Substation Condition Monitoring System

Automated 24×7 Thermal Monitoring of Substation Assets

Background

Critical substation assets can fail without warning - causing blackouts, costly emergency repairs, revenue loss, and safety hazards. Root cause? Hidden heat buildup at connections and terminations due to increased electrical resistance (I^2R) from looseness, corrosion, imbalance, aging, or harsh environments. It often goes unnoticed until it is too late.

This leads to carbonisation, arcing, trips, equipment damage, or even fires. That is why continuous monitoring of substation assets is essential to prevent critical failures before they occur.

Current Practices and Challenges

Thermal inspections are carried out periodically using handheld cameras. However, these occasional, operator-dependent checks
- Leave blind spots
- Fail to detect heat buildup between inspections
- Face accessibility and weather constraints
- Produce inconsistent results due to human intervention

Handheld Periodic Monitoring

The Smart Alternative

A continuous condition monitoring system that'
- Watches every asset 24×7
- Detects abnormal heating early
- Sends alerts and reports for planned maintenance
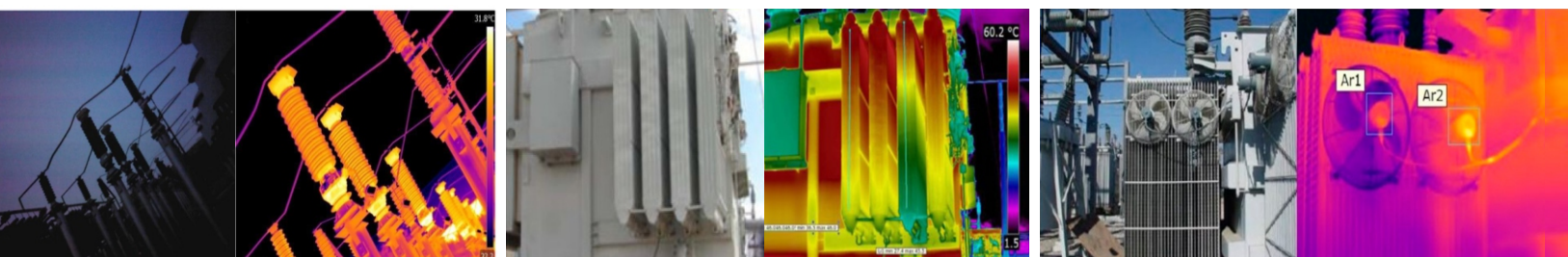
Key Benefits
- **Prevent outages** → Reduce revenue loss
- **Enhanced human and asset safety** → Avoid fire and hazard risks
- **Boost reliability** → Reduce breakdowns and extend asset life
- **Lower O&M costs** → Wide coverage quickly, data-driven, targeted maintenance
- **Increased system efficiency** → Reduced energy loss and heat build-up

Continuous Condition Monitoring

Assets Monitored

Transformer | Circuit Breakers | Isolators | Bushing & Arrestors | All Critical Jumpers & Terminations

Annual ROI Snapshot for a 220 kV Substation

PAYBACK PERIOD: LESS THAN 1.5 YEARS

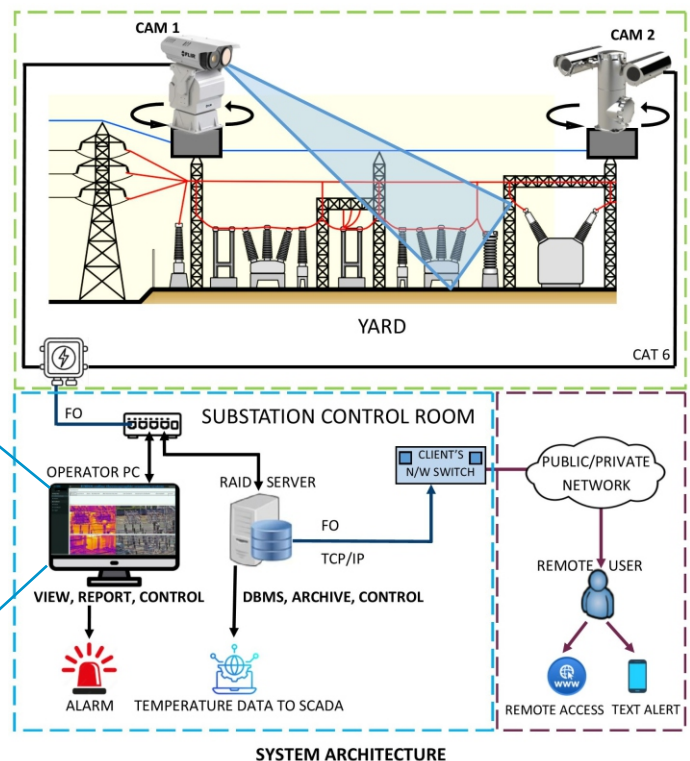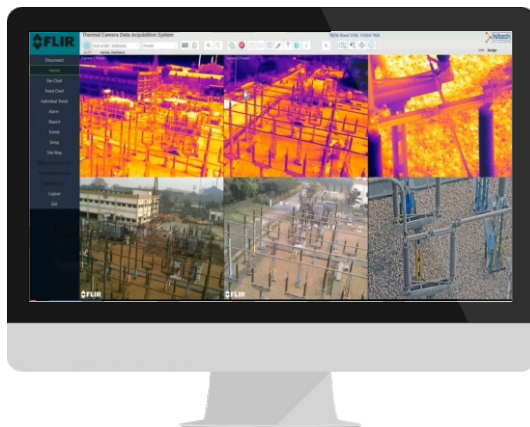| Savings head	Cr, INR
Outage reduction	1.26
Avoided throughput loss	0.42
Avoided asset replacement	0.20
TOTAL ANNUAL SAVINGS	**1.88**

Calculation parameters:
20 hrs annual outage reduction | 150 MW / hr power lost | ₹6/kWh energy cost | 350 GWh annual throughput | 0.2% loss improvement from hotspot fixes | 0.7 load factor

System Architecture

Output

- **Instant Alerts:** Email, SMS, WhatsApp with thermal reports
- **Live View:** Thermal + visual feeds with PT control, event storage and recall
- **SLD dashboard:** Traffic-light based monitoring (Green / Yellow / Red)
- **Analytics:** Trend charts, scheduled PDF/CSV reports
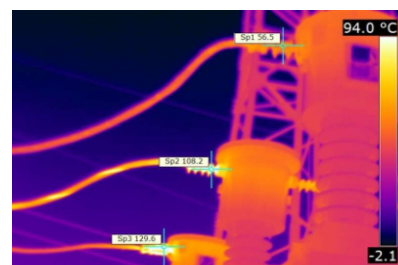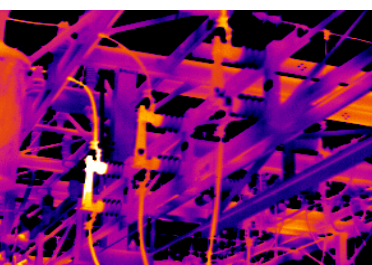

SYSTEM ARCHITECTURE

Software

- Asset mapping with substation map view
- Configurable scan frequency and temperature thresholds per asset
- Analytical tools (spot, box, polygons, isotherm alarms) for precise hotspot detection

Hardware

- IP-based thermal and visual cameras with telephoto lenses on dual-arm PTUs for full coverage
- Cameras connected to a central RAID server via dedicated network, with remote monitoring capability
- Multiple protocols available: RTSP, TCP/IP, GigE, MOD BUS, SMTP, MQTT, HTTP, REST API, FTP

Features and Functionalities

- Industrial grade thermal camera with 2-yr product and 10-yr detector warranty
- IP67 Pan-Tilt Unit (5+ years uninterrupted operation); 360° pan and ±90° tilt movements
- High thermal resolution: 640×480, <25 mK sensitivity, ±2 °C accuracy
- Best distance to spot ration which detects 17.6 mm hotspot from 100 m range
- User-friendly GUI with traffic-light status

- High frame rate: 30 fps to capture fast transients
- Scalable, SCADA - integratable, and centrally controllable from SLDC
- Wide range of optics: 6°-80° lenses for varied substation layouts
- In-house developed software with local support
- Optional AI-based perimeter surveillance and intrusion detection
- Meets IEC 62443 and ONVIF cybersecurity and data privacy protocols

Some of our Customers

About Hi-Tech

- Founded in 1989; serving power and process industries; executing 4000+ contracts annually
- Presence: 14 locations; 2 manufacturing facilities; 4 subsidiaries
- Team 400+, 150+ engineers, 35+ service team

About Teledyne FLIR

- Founded 1960; NYSE-listed; HQ Oregon (USA); 6 production facilities; 2024 sales ~$3B+
- Global leader and pioneer of thermal imaging technology
- Installation base : 5 million+ in 120 countries and 1,00,000+ in India

Hi-Tech has been the premium partner of Teledyne FLIR in India since 2016, jointly catering to power & utilities, oil & gas, metals & mining, process & manufacturing sectors across the country.

Automation Partner

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