant challenge.

Grid monitoring solutions enhance reliability by quickly identifying faults across large networks, both overhead and underground. This allows utilities to restore power efficiently, minimizing the impact of unplanned outages.

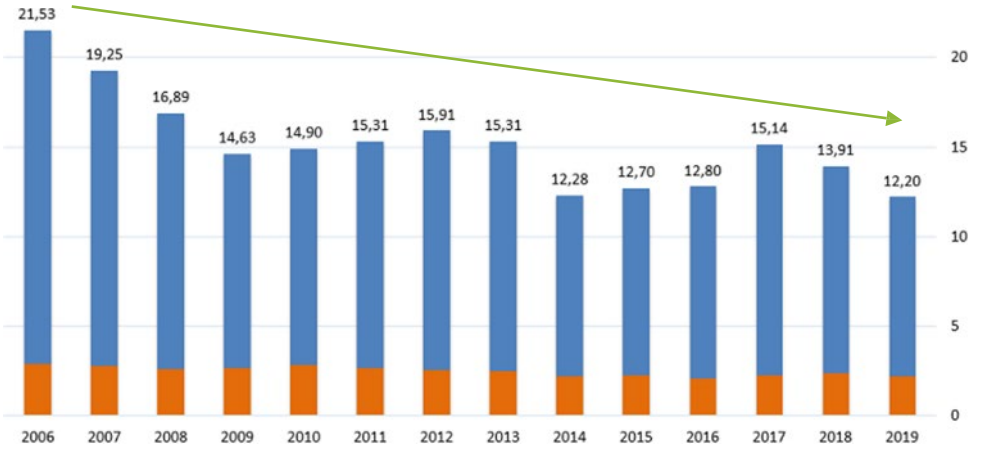
CONVENTIONAL GRID

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



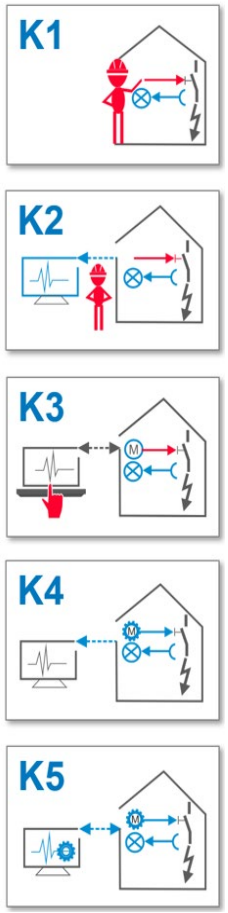
*Source: US Energy Information Administration, Annual Electric Power Industry Report

Digitalization Roadmap
From Local Indication to Network Automation

> 2 hours

Downtime

< 1 minute



Local Indication (K1)
Faults are recorded on site and displayed in the station.

Remote Monitoring (K2)
Information on faults and load profiles are transmitted remotely.

Remote Monitoring & Operation (K3)
In addition, switching operations are remote-controlled.

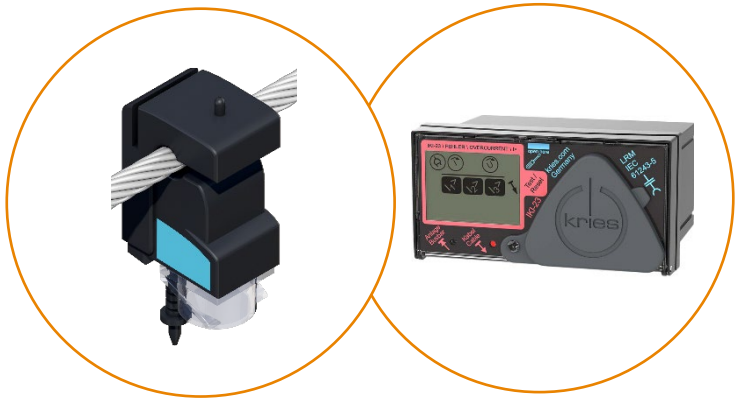
Nodal Automation (K4)
In the event of a fault, switching and enabling at the node is carried out automatically.

Network Automation (K5)
Distribution network sectors are operated automatically via algorithms (self-healing)

Detection and clearance of failure often result in outages over hours
dependent on the failure detection method and the level of digitalization

Achieve Reliable Power Supply - Key Focus

To build a smart grid and improve the reliability of your power system, it's essential to implement solutions that address the following three key aspects.



Power Presence	Fault Detection	Network Automation
Ensuring operator safety Protecting your assets	Minimizing downtime (SAIDI) Reducing economic impact	Future-proofing grids Building resilient networks

Power Presence Visibility

Enhanced safety for operators and equipment

EVERY CONNECTION COUNTS

Improving Safety for Operators

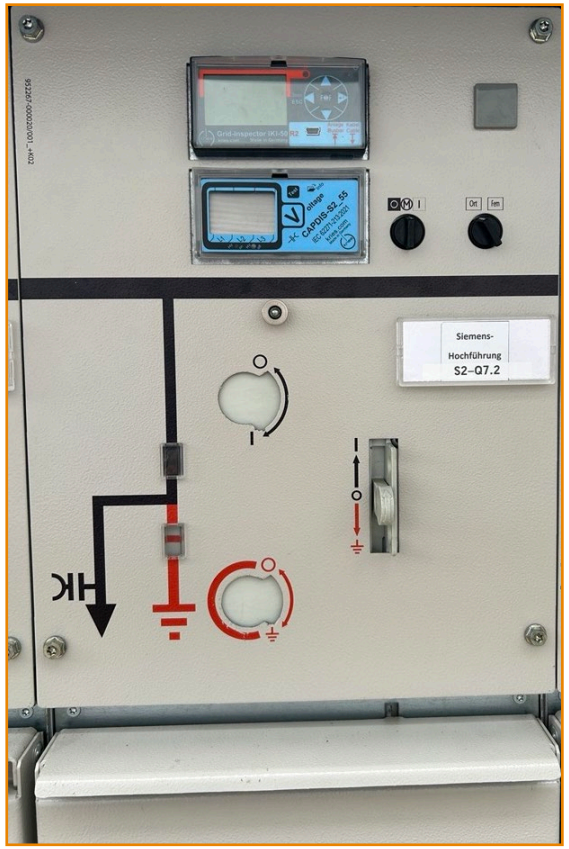
Permanently installed Voltage Detection and Indicating Systems (VDIS) offer improvement over current procedures for confirming proper de-energization.

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.

TOMORROW, VDIS CAN BRING YOU:

- **Improved reliability**
- **Improved safety**: eliminating the operator's exposure to potential hazards
- Ability to check for voltage presence and phasing at included test points

Operator using a hot stick with a voltage detector in an AIS



Permanent Voltage Detection and Indicating System on a GIS

Voltage Indicators And Detectors

The TE Connectivity (TE) Kries CAPDIS is an integrated voltage testing system designed to detect the absence of voltage in medium-voltage distribution networks ranging from 1 to 52 kV and is engineered for new or retrofit installations.

Features & Benefits

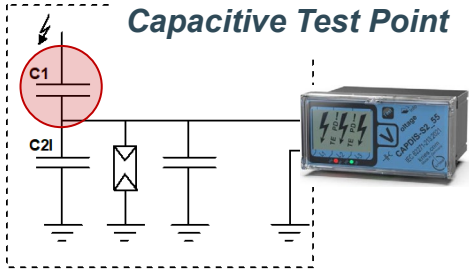
- No battery required
- Three-phase indication
- Integrated self-test
- No maintenance required
- Partial discharge detection (CAPDIS R5)
- Remote signaling (in combination with IKI-Line)

CAPDIS S1 R4.5

CAPDIS S2 R4.5

CAPDIS Sx_55 R5

Where to measure voltage presence?



Capacitive Test Point

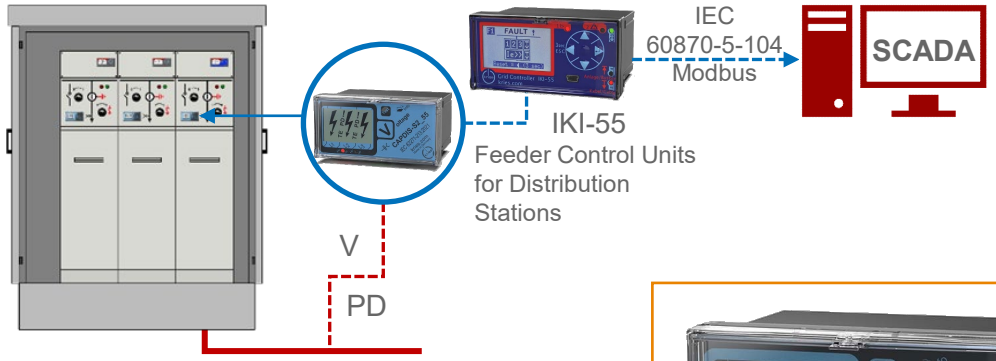
Cable Accessories

Bushings

Capacitive Sensors

Maximize grid reliability and safety with advanced precision voltage detection

Voltage Indicators And Detectors



CAPDIS-S1+ (R4.5)
Capacitive Voltage Detecting Systems

IEC 62271-213, IEC 60255-1
1..52 kV (Medium-voltage)
50 Hz, 60 Hz
Adjustable C2 capacitor
Self-test button
No battery required
Broken lead detection

CAPDIS-S2+ (R4.5)
Capacitive Voltage Detecting Systems
with Relay Contacts

IEC 62271-213, IEC 60255-1
1..52 kV (Medium-voltage)
50 Hz, 60 Hz
Adjustable C2 capacitor
Self-test button
No battery required
Broken lead detection
2 relays contacts
LED

CAPDIS-S1_55 (R5)
Capacitive Voltage Detecting Systems
with Partial Discharge Detection

IEC 62271-213, IEC 60255-1
1..52 kV (Medium-voltage)
50 Hz, 60 Hz
Adjustable C2 capacitor
Self-test button
No battery required
Broken lead detection
Partial discharge detection

CAPDIS-S2_55 (R5)
Capacitive Voltage Detecting Systems
with Relay Contacts for Protection
Applications, with Partial Discharge
Detection

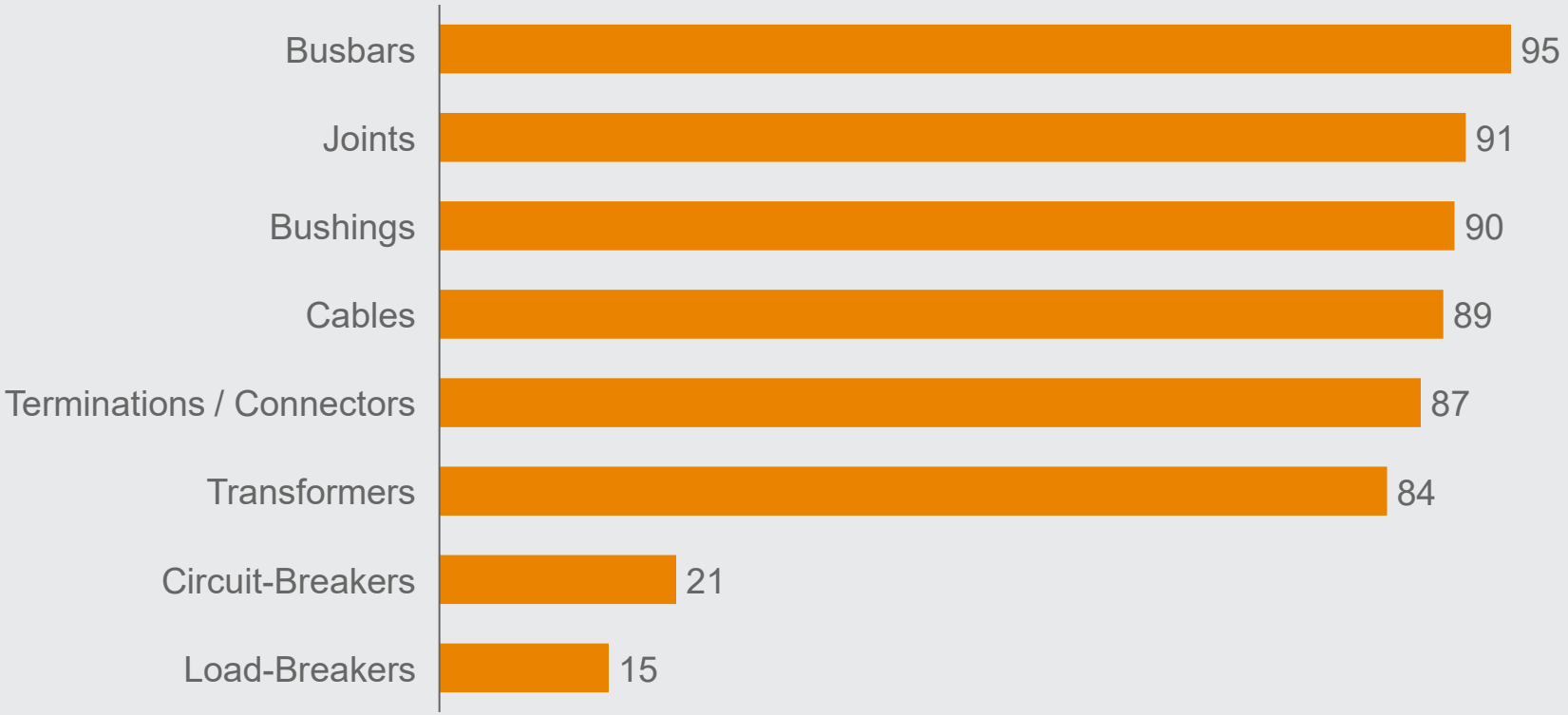
IEC 62271-213, IEC 60255-1
1..52 kV (Medium-voltage)
50 Hz, 60 Hz
Adjustable C2 capacitor
Self-test button
No battery required
Broken lead detection
Partial discharge detection
2 relays contacts
LED

Application for LV and HV :
Capdis-Sx_LV
0,1..2 kV (Low-voltage)

Capdis-Sx_HV
53..480 kV (High-voltage)

Insulation Losses = Root Causes for Failures

In IEEE Goldbook Table 36 the failure-frequencies due to insulation losses - (i.e. Partial Discharge) for individual components are listed:

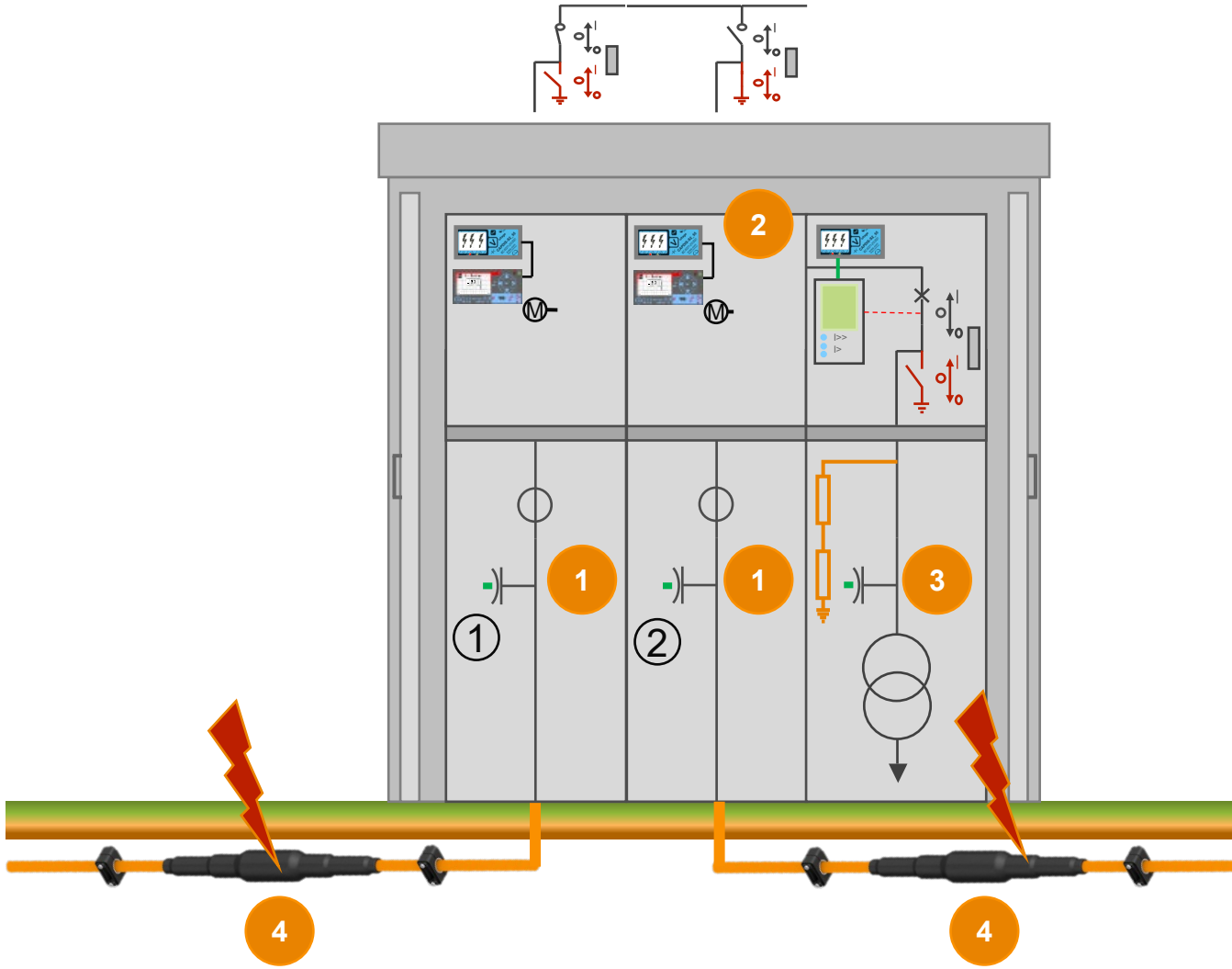


Example: 84% of Transformer failures are related to insulation losses

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



Improving Reliability in Underground Networks

Fault passage indicators for detecting & locating faults in underground networks

EVERY CONNECTION COUNTS

The Real Cost of Power Outages

$10 000 USD
Average replacement cost
of a single medium voltage joint

$100 000 USD
Average cost of an outage
per hour

$18B USD
Estimated lost economy annually
due to animal-induced outages

Utilities face expensive lawsuits for the wildfires they cause.
The commonly reported causes are avoidable:

- Electrocuted wildlife, 10-12%
- Vegetation & conductor clashing, 15-30%

The cost of a failed transformer can easily reach hundreds of thousands of dollars.

Sources: 1. Wildfire Mitigation Plan. Southern California Edison Company, 2019. 2. Bushfire Mitigation Plan. AusNet Services, 2019. 3. The Rand Group LLC, 2021. 4. Utility Products, 2020.

Reliable Fault Detection with our IKI-Line

Directional **short-circuit detection**

Directional **earth-fault detection**

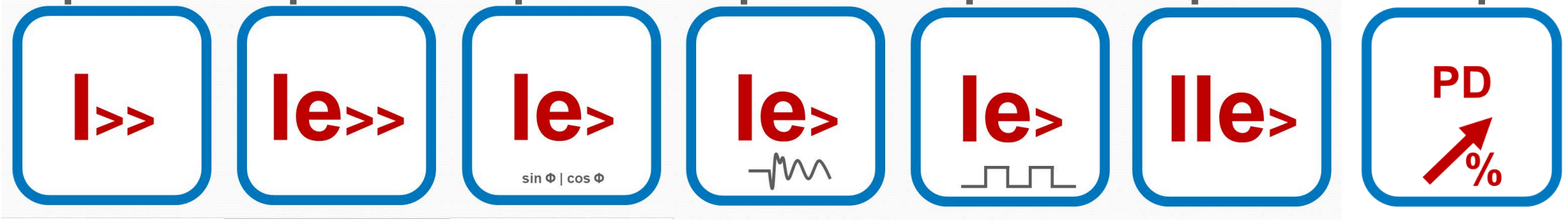
Directional **static earth-fault detection**

Directional **transient earth-fault detection**

Earth-fault detection via pulse-detection

Transient disturbance

Partial Discharge with CAPDIS (R5)



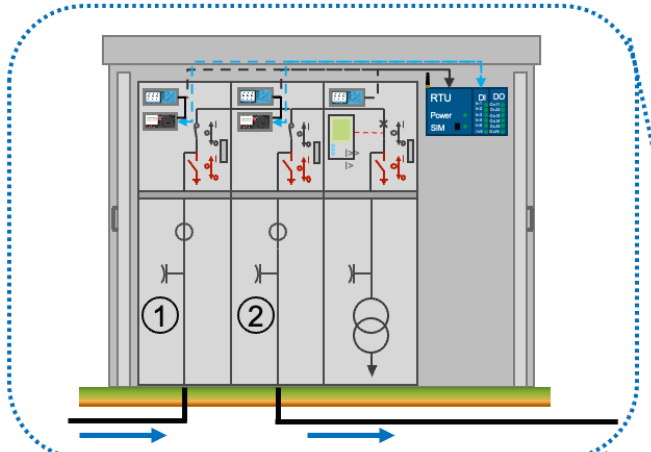
Why Directional Fault Detection and Load-Measuring?

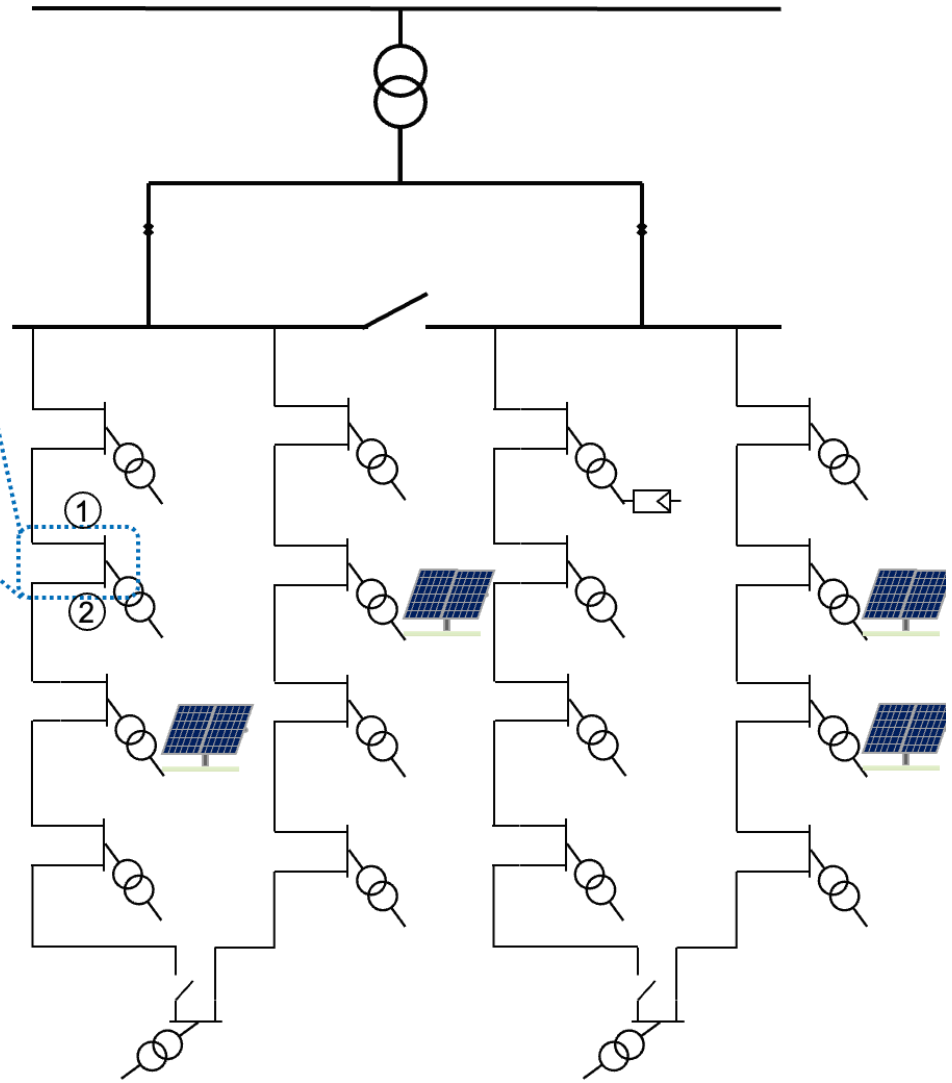
General conditions:

Multiple energy sources lead to different load flow directions.

Challenge in the event of faults:

Fault current can flow in different directions.

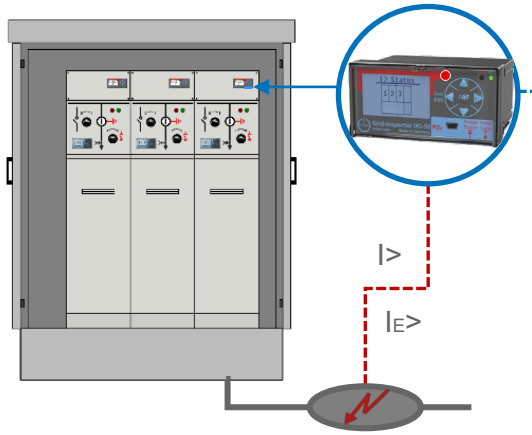




*Fault in direction of the **busbar***

*Fault in direction of the **cable***

Evolution of Underground Fault Passage Indicators



IKI-10
Earth short-circuit indicator, flag + LED

Indication and signalling of earth short circuit

IKI-20
Short-circuit / earth short-circuit indicator

Detection, indication and remote signalling of short circuits / ground short circuit

IKI-23
Universal fault indicator, directional

The complete fault detection, indication and remote signalling with all proven fault detection algorithms for all network

Directional short-circuit / earth short-circuit detection

Directional static ground fault detection (wattmetric method)
Directional transient ground fault detection (wiper method)
Earth fault detection via pulse locating suitable for all neutral point treatments
Modbus

IKI-50
Universal fault indicator for intelligent distribution substations

Early fault detection
of transient disturbances partial discharge trend detection together with CAPDIS-S2_55 (R5)

Load flow measurement
Voltages, Currents, powers, frequencies, cos-phi, . .“
Momentary and average values
Limit monitoring

Network automation
Extensive logic functions freely programmable with PC software KriesConfig

IKI-55
Advanced fault indicator for intelligent distribution substations

Early fault detection
of transient disturbances partial discharge trend detection together with CAPDIS-S2_55 (R5)

Load flow measurement
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Limit monitoring

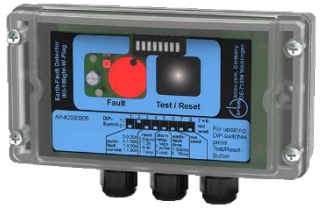
Network automation
Extensive logic functions freely programmable with PC software KriesConfig

Communication
ModbusRTU / IEC-104 / MQTT /REST

Grid Analysis
Disturbance records
PQ evaluation

Fault Indicators for Underground Distribution Lines

Our IKI-10, IKI-20 and IKI-23 are fault indicators designed for switchgears and underground grids from 3 to 52 kV. Efficient fault detection and immediate response are essential for maintaining the reliability of your power grid.



IKI-10 Light

IKI-20

IKI-23
(Directional fault Indication)

BENEFITS // IKI-10 Light

- Ideal for single-phase underground power grids
- Detection, indication and remote signaling of earth faults
- Signalization via integrated bright LED, external LED blinker or mechanical flag
- Integrated battery buffer in case of power loss
- Reset by time or via supply voltage

BENEFITS // IKI-23

- For both single-phase and three-phase grids
- **Directional and non-directional fault detection with CAPDIS**
- Transient disturbance for insulation problems in cables
- Integrated diagnostic function
- Event memory

Increase grid reliability and minimize downtime by monitoring faults and earth faults.

Reliability for Overhead Distribution Networks

Fault passage indicators for detecting & locating faults in overhead networks

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.**

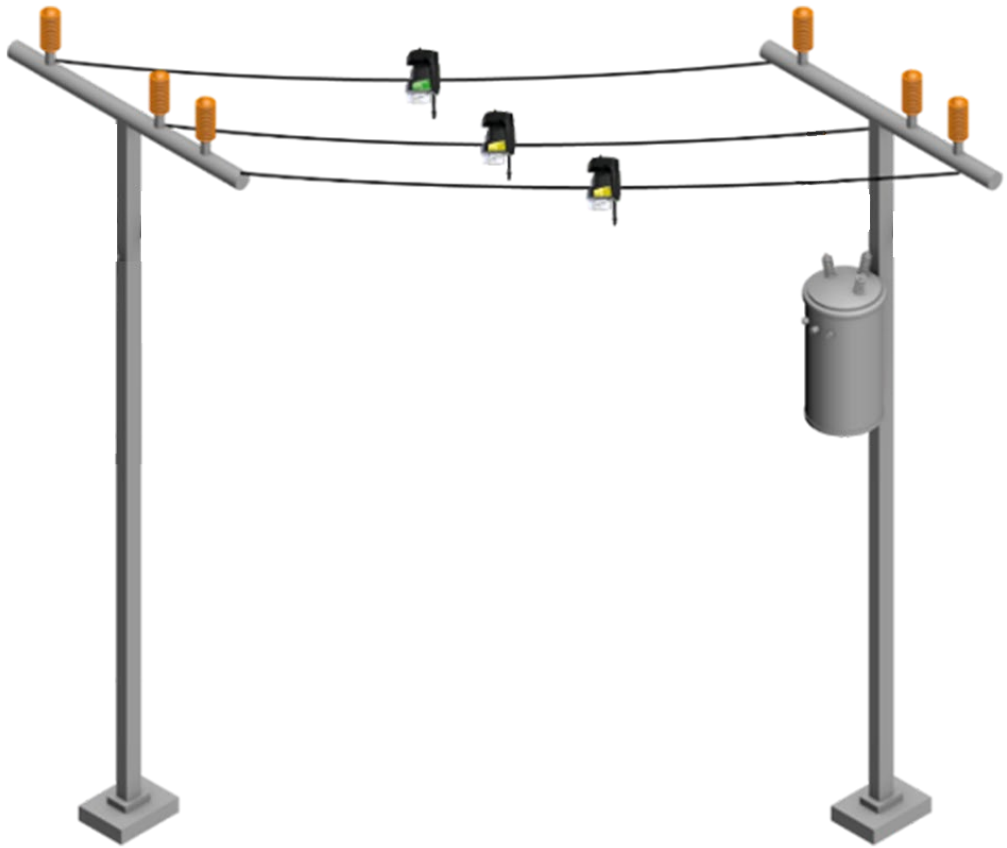
Benefits of Fault Current Indicators

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?

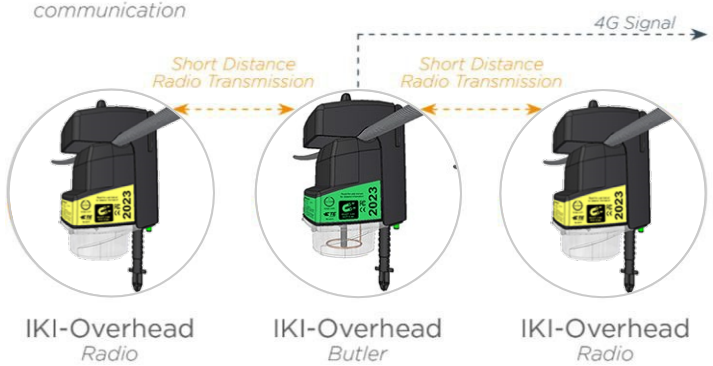
- Troubleshooters will see if the **fault indicator is flashing.**
- **Communicating fault indicators** can also notify Operations, Engineering, or SCADA master system.



Local and Remote Indication Systems

IKI-Overhead
Without communication

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



2. Communicating devices
With SMS/TCP over 4G (NB-IoT/CAT-M1)

Fault Detection:

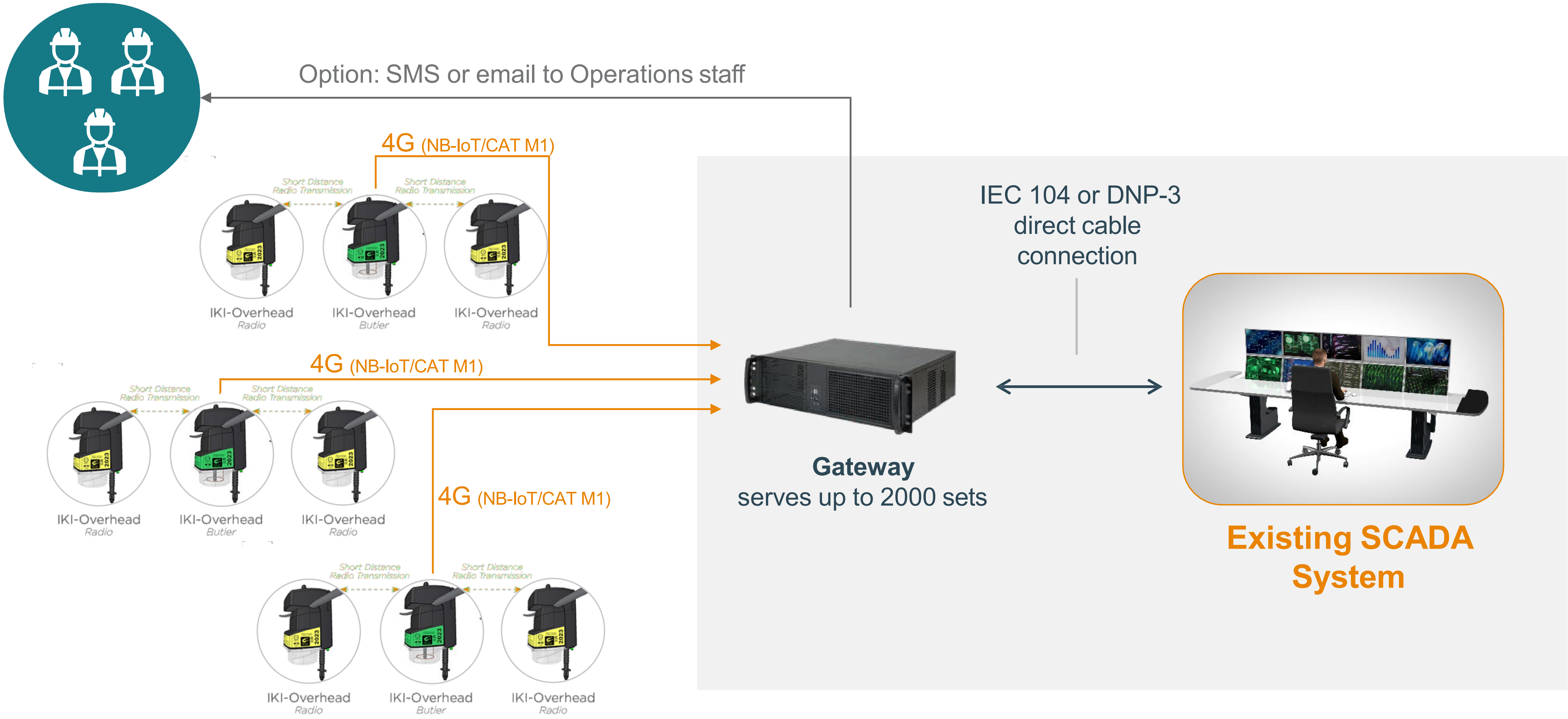
- Overcurrent detection: Auto, 200 A, 400 A, 600 A
- Asymmetry of current
- dI/dt detection (change rate of current over time)

IKI-OH2-Butler
Fault indication and status information through SMS

2x IKI-OH2-Radio linked to 1x IKI-OH2-Butler
Radio link up to 10m

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**.

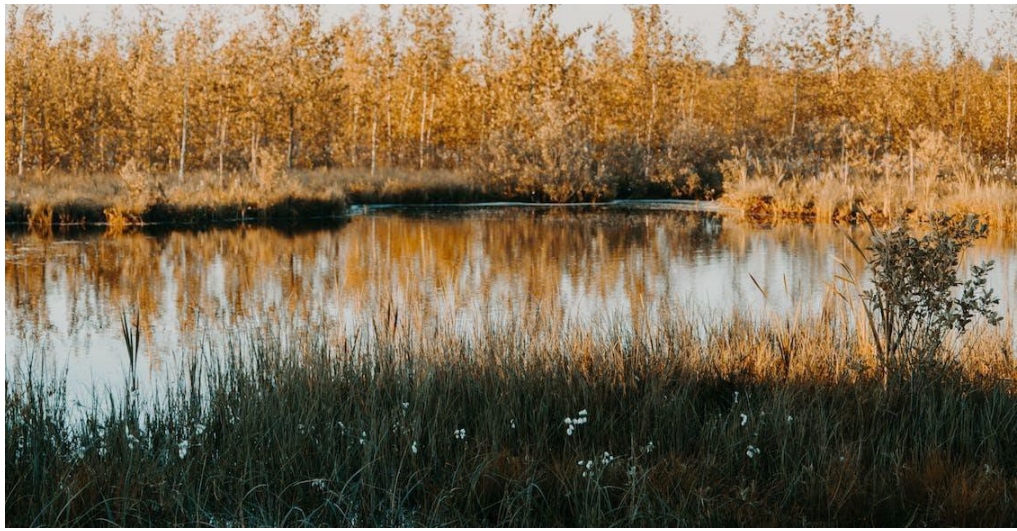
Solution

- **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.

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

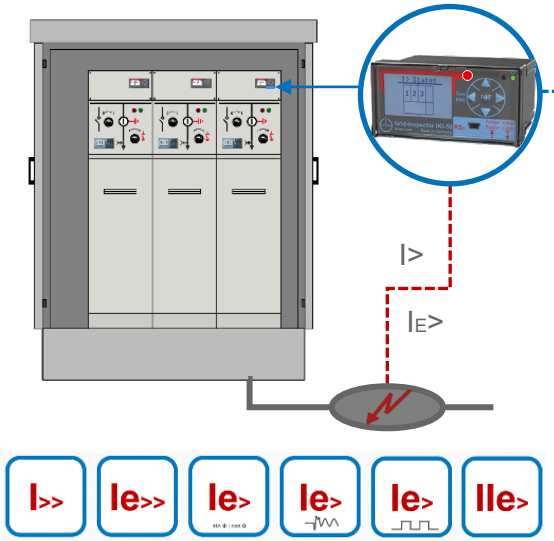
- Place **fault indicators on source edge** of difficult area.
- If fault indicators **not flashing**, no need to enter.

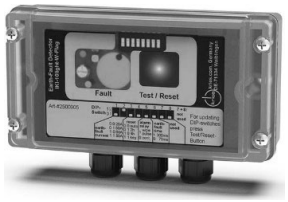
Increasing Intelligence in Underground Grids

Advanced fault passage indicators (FPI) as the backbone of digital RMU

EVERY CONNECTION COUNTS

Evolution of Underground Fault Passage Indicators





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Universal fault indicator for intelligent distribution substations

Early fault detection
of transient disturbances partial discharge trend detection together with CAPDIS-S2_55 (R5)

Load flow measurement
Voltages, Currents, powers, frequencies, cos-phi, . .“
Momentary and average values
Limit monitoring

Network automation
Extensive logic functions freely programmable with PC software KriesConfig

IKI-55
Advanced fault indicator for intelligent distribution substations

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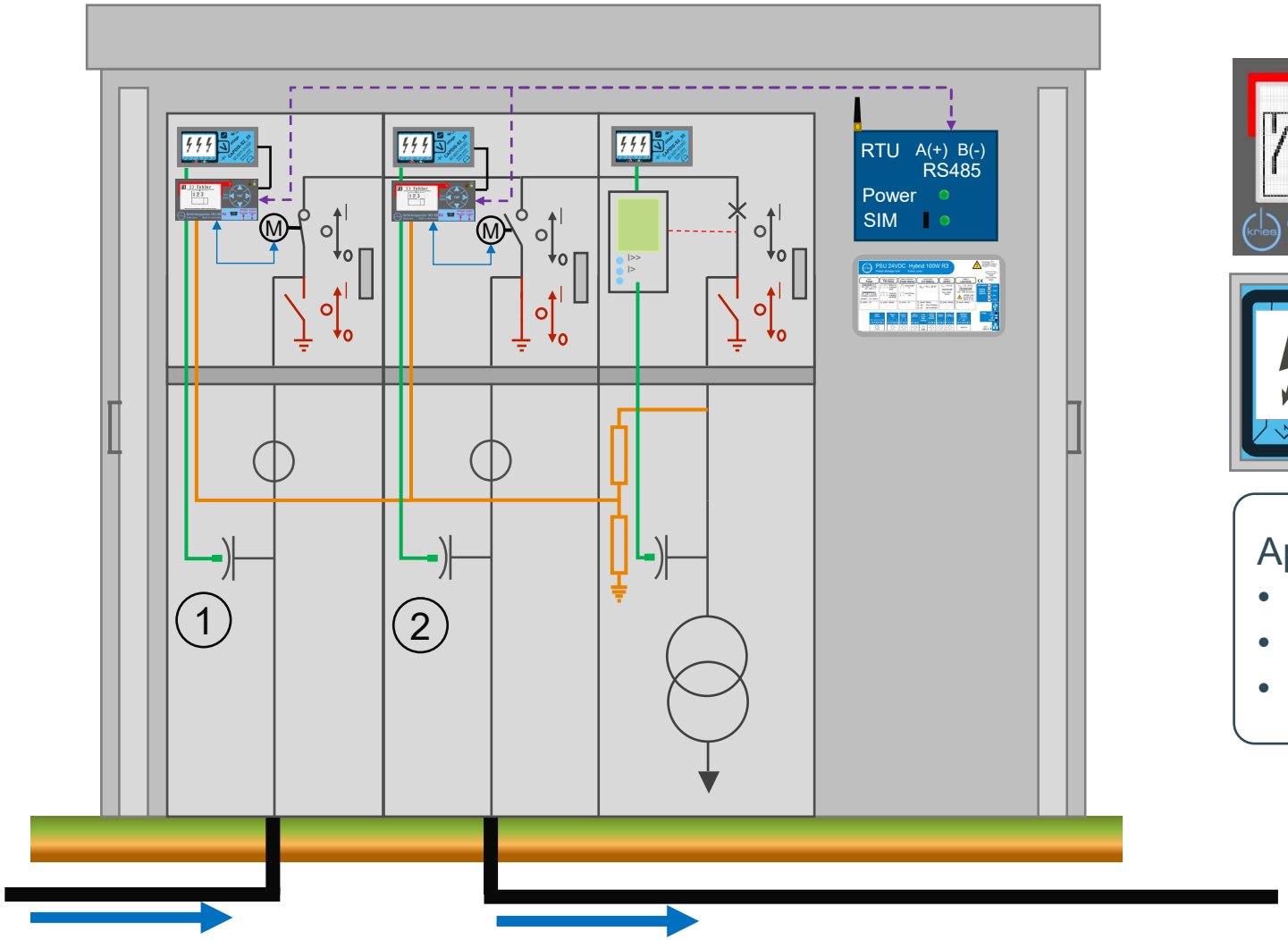
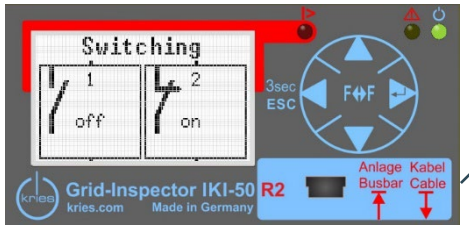
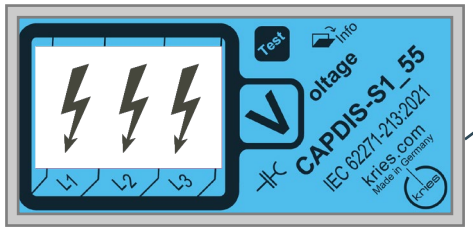
Intelligence per Feeder for RMU to Achieve Flexibility and Scalability





Fault detection
Power flow monitoring
Automation (logic / control)



Power presence
Failure prediction

Applications:
- GIS
- AIS
- Retrofit

U-sensors
I-sensor
PD-sensor

CAPDIS + IKI = Grid Intelligence

CAPDIS-S1
Voltage Indication

CAPDIS-S2 (R5)
Voltage Indication & Partial Discharge Detection

IKI-23

→ Local Indication

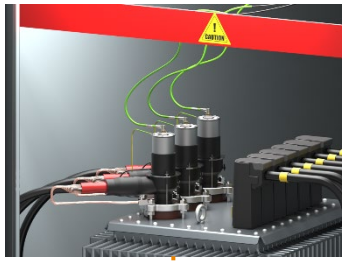
IKI-50

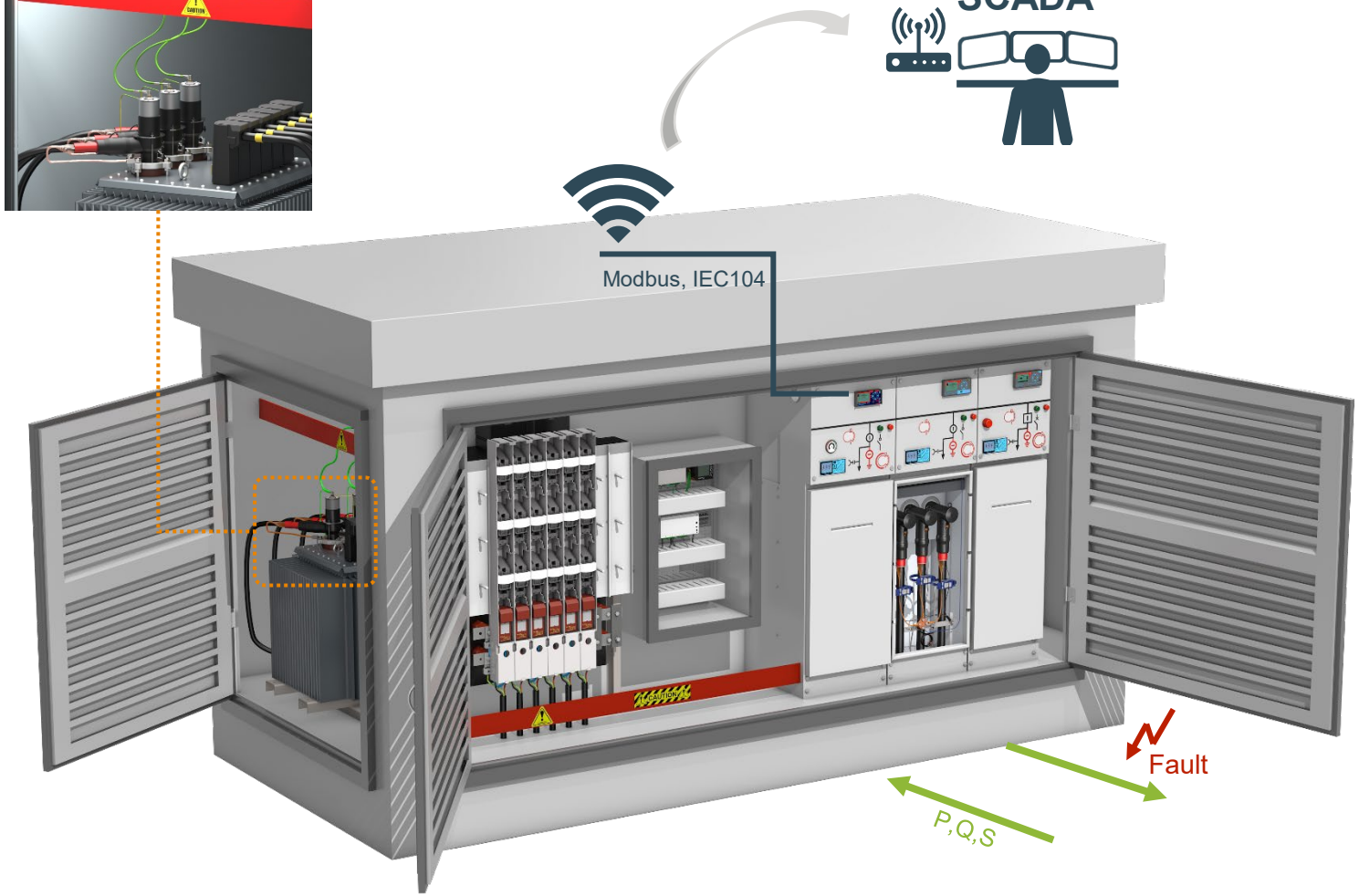
→ Remote Monitoring
→ Remote Control (switching)

IKI-55

→ Remote Monitoring
→ Remote Control (switching)
→ Automatic Switching

Advanced FPI for Smart Secondary Substation

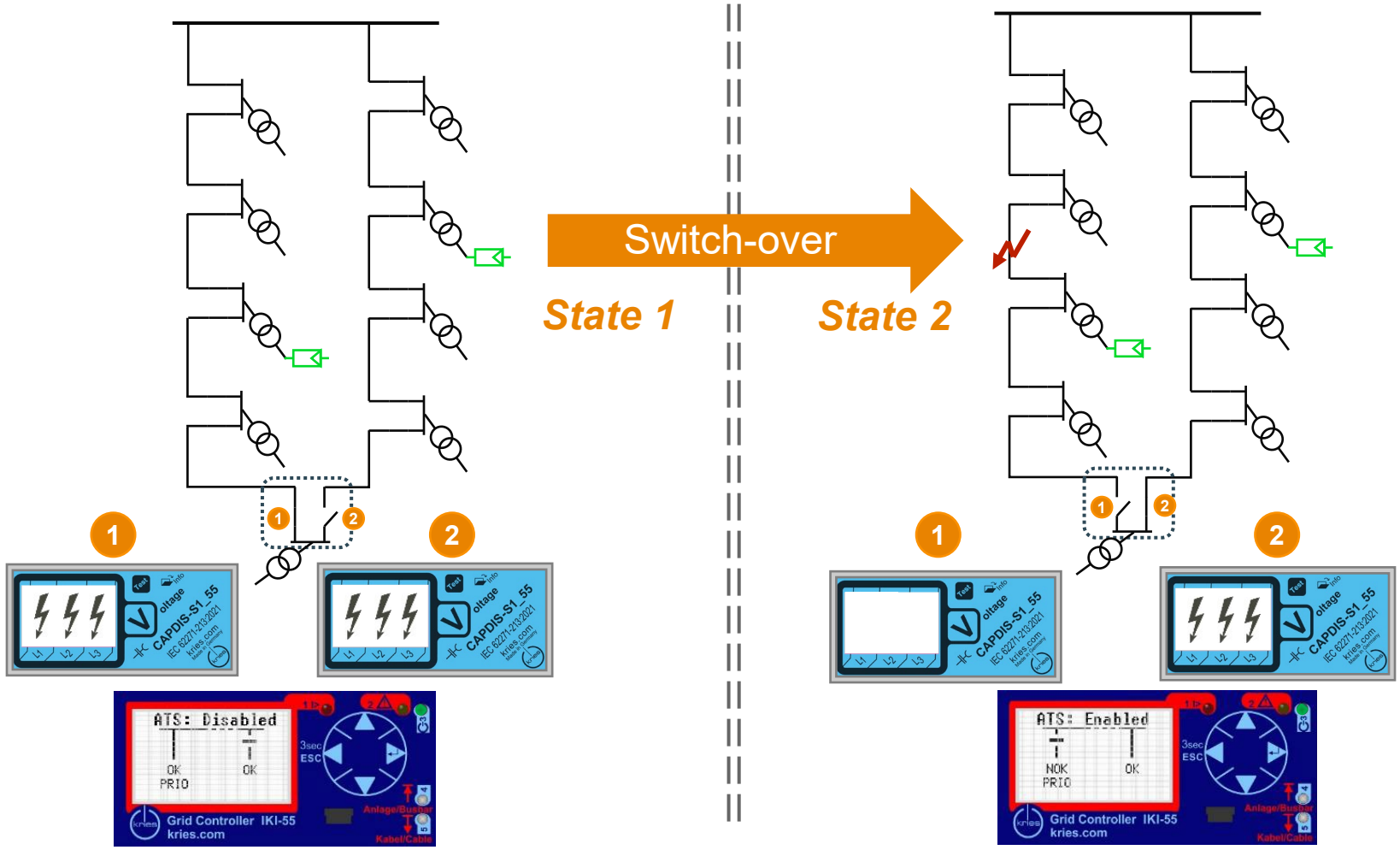




Functionalities	IKI-50	IKI-55
Directional fault detection	✓	✓
Failure prediction (+ **CAPDIS-S2_55 R5**)	✓	✓
Power flow monitoring	✓	✓
Remote signalling	✓	✓
Remote control	✓	✓
Communication interface	✓	✓
Precise voltage measurement and cross-calibration	✓	✓
Network interface	-	✓
Power grid analysis (PQ, Disturbance recorder)	-	✓

Use Case: Automatic Transfer Switch

Downtime reduction at NOP and VIP using Capdis & **IKI-55**



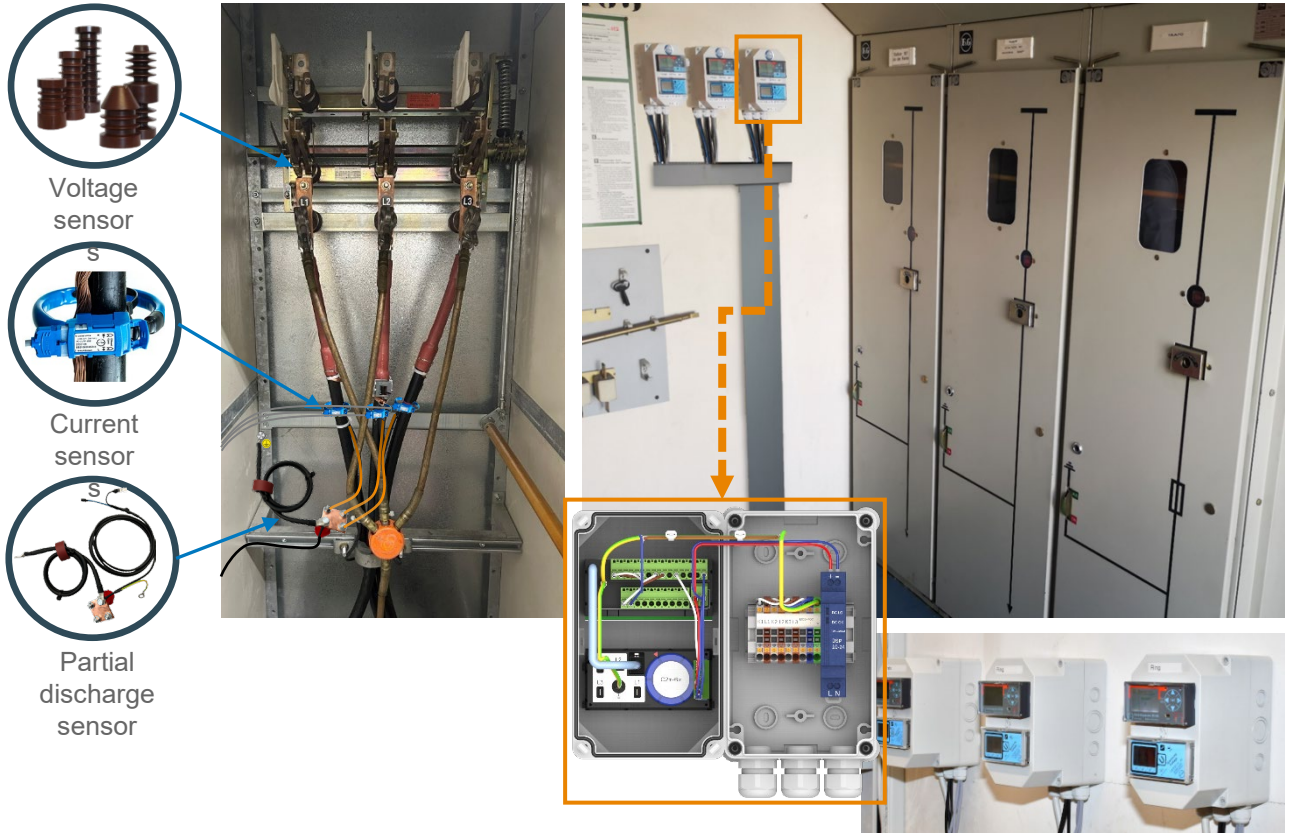
ATS configuration and commissioning

Intelligence for Retrofit - Kries Feeder Inspector (KFDI)

A Comprehensive Plug & Play Solution

Complete solution for monitoring the condition of feeders in distribution networks and offshore installations. Ideal for modernization projects, new switchgear installations, and transition cabinets, **the KFDI provides critical insights to enhance grid performance and reliability**.

With its **Plug & Play design**, the KFDI is user-friendly - **simply connect the sensors to the main terminals for seamless setup**. Its innovative housing, equipped with magnets, ensures a quick, safe, and hassle-free installation process.



Industrie Utilities Offshore

Key Takeaways from Today's Webinar

Distribution power networks are changing as a results of transition to renewable sources of power.

Reliable supply of power remains a key area of focus for network operator.

Digitalization provides the right tool to overcome these challenges.

Combining VDIS, FPIs and the right sensors offers an effective solution for achieving the ideal level of digitalization, enabling reliable and intelligent power grids.

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

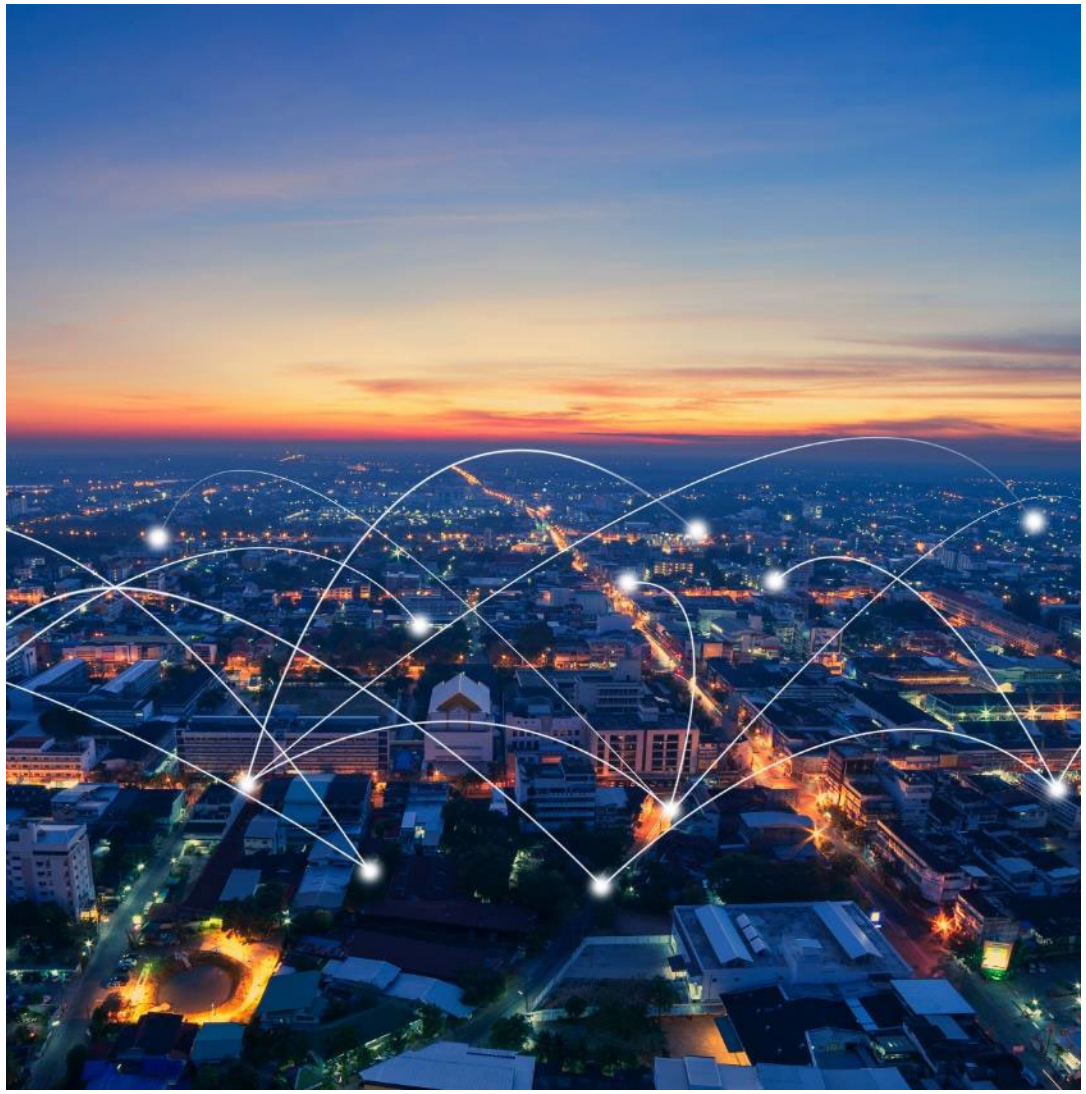
Q&A

Visit TE.com/smartgrid to discover our full range of TE Kries grid monitoring and automation solutions.

Register for our upcoming webinars and gain access to our webinar library at TE.com/webinar-series

Hamed Rezaei
Global Product Manager, Grid Monitoring
TE Connectivity

Tilo Kubach
Head of Sales, Grid Monitoring
Kries Energietechnik, now part of TE Connectivity



EVERY CONNECTION COUNTS

TE connectivity