SP Energy Networks

Energy Innovation Summit 2025

Battery Condition Monitoring Project

Creating Trusted Solutions to Improve Fault Protection on Interconnected Distribution Networks

Contacts

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Agenda

SP Energy Networks

- Introduction
- Background
- Problem Statement
- Solution Conceptualisation & Design
- Benefits
- Next Steps

Project partners:

SP Energy Networks | ea technology

Who We Are

SP Energy Networks, part of ScottishPower, owns four regulated electricity network businesses in the UK:

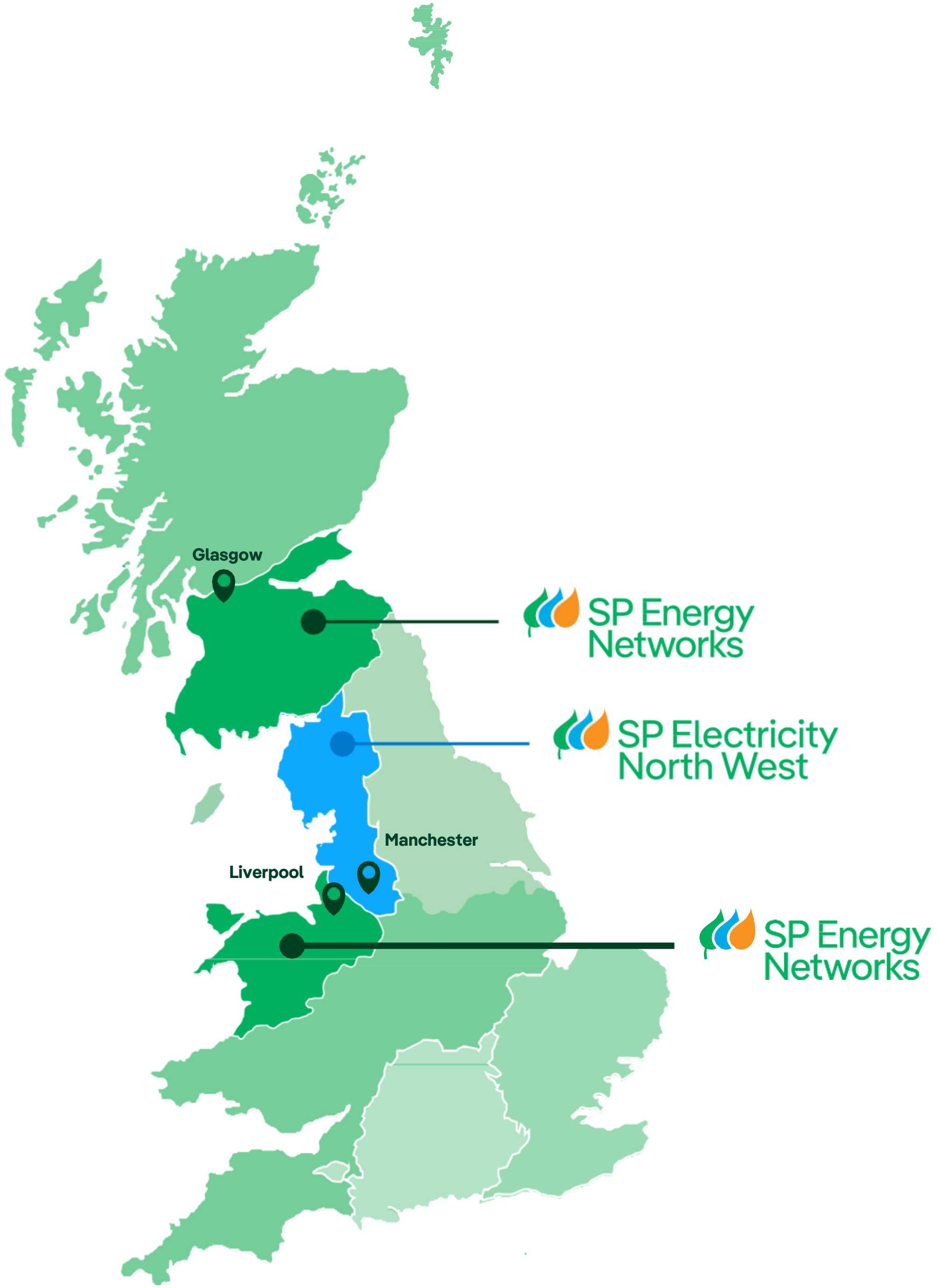
- SP Distribution plc (SPD)
- SP Transmission plc (SPT)
- SP Manweb plc (SPM)
- SP Electricity North West (SP ENW)

Together we keep electricity flowing to over **12 million** people across a network spanning more than **172,000 kilometres.**

Operating in some of the UKs largest cities as well as significant rural areas. It's our job to move electricity to and from homes and businesses over our network.

Our aim is to deliver a safe and reliable electricity supply 24 hours a day, 365 days a year whilst providing exceptional value for money.

It's a role that puts us right at the heart of the UK's Net Zero carbon emissions ambition.



Background

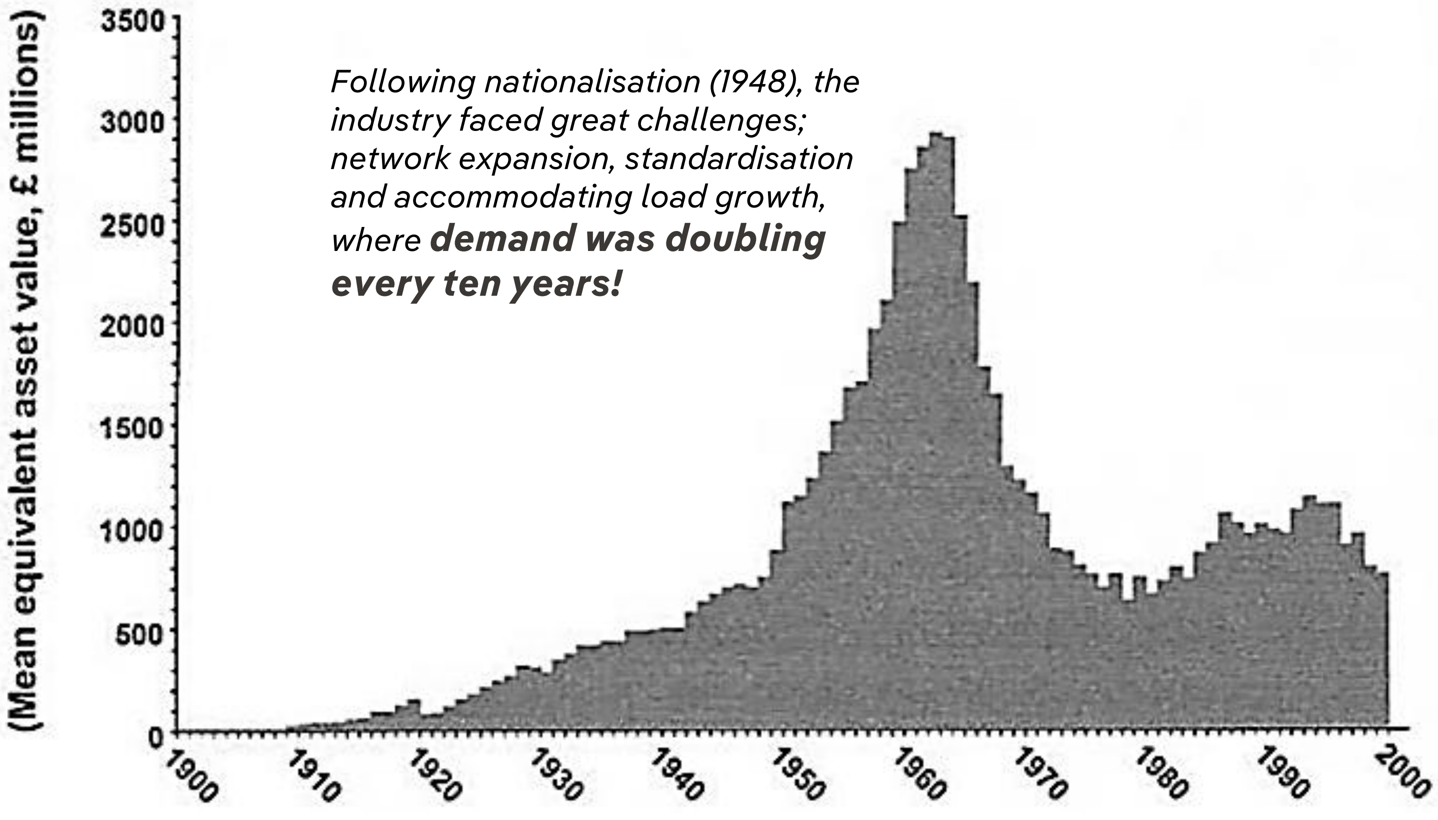
Background

- Electricity networks have evolved over an extended period of time
- Many features of past practice continue to exist for a very long time
- These past features also have a bearing on future design given the need to make the best use of what we already have
- Some knowledge of the background is necessary to a full appreciation of distribution practice
- This makes it somewhat difficult to make categorical statements about a distribution network for it is not, nor will it ever be, a coherent entity exhibiting characteristic features uniformly throughout it

P. d'E Stowell, 1955

Chairman of the Mersey and North Wales Centre of the Institution of Electrical Engineers

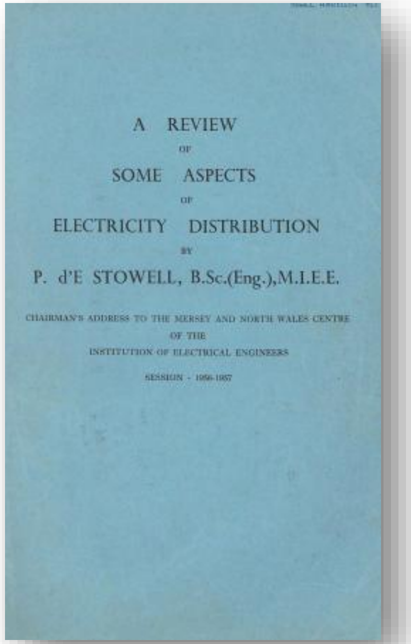
Asset base age profile of British electricity distribution networks *(2004 cost base)*



Source: Douglas J. (2007)

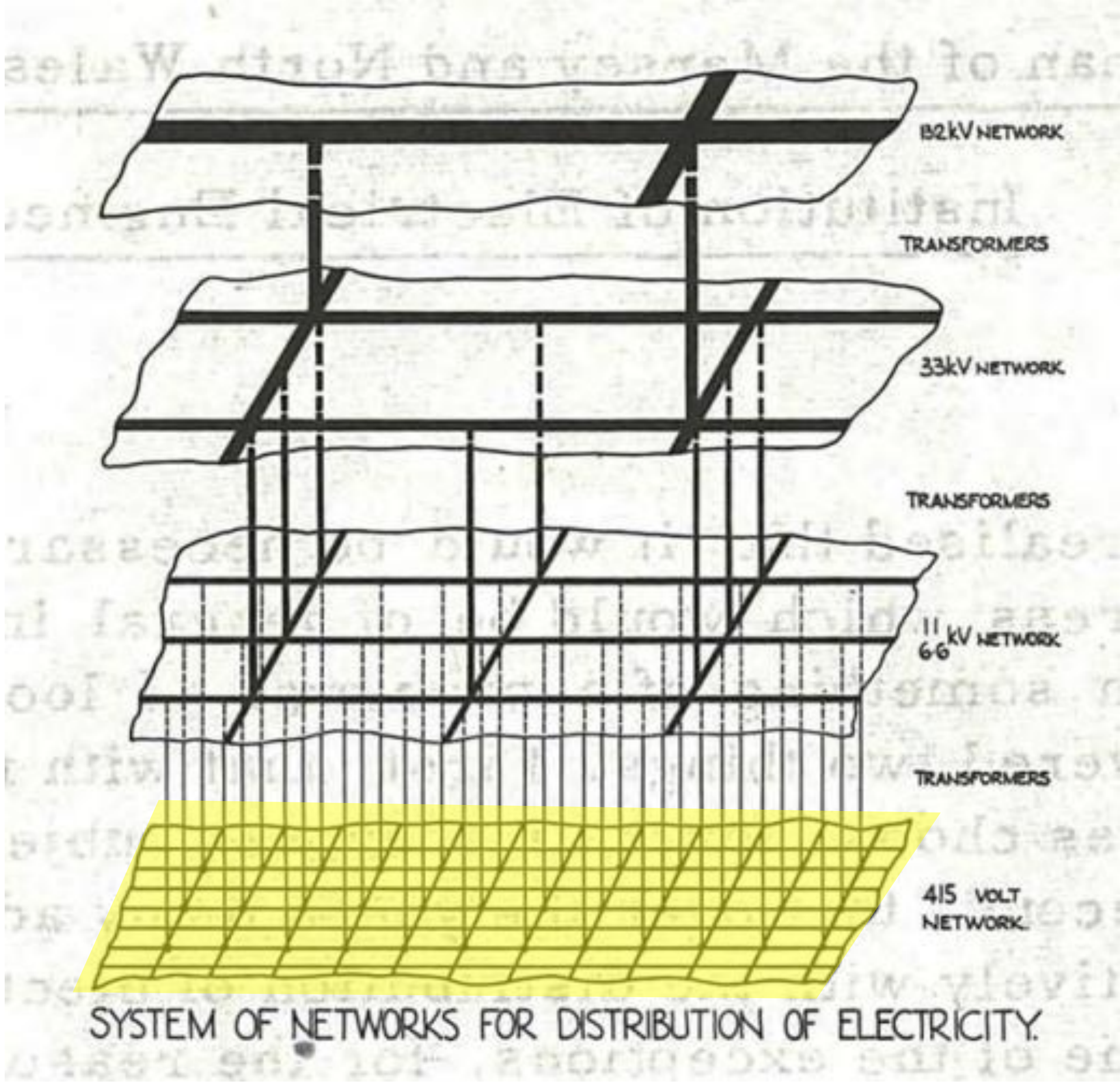
Background

The then Merseyside & North Wales Area Board was unique in adopting fully interconnected low voltage (LV) distribution networks as standard practice from 1950s.



http://manweb-remembered.co.uk/PStowell.pdf

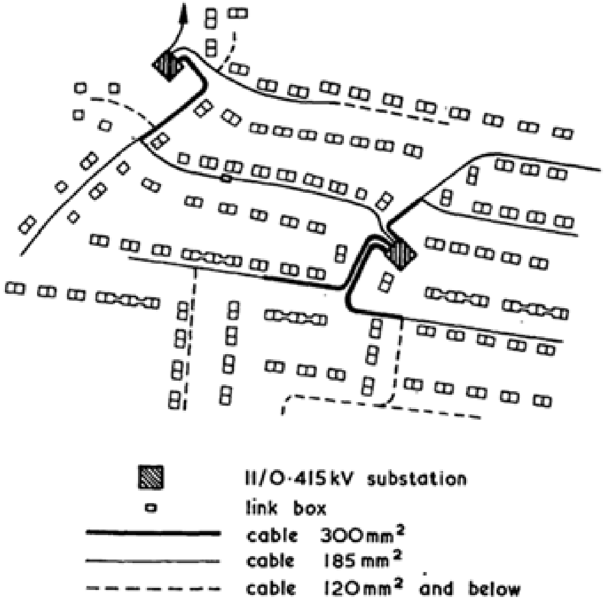
Interconnected LV networks



Background

Examples of electricity distribution network topologies designed for 1960/70s housing estates

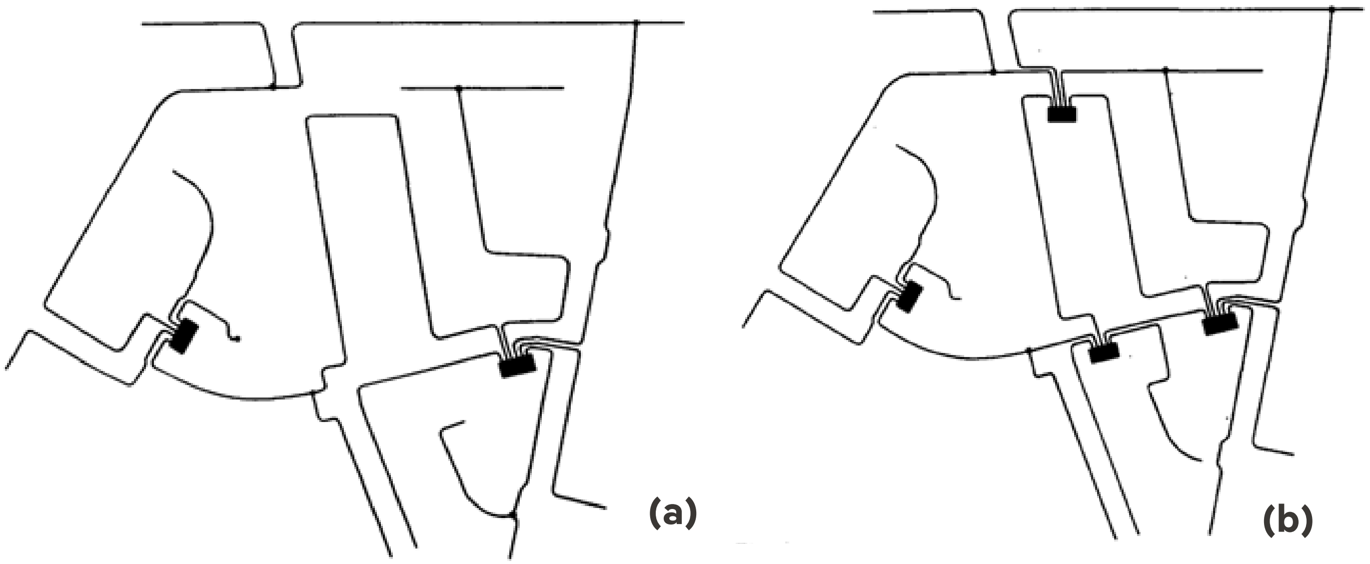
Radial



Limited interconnection between substations and the **tapering** of mains cables

Source: Sayers DP, Hill E. . (1969)

Interconnected



(a) 2 kW after diversity maximum demand (**ADMD**) per customer
(b) 4 kW ADMD per customer

Substations are rated at 500 kVA and a **uniform** aluminium distribution cable is used that has a conductor cross-section area of 95 mm^2

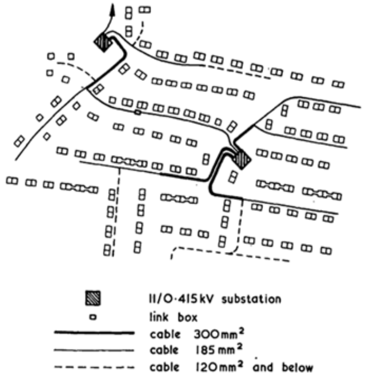
Source: Fisher J. (1963)

Background

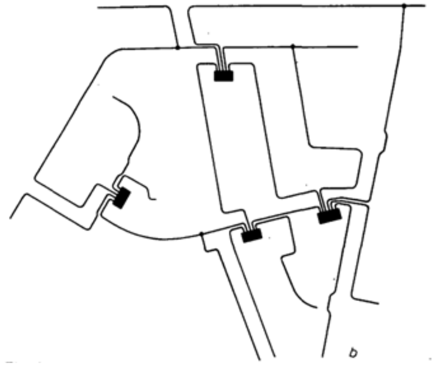
While modern radial networks are more reliant than they were in the past, an existing fully interconnected network still offers superior benefits.

However, meshed networks are more complex in terms of fault protection.

Radial



Interconnected



Reliability

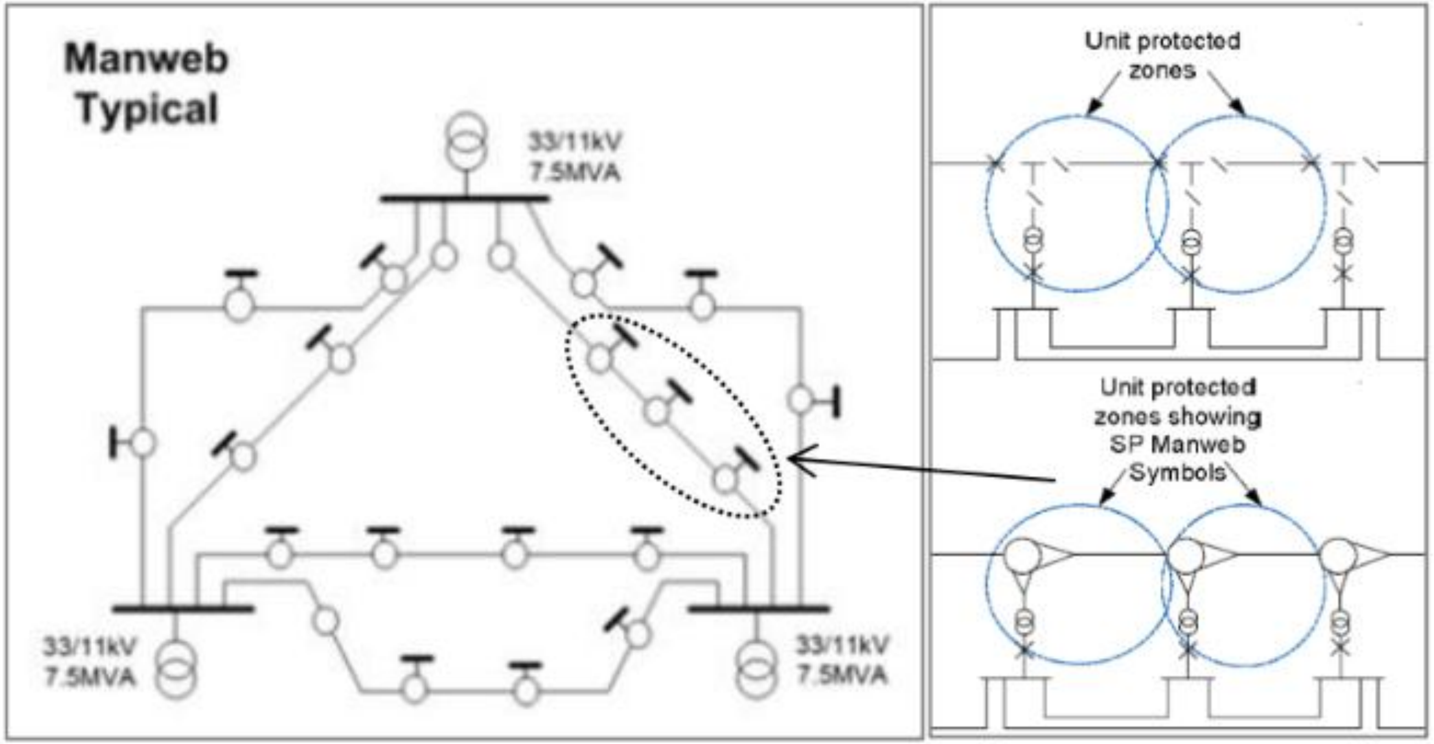
Complexity

Ability to accommodate load growth

Background

X-Type Unit Protected Substations

A unit protected network fully interconnected at HV and LV that uses pilot wires as part of a Solkor protection scheme to measure voltage or current imbalance.



X-Type unit protection (solkor) configuration showing in-zone isolation for a HV fault between RMU OCBs and LV ACB.

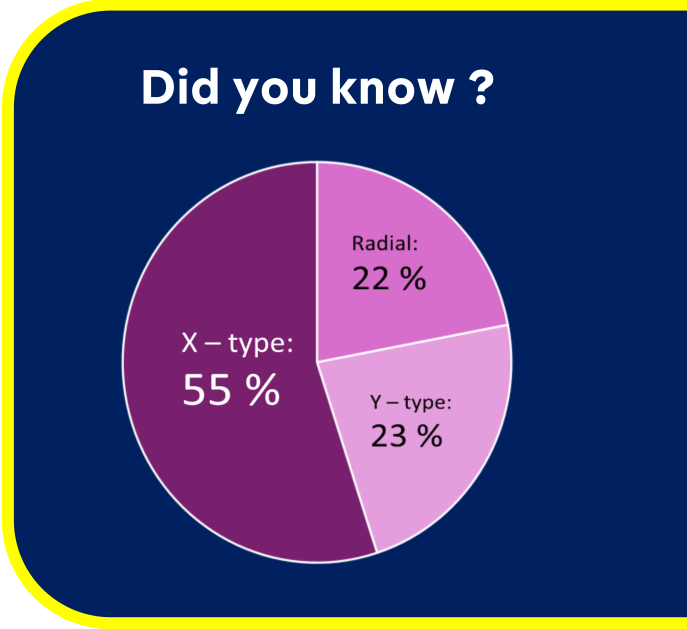
No customer supplies interrupted for an in-zone HV fault through LV interconnection between adjacent 500kVA X-Type substations.

Background

It is estimated that it would cost more than circa **£5 billion to convert SP Manweb's interconnected networks to a radial topology.**

There is also a national skills shortage to carry out such works.

Innovation is a key enabler to ensure that we can **maximise the embedded benefits of our existing interconnected asset base** at **lowest cost to the consumer!**



Problem Statement

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Problem Statement

HV protection at certain interconnected secondary substations across SP Manweb do not operate correctly **due to faulty battery systems**, causing additional avoidable CI/CML. No warnings are produced when these battery systems are faulty.

Avoidable yearly costs = £206,000

Typical IIS Penalty & BMCS Reports

Typical Case 1

CI Penalty: **£2k to £3k**

CML Penalty: **£3k to £4k**

BMCS score avg: **5** (over 4 responses)

Complaints: **21**

Typical Case 2

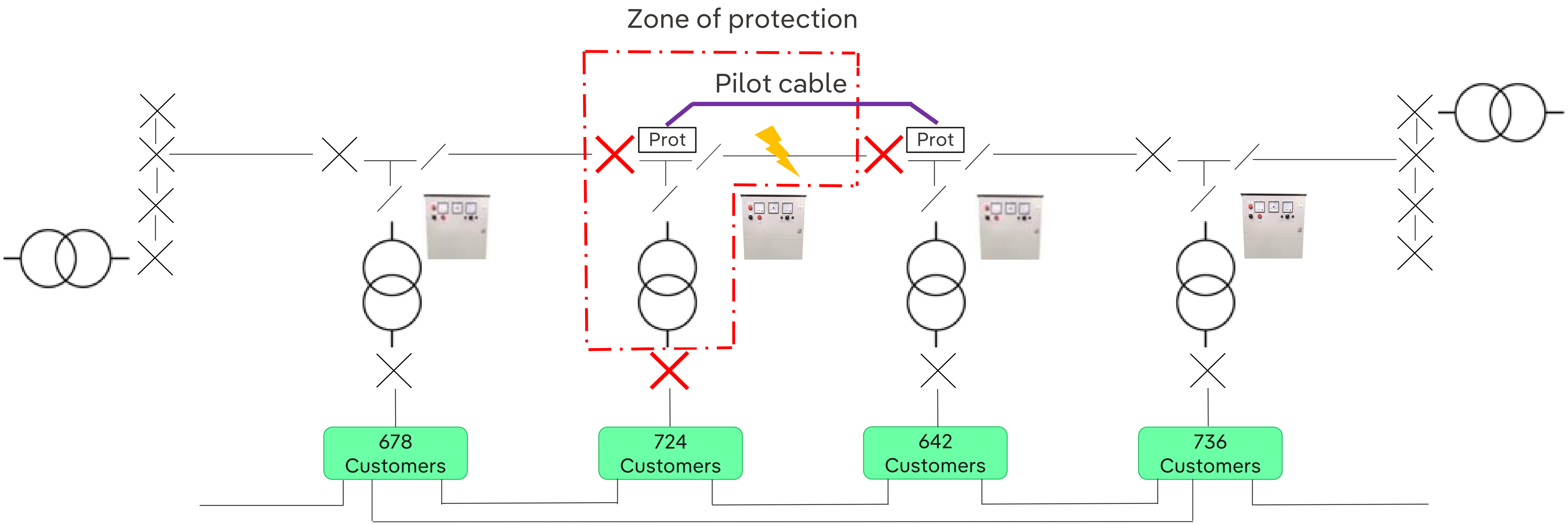
CI Penalty: **£16k to £17k**

CML Penalty: **£30k to £35k**

BMCS score avg: **7** (over 15 responses)

Complaints: **7**

Background



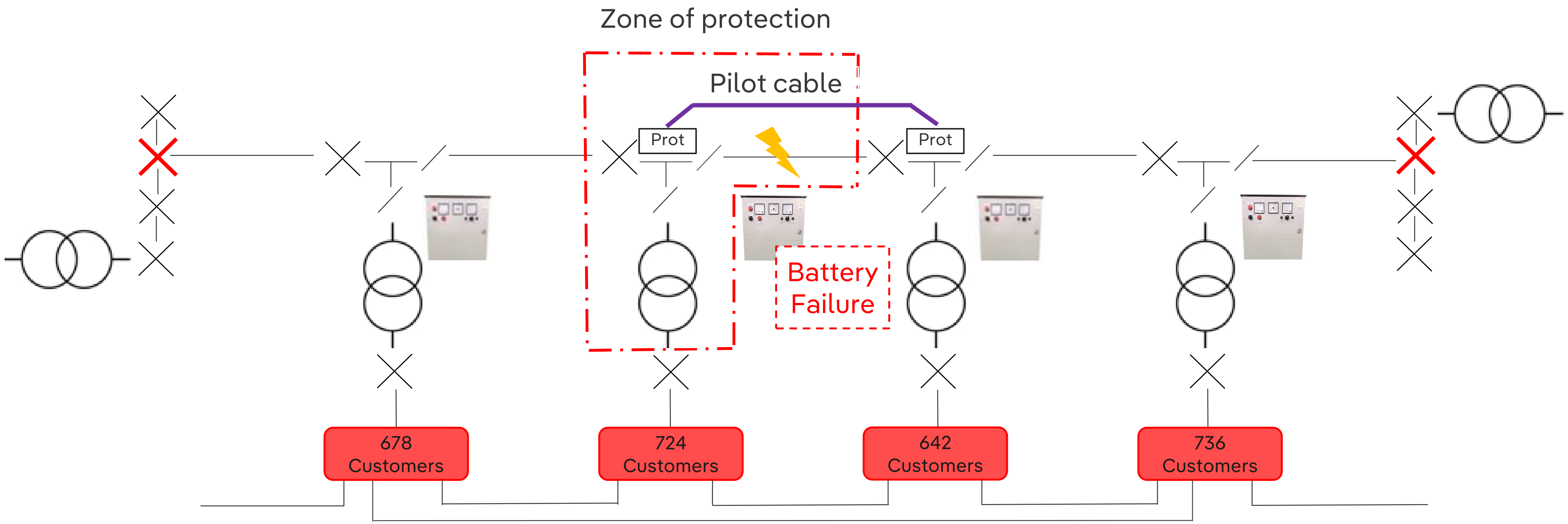
Scenario: System operating normally *(but battery system not monitored)*

When Fault Occurs:

- Cable fault within protected zone
- Protection operates; faulty zone made "not live"
- LV supplies maintained through interconnection

Customer Interruptions = **0**

Background



Scenario: 30V Battery System has failed

When Fault Occurs:

- Protection within faulted zone has failed to operate.
- Back up protection at the two primary substations has operated

Customer Interruptions = **2780**

Solution Conceptualisation

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Solution Conceptualisation

Solution Goals

01.

Visibility of battery-charger system condition

02.

Latent battery fault identification

Existing Functionality

- VisNet Hubs (LV network monitoring devices) present in substations across SPEN's region
- VisNet Hubs have **spare IO** and **computing capabilities**

Can we *utilise* this?

Solution Design

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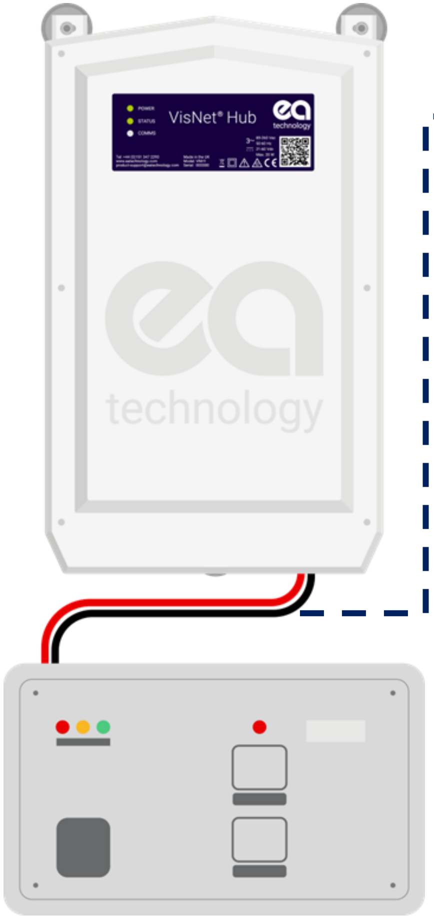
BCM Solution

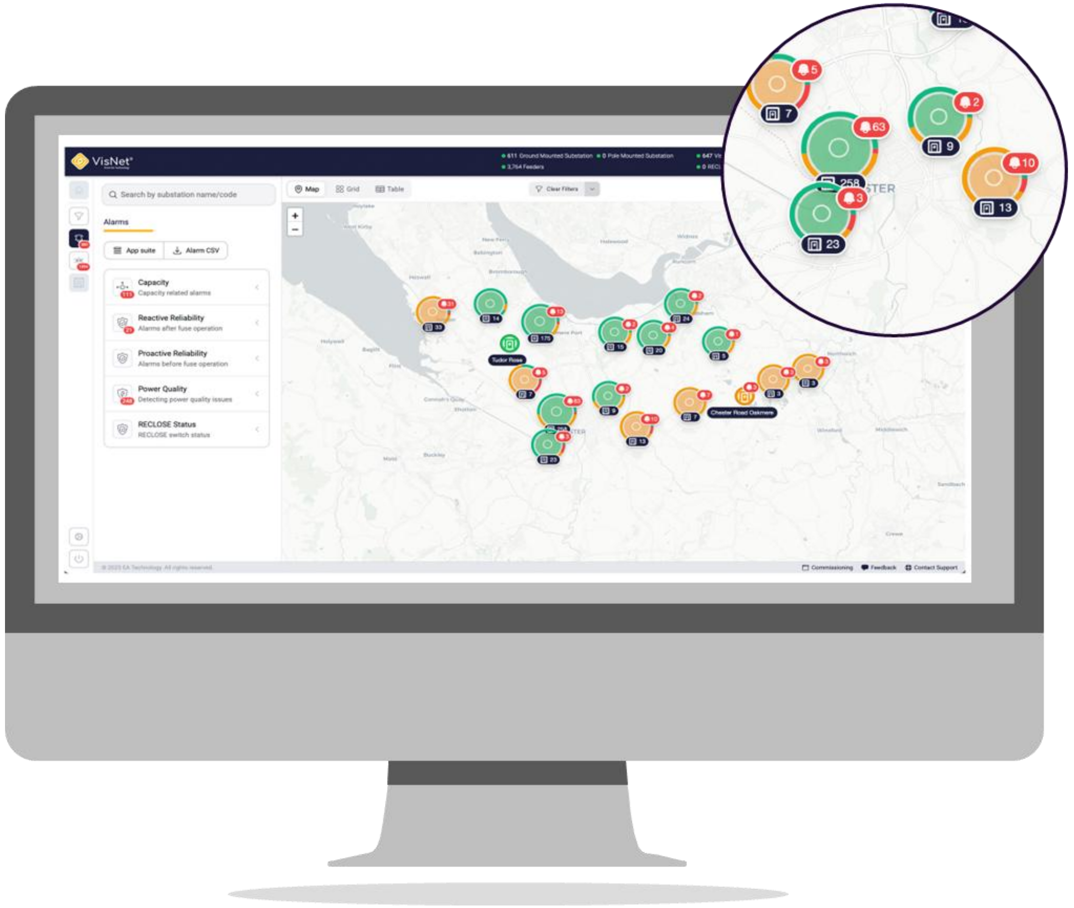
LV Monitor



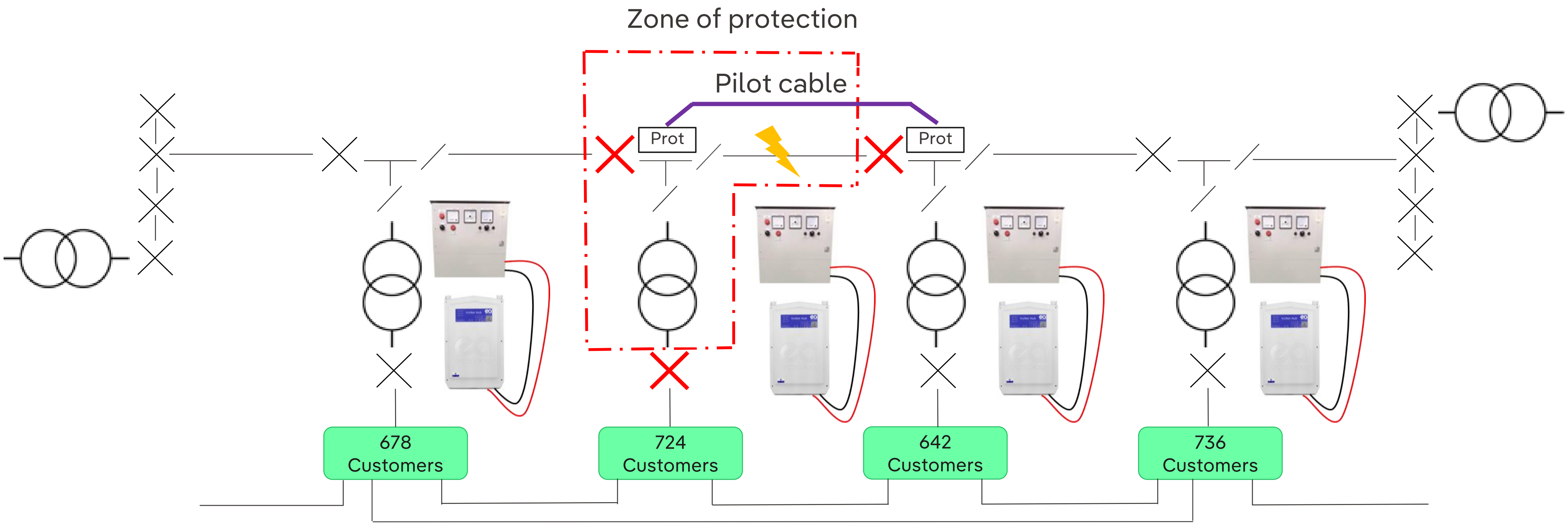
Battery-charger system monitoring:
- Output Voltage
- Output Ripple Voltage

Voltage graphs visualised on DetectPro

Alarms Raised:
- Low Voltage Alarm
- High Voltage Alarm
- High Ripple Voltage Alarm



BCM Solution



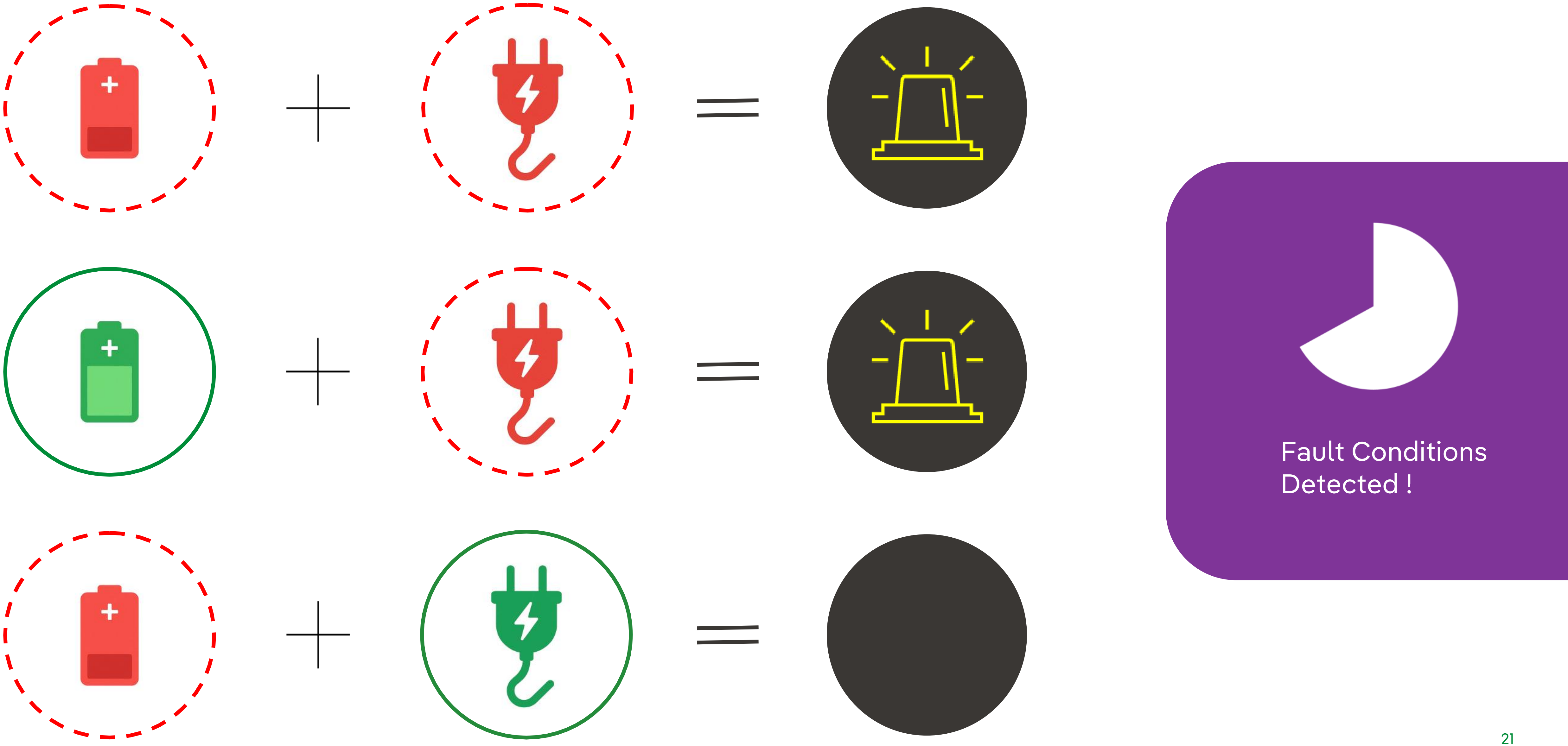
Scenario: Battery system continuously monitored (**SPEN notified if system is failing)**

When Fault Occurs:

- Cable fault within protected zone.
- Protection operates; faulty zone made "not live"
- LV supplies maintained through interconnection

Customer Interruptions = **0**

BCM Solution



BCM Solution

- **Simple and low-cost** solution
- Utilising existing technology to increase capability and overall value

- Practical and configurable
- Remote programming and OTA transmission of system update

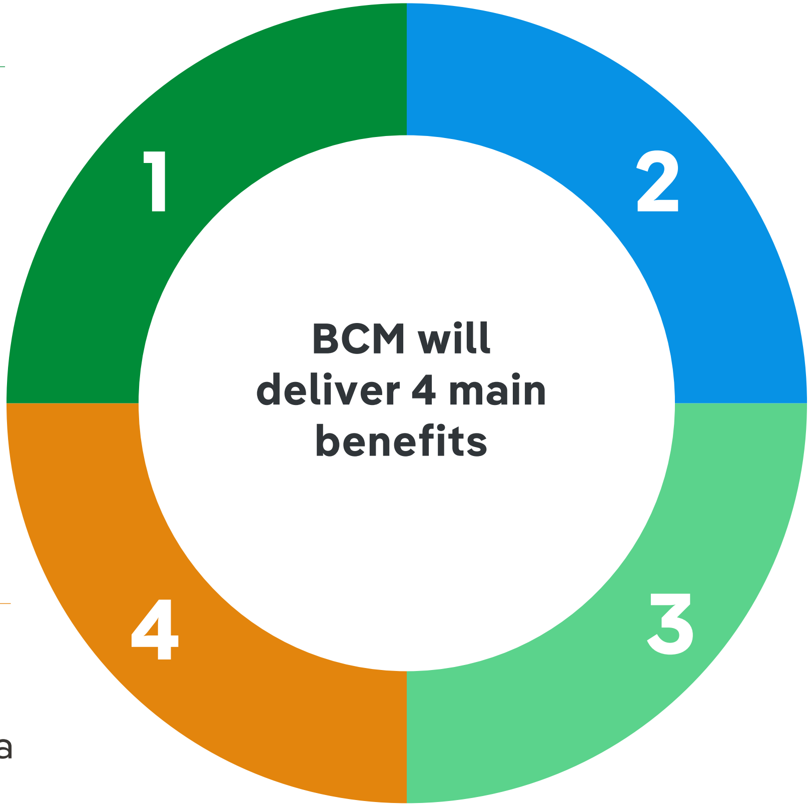
- **Proactive network monitoring**
- Improved operational efficiency

Benefits

Benefits

1. Financial Benefits

- **Low-cost, high-impact solution**
- Avoid costs (>£200k/year)
- Reduce CI/CML
- Cost-effective deployment using existing infrastructure being rolled out as part of ED2



2. Operational & Safety

- Improved fault isolation
- Early detection of battery issues
- Targeted inspections
- **A scalable, flexible solution compatible with various manufacturers**

4. Social Benefits

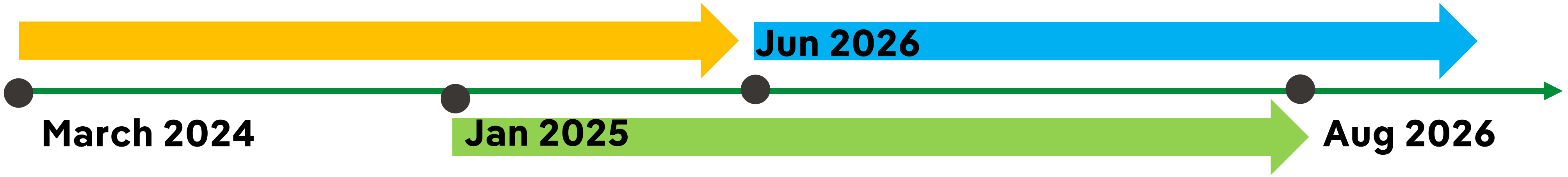
- A reduction in **stress** for vulnerable customers
- minimising the **inconvenience** of a disruption in power supply to all customers

3. Reputational

- Improve customer and stakeholder confidence
- Improve BMCS score

Next Steps

Next Steps



WS1: Phase 1 Trials

- **Installation of 100 DC cables** in subs containing VisNet Hubs
- Conduct **6 months of trial** with monitoring and data analysis
- **Gather learnings** during and at the end of trial and evaluate any changes needed to solution/scope before rolling out
- Continue to **scope Phase 2 trials** with alternative LV monitoring solution

WS2: Phase 2 Trials

- **Phase 2 trial** with an alternative LV monitoring solution
- Conduct **6 months of trial** with monitoring and data analysis
- **Gather learnings** during and at the end of trial and evaluate any changes needed to solution/scope before rolling out

WS3: BaU Integration & Rollout

- **Employ learnings** from Phase 1 & 2 trials
- Evaluate how solution can be translated to SPEN's **BaU** internal IOT system
- Trial deployment in other X-type SPM subs

The End

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