

# **2023-2025 WMP Joint IOU Covered Conductor Working Group**

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**New Technologies  
Workstream**

**Topic:  
EFD**

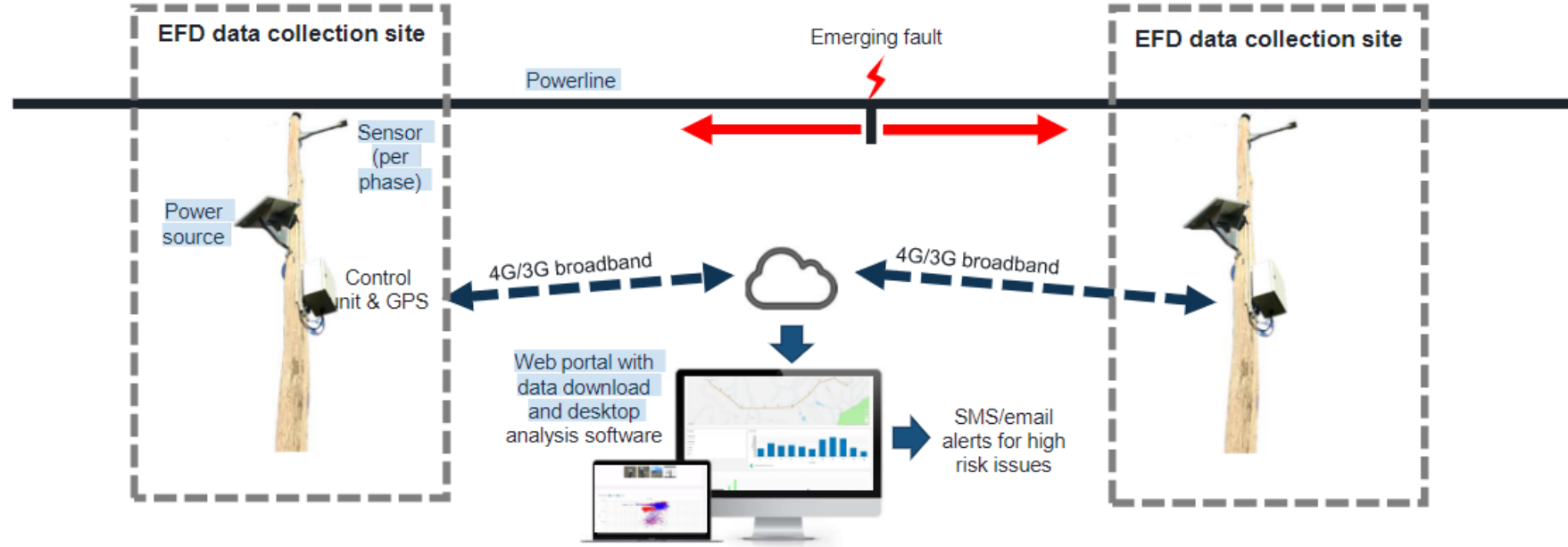


- Technology developed by IND.T in Australia to help prevent Bushfires
- The EFD system uses accumulated detections of partial discharge events to pinpoint equipment issues.
- Detection conditions types
  - Broken damaged conductor/splices
  - Broken damaged insulator
  - Failing service transformers
  - Vegetation encroachment
  - Fuse Cutout Malfunction

# SENSOR THEORY OF OPERATION AND SPACE

Sensors installed along circuit approximately every 3 miles

## Early Fault Detection (EFD) system

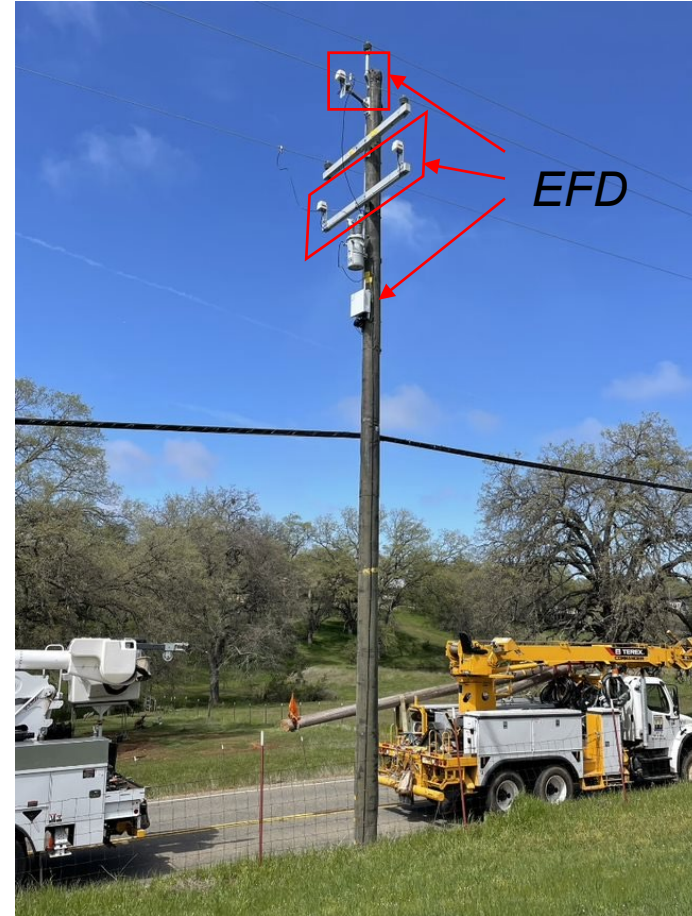


High frequency monitoring technology.

EFD delivers information you can act on before the event.

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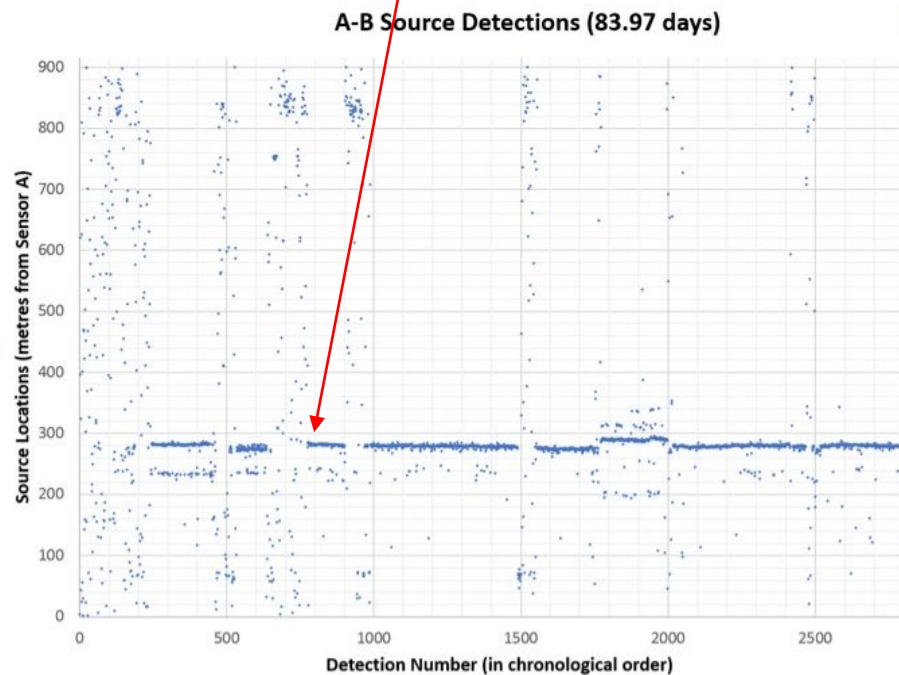
# Installation



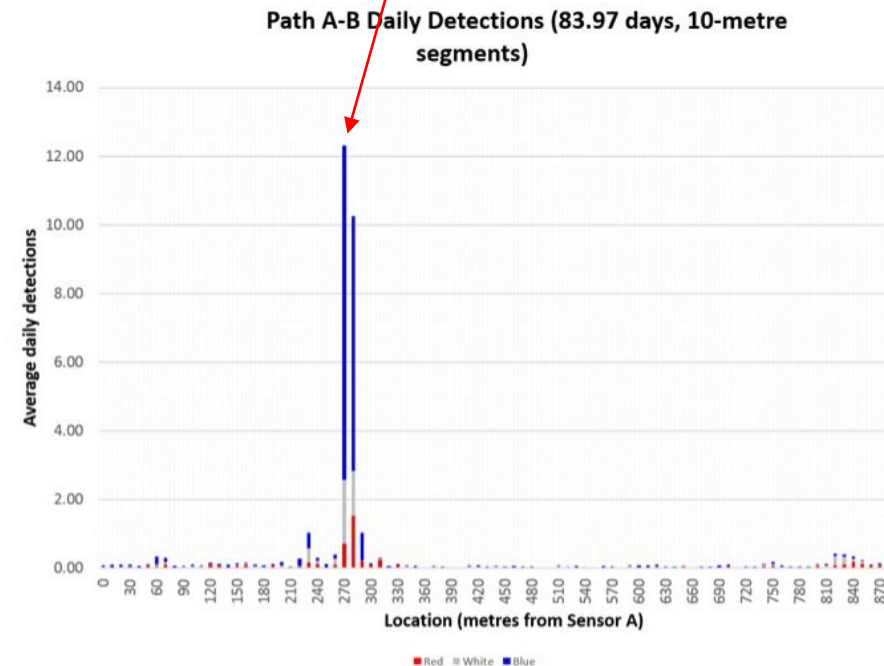
# Signal Analysis Example

## Signal Analysis Example

- Source Detections indicate where on a sensor path a problem is located

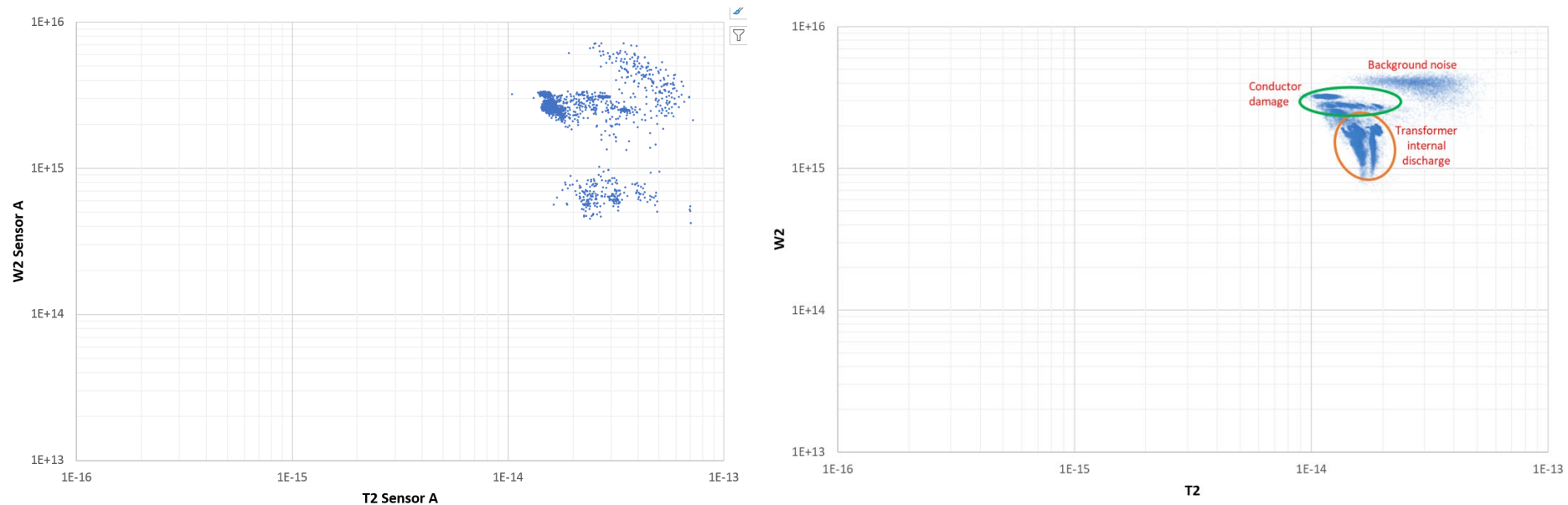


- Daily Detections indicate on which phase a problem is located



# Signal Analysis Example

- Below is SCE frequency-time (FT) Chart (left) with comparison FT Chart from another utility (right)
- Patterns on FT chart indicate potential cause of issue(s)
- Consistent across different voltage classes and utilities





# Examples of Findings - SCE



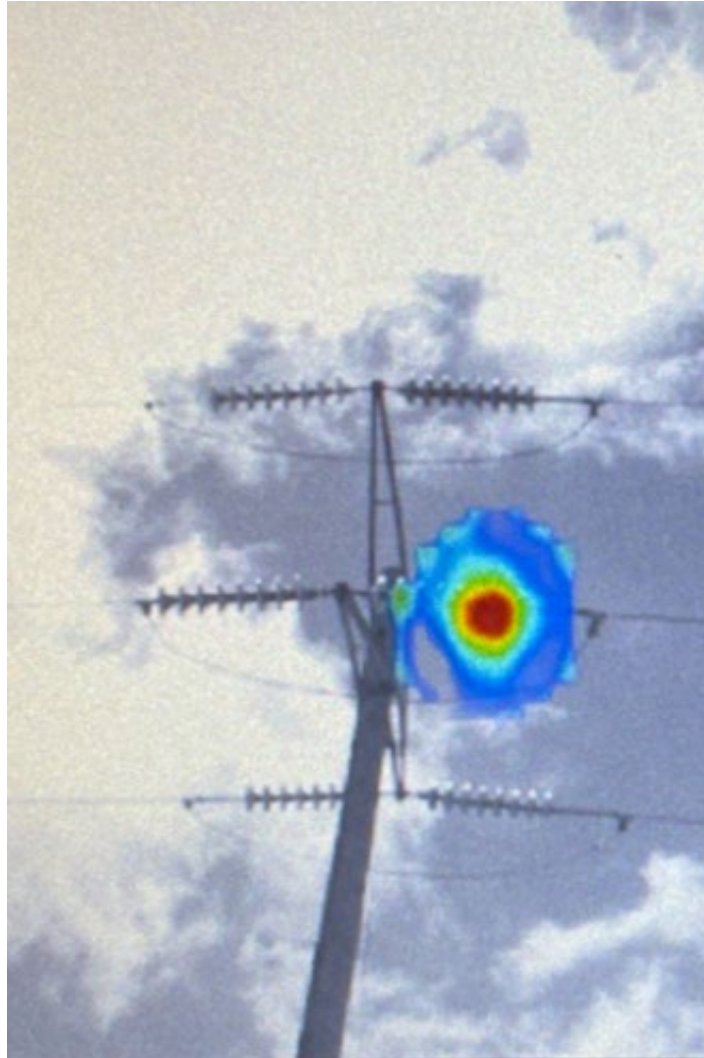


# Examples of Findings - SCE





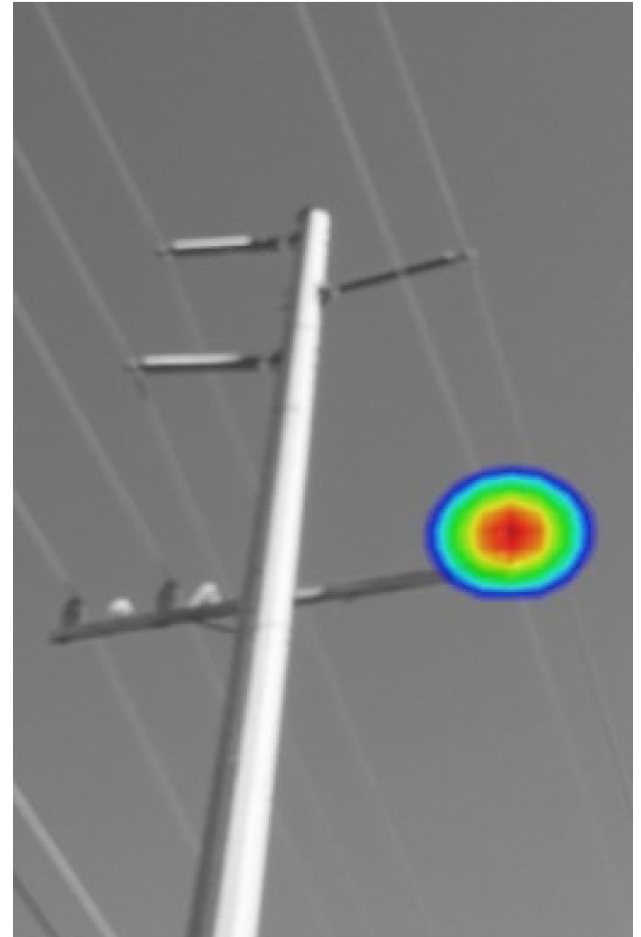
# Examples of Findings - SCE



Industrial Acoustic Imaging Camera

FLIR Si124

# Examples of Findings - SCE





# Examples of Findings - SCE





# Examples of Findings – SDG&E



# Examples of Findings – SDG&E





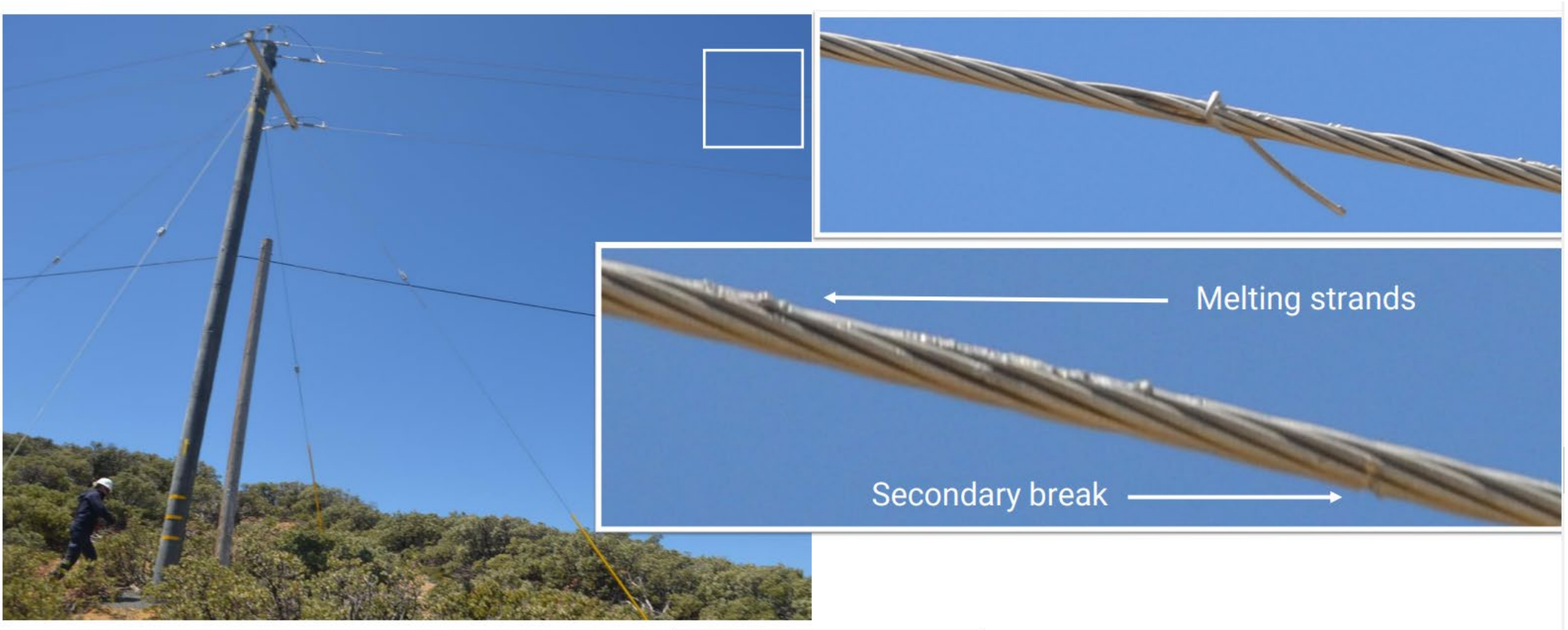
# Examples of Findings – SDG&E





# Examples of Findings – PG&E

Identified Condition – Broken Strands



# Examples of Findings – PG&E

Identified Condition – Broken Strands



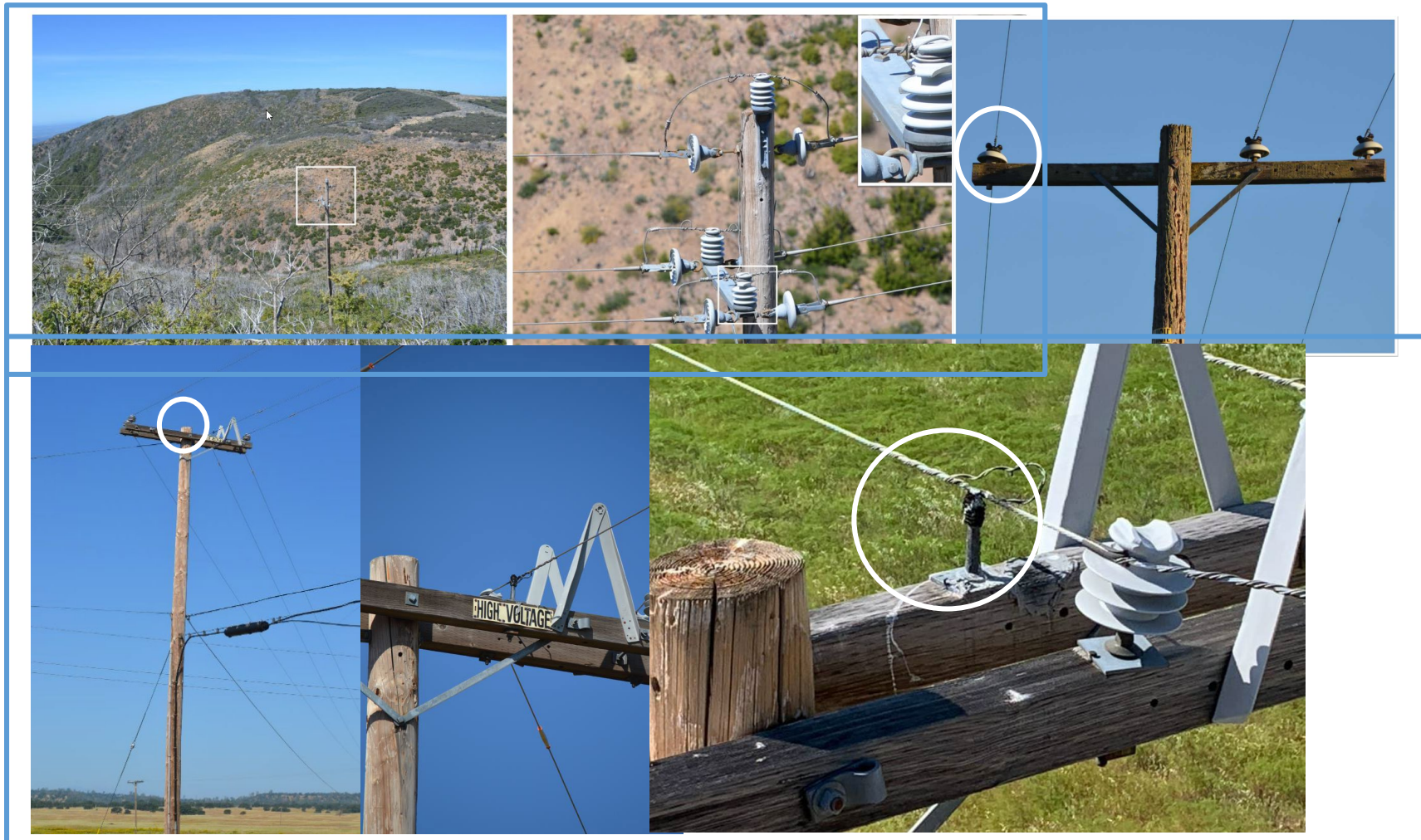
# Examples of Findings – PG&E





# Examples of Findings – PG&E

Identified Conditions- Broken Insulator/Pin, Melted Insulator



# Technology Overview – PG&E

## Situational Awareness Sensor Technology – Overview



### Line Sensors / cFCI's

- Single phase, conductor mounted harvesting device; generally requiring 25 amps continuous power (line sensor) or battery-powered (cFCI)
- Continuously monitoring to capture overcurrent events
- Generates alerts and waveforms thru to PI and DMS; these alerts are usable in fault locator models like CYME to estimate disturbance location



### EFD – Early Fault Detection

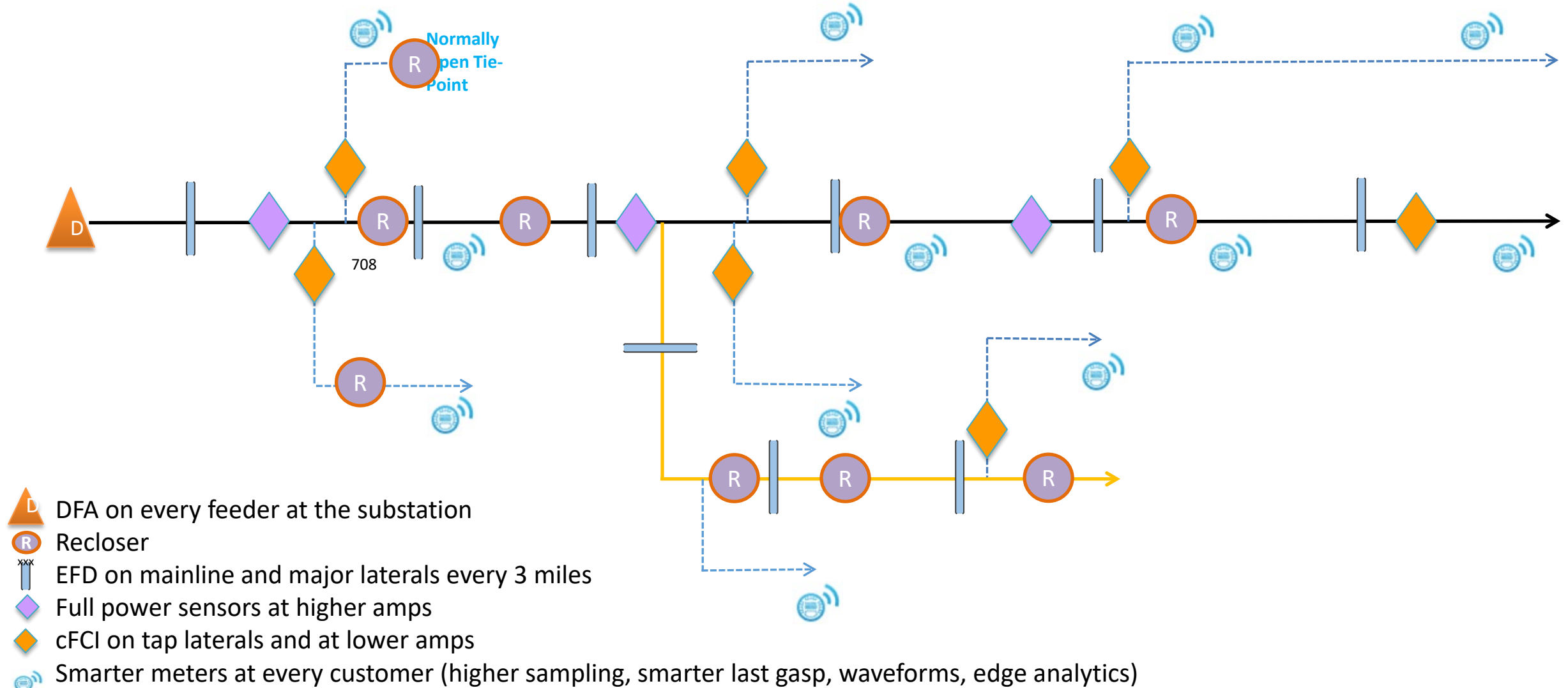
- RF sensors mounted underneath conductor; 3 miles between sensor sets
- Sensors work in coordination from set-to-set; samples on a duty cycle basis
- Display matrix identifies concentrated patterns of discharge to a single span



### DFA – Distribution Fault Anticipation

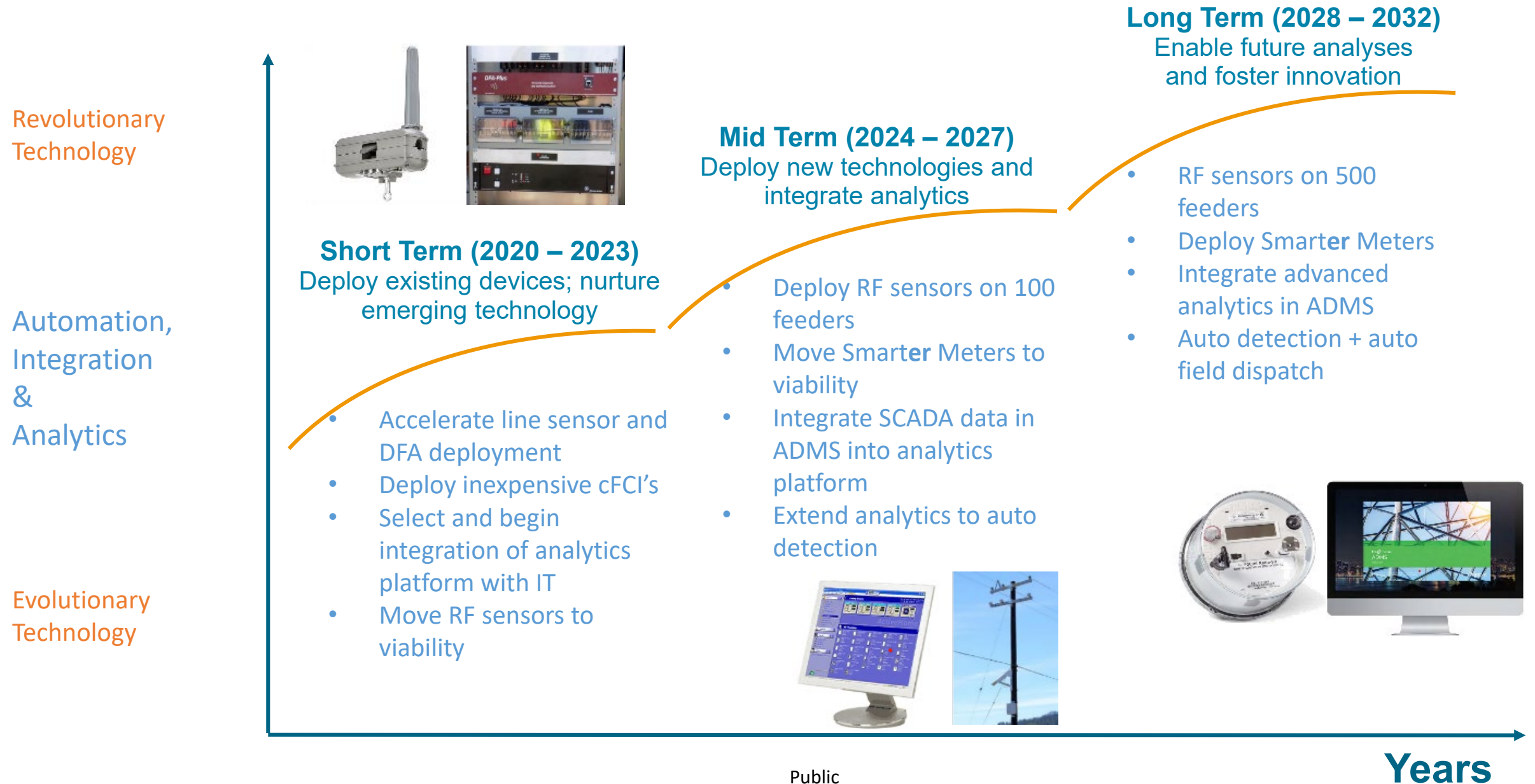
- Substation CT / PT-based device measuring volts, amps and arcing
- Monitors magnitude, phase, harmonics, real and reactive power, cycle-to-cycle deltas in these values
- Clusters and categorizes events and generates waveforms; these alerts are usable in fault locator models like CYME to estimate disturbance location

# Illustrative Circuit When Fully Implemented – PG&E





# Rollout Process – PG&E



# Rollout Process – PG&E

