SP Energy Networks

Energy Innovation Summit

LCT Determinator

Increasing Connecting LCT Visibility in Transitioning Networks.

11/2025

Who We Are

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

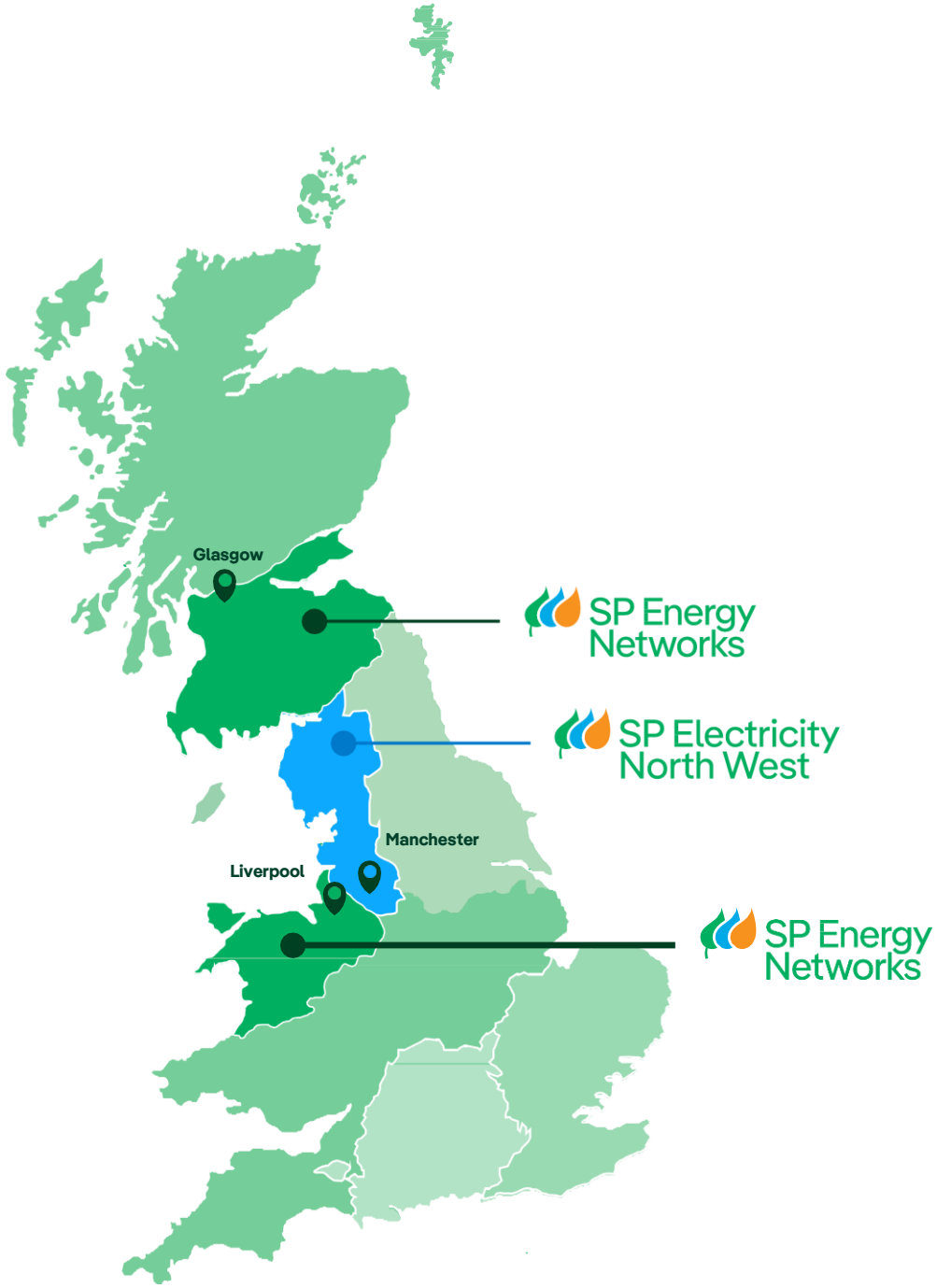
- SP Distribution plc (SPD)
- SP Transmission plc (SPT)
- SP Manweb plc (SPM)
- SP Electricity North West (SP ENW)

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.



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2. Where Are We Going?
3. The LCT Determinator Solution.
4. Journey So Far.
5. Next Steps

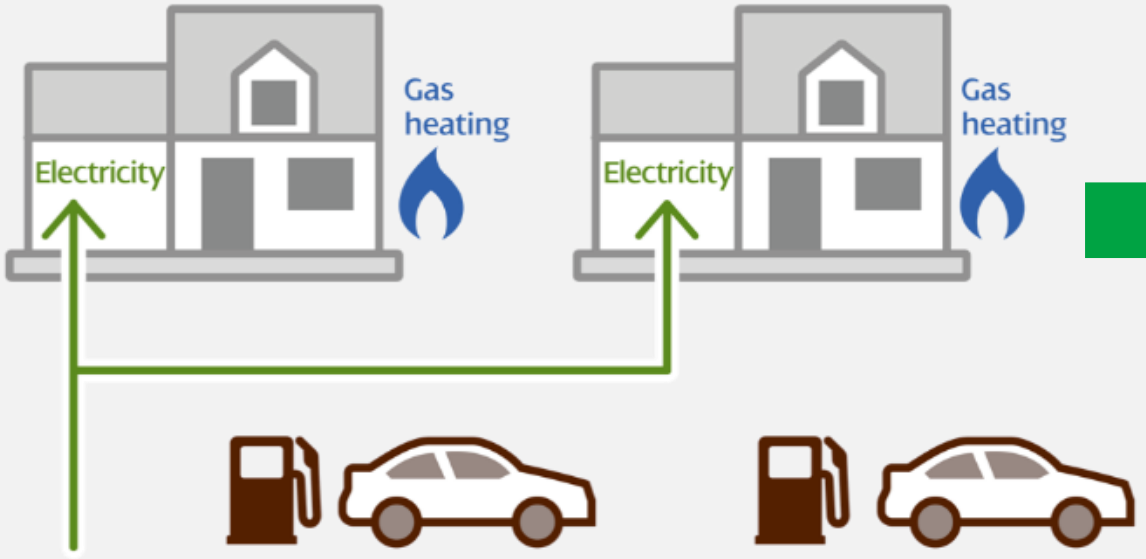
Project partners:

1. Introduction

1. Intro - Enabling Domestic Customer Decarbonisation

Old Needs

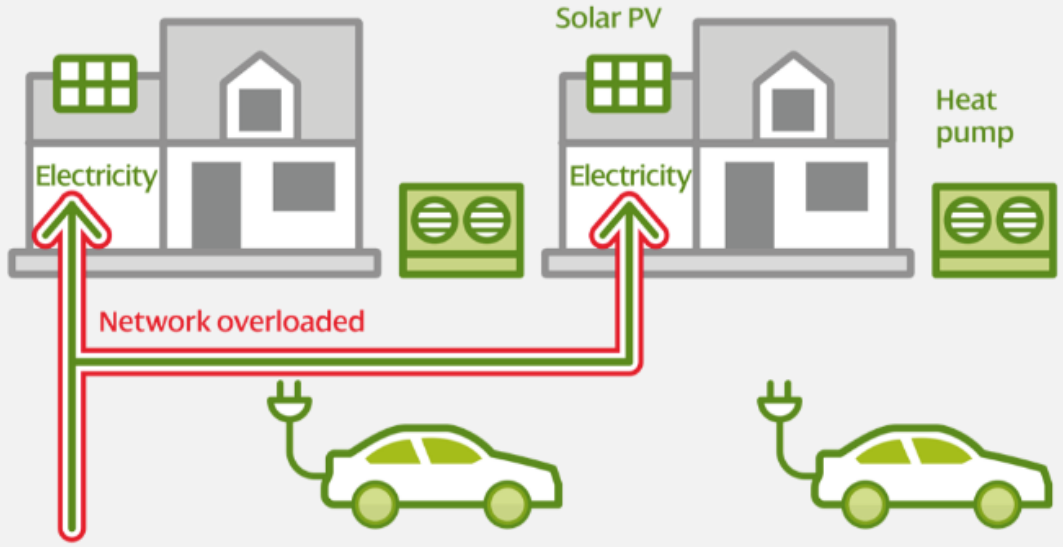
A household's energy is provided by three routes: **electricity**, **gas**, **petrol/diesel**.



The electricity network is currently designed for this level of electricity usage.

The New Normal

A household's energy is provided by one route: **electricity**.



As electricity use increases – the network is not currently designed for this. We must intervene to avoid customers losing supply and damage to critical infrastructure.

Where Are We Going?

2. Where Are We Going? - Background

What's the Problem

Rise in LCT (Low Carbon Technologies. installations, heat pumps (HPs) and electric vehicles (EVs).

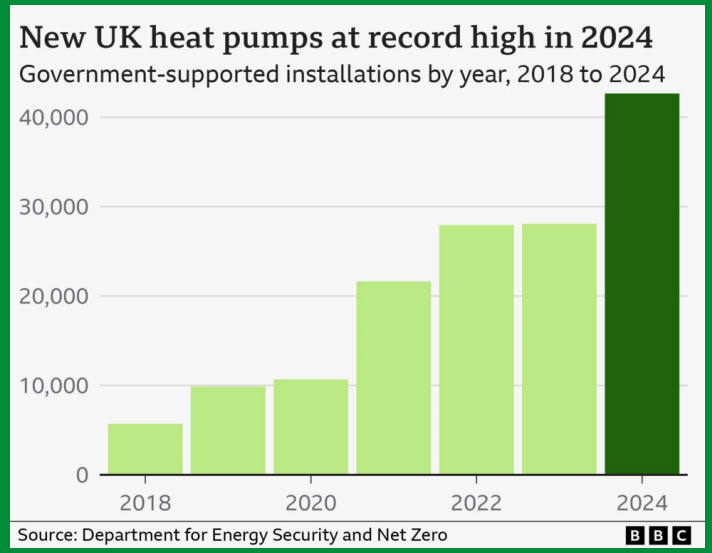
More heat pump sales than registrations.

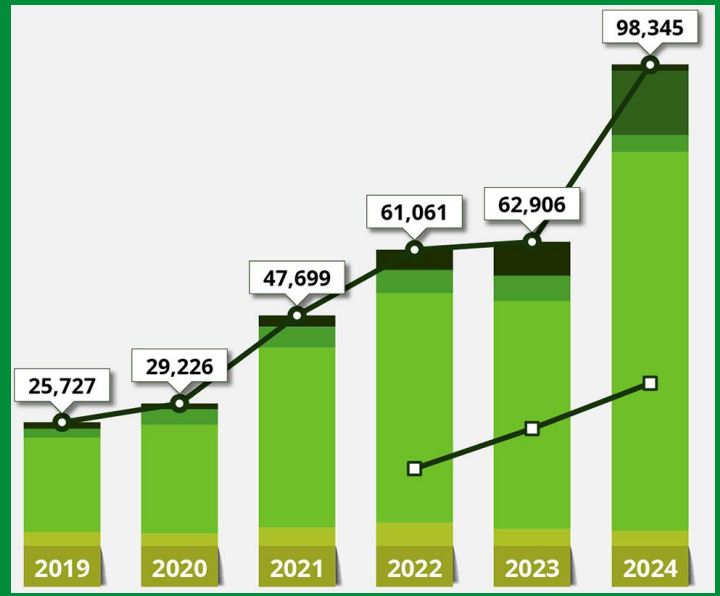
Unlooping services need to be LCT targeted .

Limitations of Current Methods

Targeting of unlooping services relies on data sources, **with gaps:**

- Heat-UP and EV-UP prediction tools,
- Customer feedback,
- Data from LV monitors,
- Smart Meters.





LCT Determinator

2. Where Are We Going? - Problem Statement

Undetected LCT Uptake

Misallocation of looped **services prioritisation**. **Gaps** in LCT registration present **thermal risks**. Capacity must be ready when customers need it.

Reliance on ENA/MCS Registrations

Lowering of low carbon heat incentives.
Lowering MCS HP registrations.
Not all installations register on ENA Connect Direct

Predictive Modelling Tools

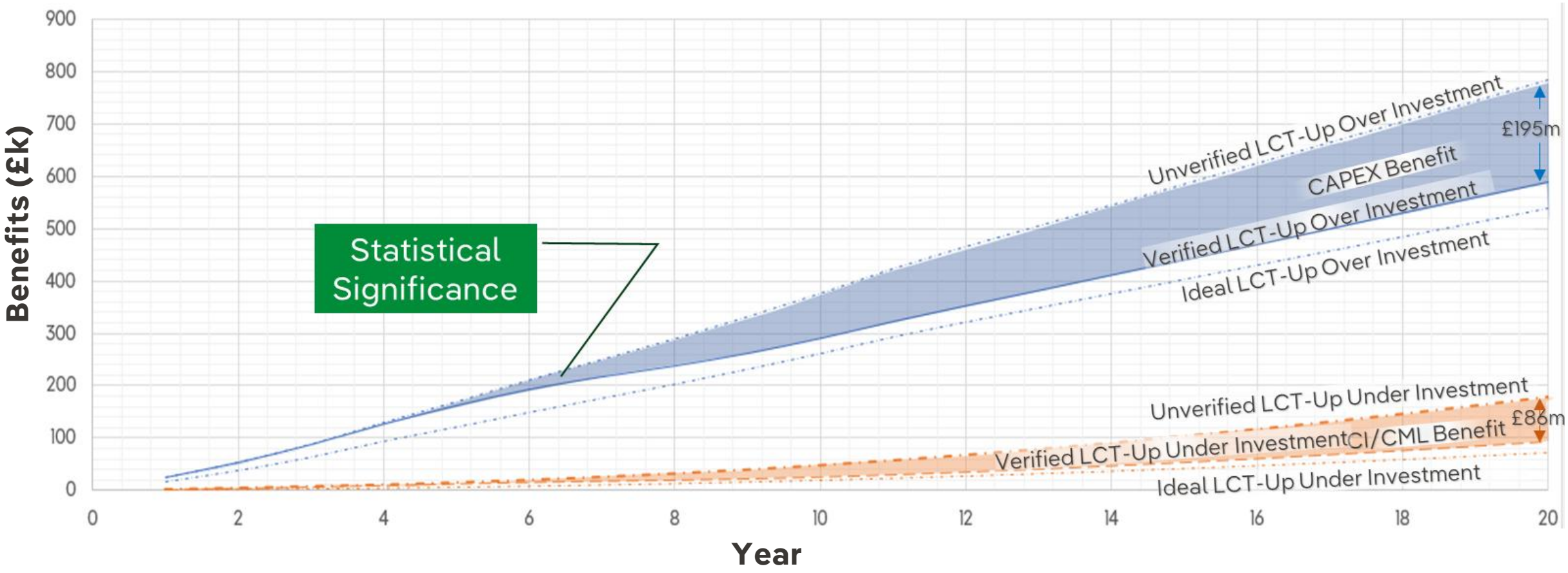
☑ *Heat-UP/EV-Up based on DFES and LCT uptake.*
☒ *Basic Models for ADMD.*
Uncertain Uptake.

Monitoring Data

***14,000 LV monitors** in ED2*
Network visibility and optimization.
***Over 30%** of Customers.*
Smart Meters
☑ *Voltage changes and aggregated loads.*
☒ *Individual load and harmonic data.*

3. The LCT Determinator Solution

The LCT Determinator Solution Benefits Concept



LCT Determinator – Partner Collaboration

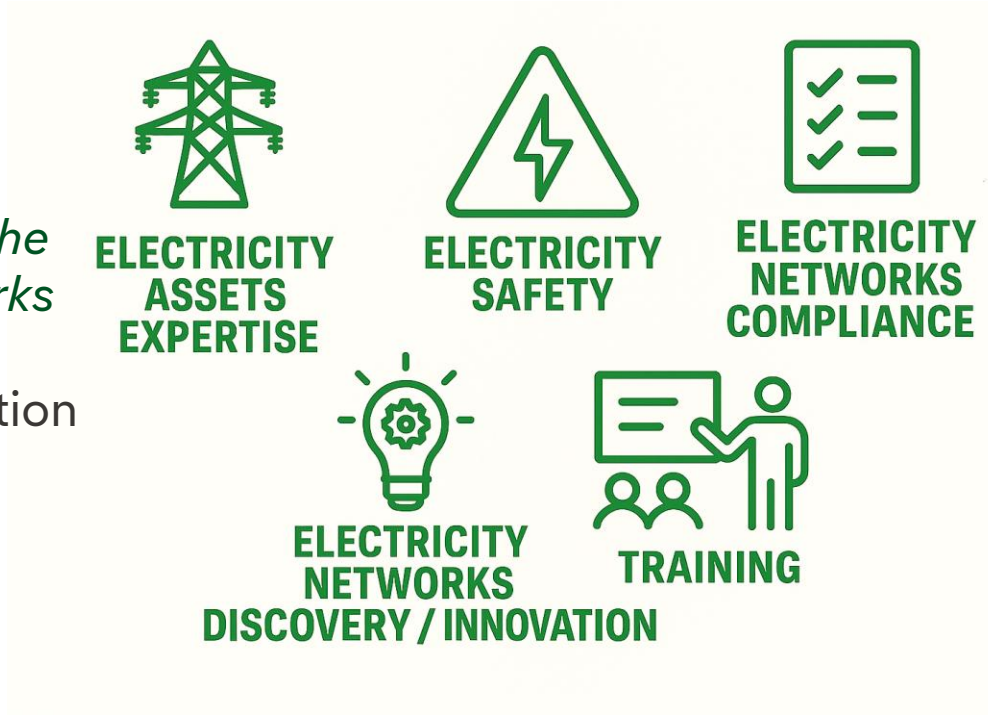
Established in 2010 by Colin Ross

Our mission: *Helping to Improve the Performance of Electricity Networks*

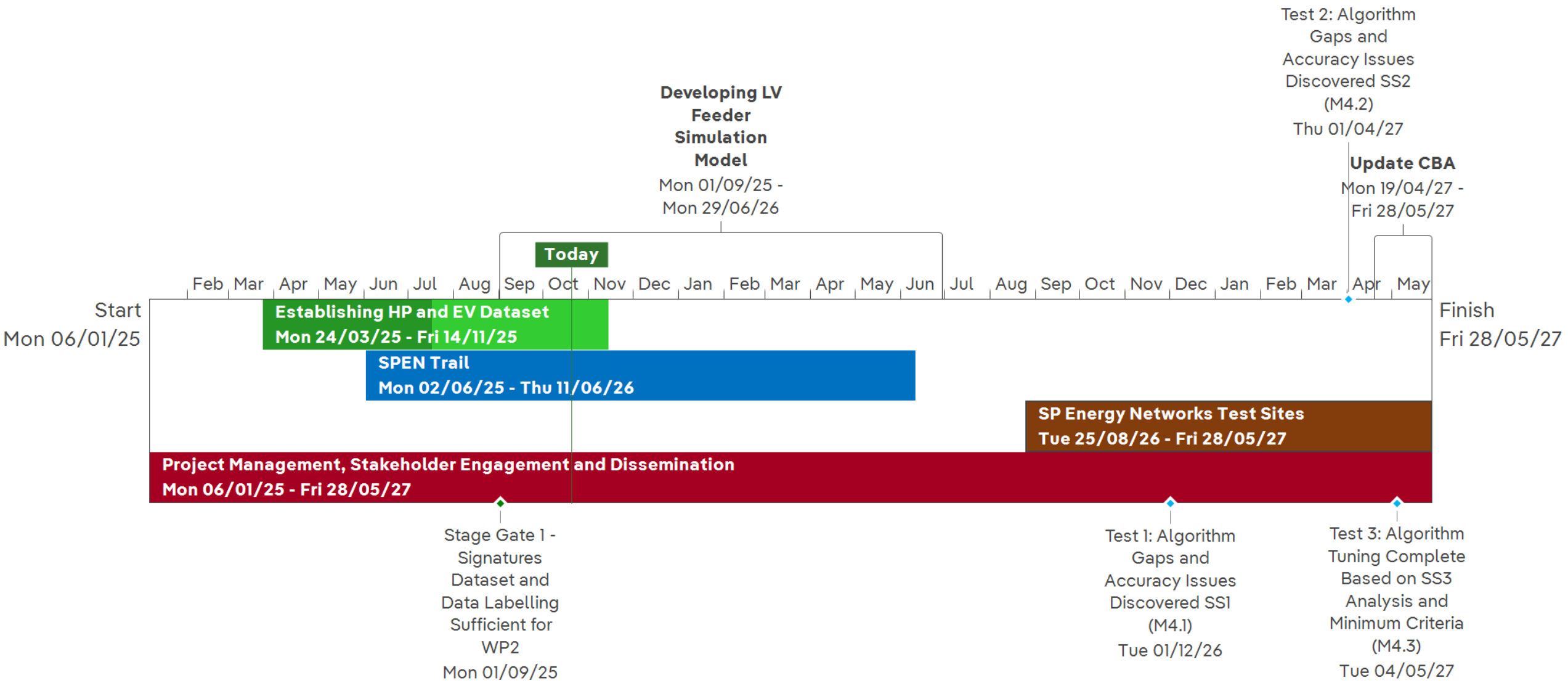
- Expertise in electricity distribution
- Understanding clients needs
- Embracing innovation

threepwoodconsulting.com

Find us on LinkedIn as Threepwood Consulting Ltd



LCT Determinator - Project Plan



LCT Determinator Solution

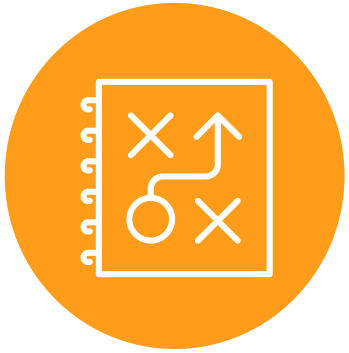
How to solve the problem?

The Idea

LCTs have signatures?

Collaboration Leads to Innovation

Knowledge and Expertise in
LV Network Operation and Design
LCT Operation and Design
Data Analysis

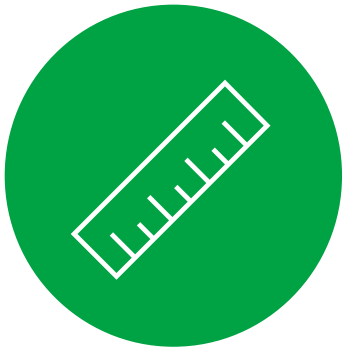


The Challenges

LCT usage is not predictable
Measured Domestic load can fluctuate minute by minute.

What are the success criteria?

Must



Detect and Measure the number of LCT

Determine the number of HPs and EVs connected to a domestic LV feeder

Would be good

Measure total LCT usage time?

Measure the duration LCT operation to obtain statistics on usage, predicted patterns, and impact on network today and in future events

Total Solution

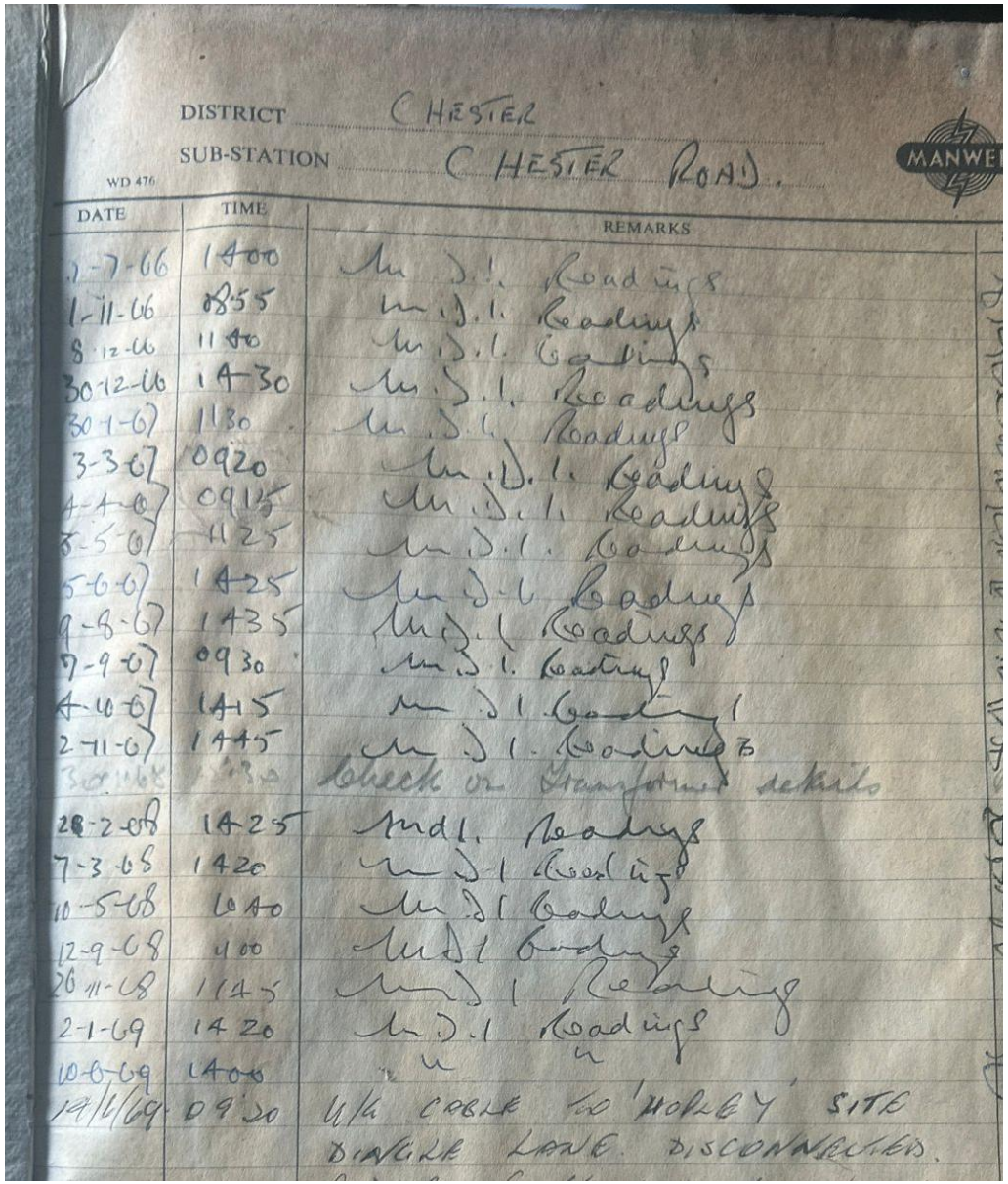
Evaluate network capacity total headroom

Provide DNO with accurate network capacity into the future, to enable 'Just In Time' avoiding barriers to connections and stranded assets

Journey So Far

Project Progress & Results

Once upon a time....



DISTRICT CHESTER

SUB-STATION CHESTER ROAD.

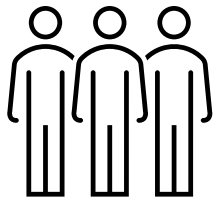
WD 476

DATE	TIME	REMARKS
2-7-66	1400	M.D.I. Readings
1-11-66	0855	M.D.I. Readings
8-12-66	1100	M.D.I. Readings
30-12-66	1430	M.D.I. Readings
30-1-67	1130	M.D.I. Readings
3-3-67	0920	M.D.I. Readings
4-4-67	0915	M.D.I. Readings
3-5-67	1125	M.D.I. Readings
5-6-67	1425	M.D.I. Readings
9-8-67	1435	M.D.I. Readings
7-9-67	0930	M.D.I. Readings
4-10-67	1415	M.D.I. Readings
2-11-67	1445	M.D.I. Readings
30-11-67	1130	Check on Transformer details
28-2-68	1425	M.D.I. Readings
7-3-68	1420	M.D.I. Readings
10-5-68	1410	M.D.I. Readings
12-9-68	1100	M.D.I. Readings
26-11-68	1145	M.D.I. Readings
2-1-69	1420	M.D.I. Readings
10-6-69	1400	" "
19/6/69	0930	U/G CABLE TO 'HORLEY' SITE DANGLE LANE DISCONNECTED.

LCT Determinator - Project Plan

Month 1-4	Month 5-12	Month 13-21
HP and EV Signature Definition and initial data labelling	Develop the HP and EV detection Algorithm, using network data	Testing and refining the Algorithm using further network data
Completed this ✓	Just commenced this	

LCT Determinator – Initial learnings

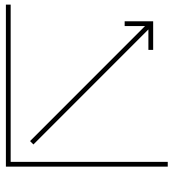


Human behaviours can vary

- Daily habits (going to work, working from home, showers..)
- Home temperature comfort levels
- Heat pump operation (auto, manual interventions)

HP Utilisation can be low

- HP are designed for most onerous conditions (cold weather) – hence they are under utilised in normal conditions
- UK average weather temperature means lower HP power consumption i.e. lower current draw.

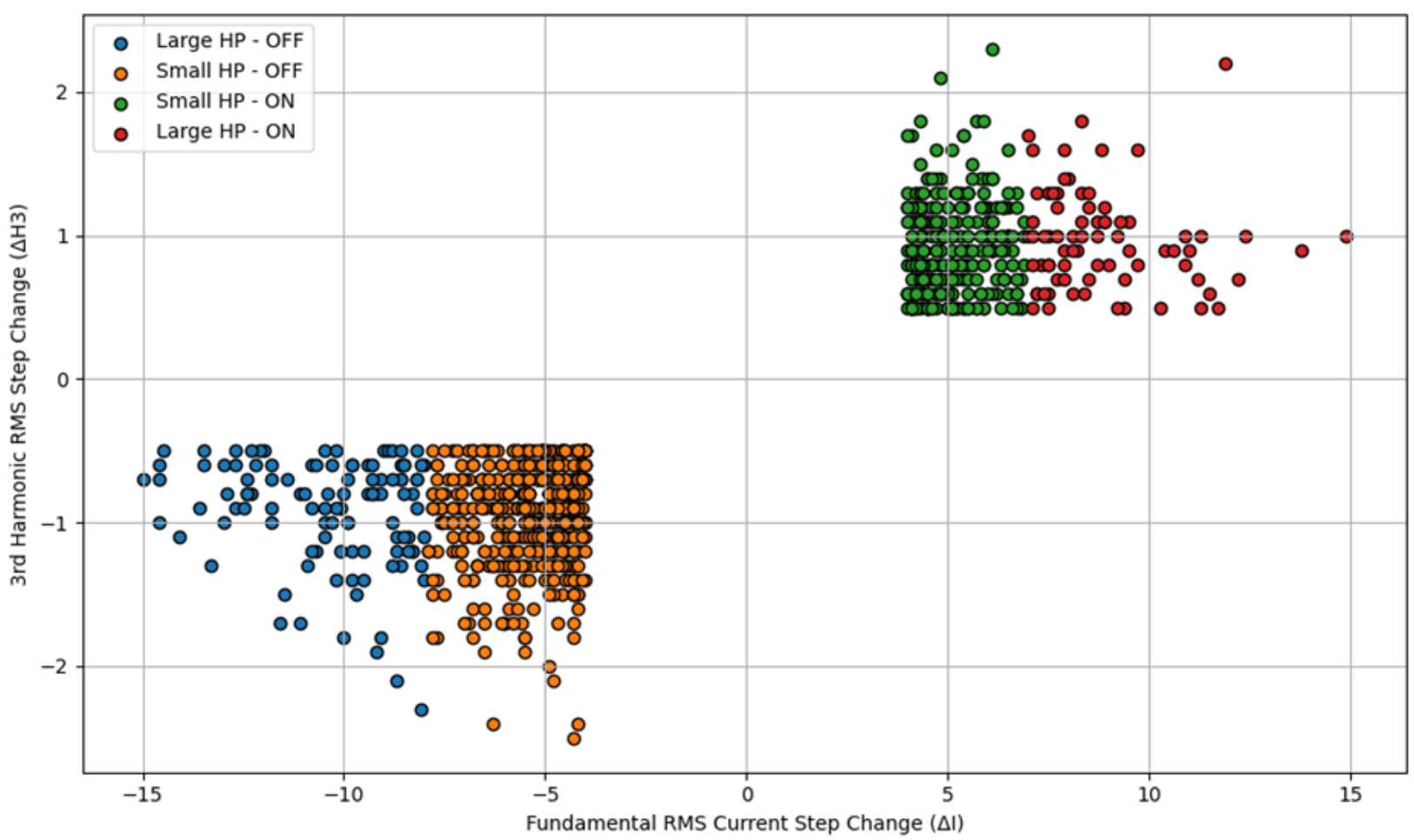


Other domestic Appliances appear

- Microwave
- Vacuum cleaners
- Oven
- Vegetable steamer

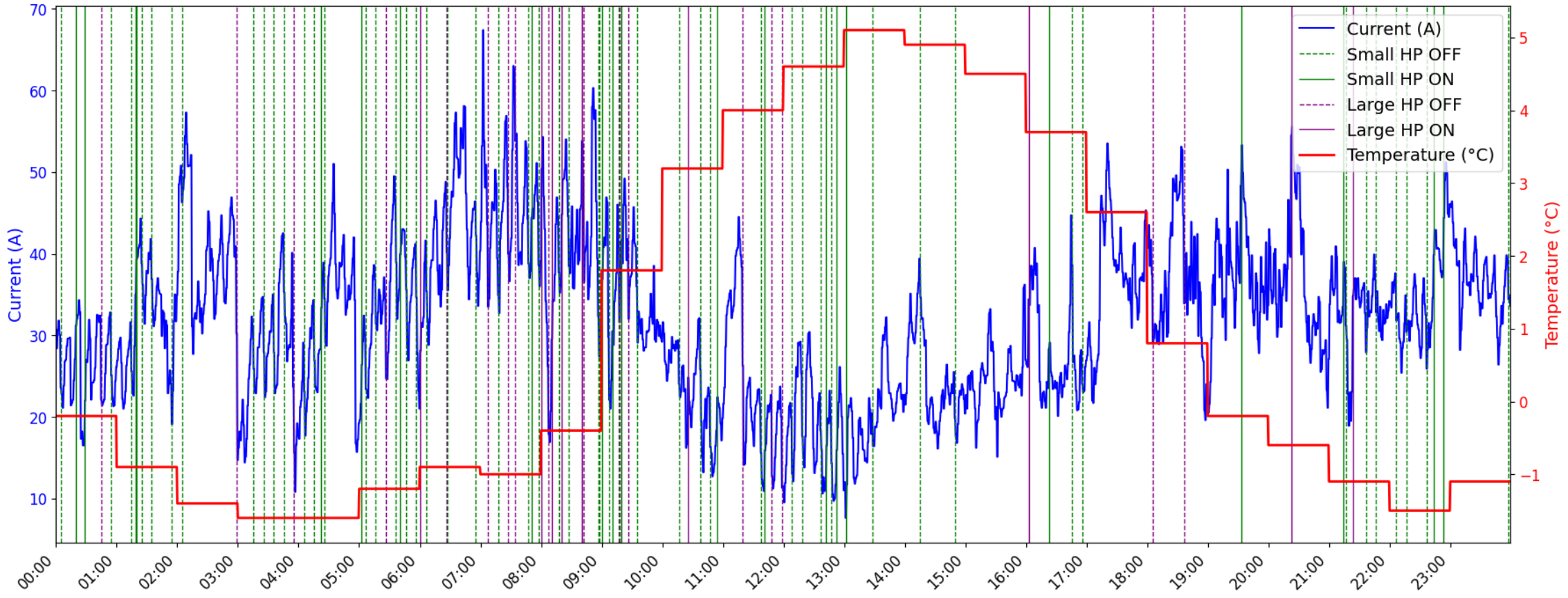
LCT Determinator - Initial Results

HP Switch on/off events for LV feeder phase based on fundamental current and 3rd harmonic current.



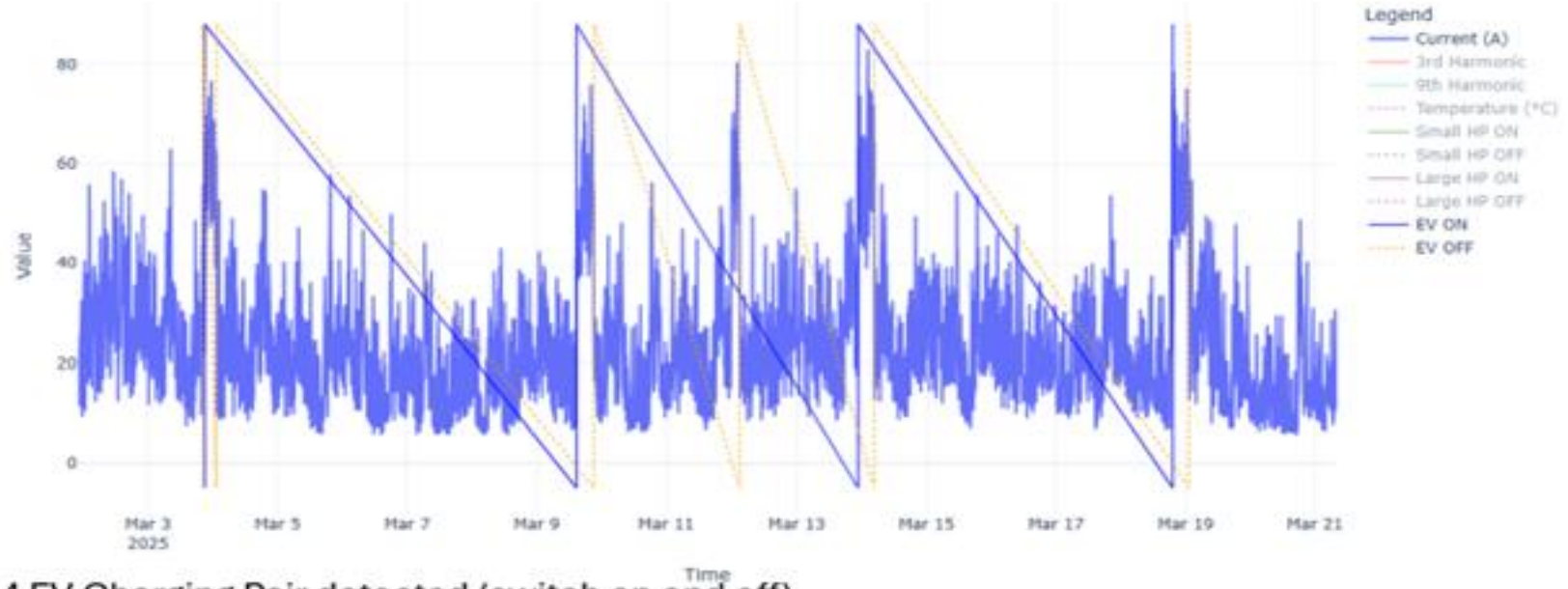
LCT Determinator - Initial Results

HP Switch on/off events for an LV feeder phase for a 24hr period in February 2025



LCT Determinator - Initial Results

March EV detection Feeder 4 Phase A



- 4 EV Charging Pair detected (switch on and off)

Session 1 – March 3–4, **ON:** 2025-03-03 21:04:30 **OFF:** 2025-03-04 01:21:30
Session 2 – March 9, **ON:** 2025-03-09 14:45:00 **OFF:** 2025-03-09 21:09:30
Session 3 – March 13–14, **ON:** 2025-03-13 22:39:00 **OFF:** 2025-03-14 04:45:30
Session 4 – March 18–19, **ON:** 2025-03-18 19:14:00 **OFF:** 2025-03-19 01:19:30

- 1 Positive switch off event detected (March 12 03:14hrs)
- 1 False Positive switch off event detected (March 3, 20:39hrs)

Next Steps

LCT Determinator – Next Steps

Original Intent

Initial plan was to use simulated LV feeder data to train the labelling algorithm.
It was expected that a digital twin of a real LV network could be created to produce current and harmonic data, based on domestic properties operating EV and HPs.

Learning

During another innovation project (SSEN LVPQ, Summer 2025) Threepwood developed a LV simulation for an LV feeder with HPs. This exercise demonstrated that a 'static' (non time varying) simulation is relatively straightforward, but a **time varying simulation is very complex for an LV feeder** with a multitude of devices operating, particularly for harmonics.
In conclusion, it is much more complex to produce time varying data (current and harmonics) for an LV feeder than originally envisage.

Proposed way forward

Collect more **'actual' network data** to train the algorithm including:

- Collect actual data for a range radial LV feeders and mesh LV feeder.
- Collect actual data for a domestic property + LV feeder.

LCT Determinator – Next Steps

1 **Collect More Network Data**

Collect more network data for LV radial and mesh feeders (Outram PM700, VisNet Hub).

2 **Develop labelling Algorithm**

- Refine detection rules for HPs and EVs and improve the algorithm
- Develop counting methodology for HPs and EVs

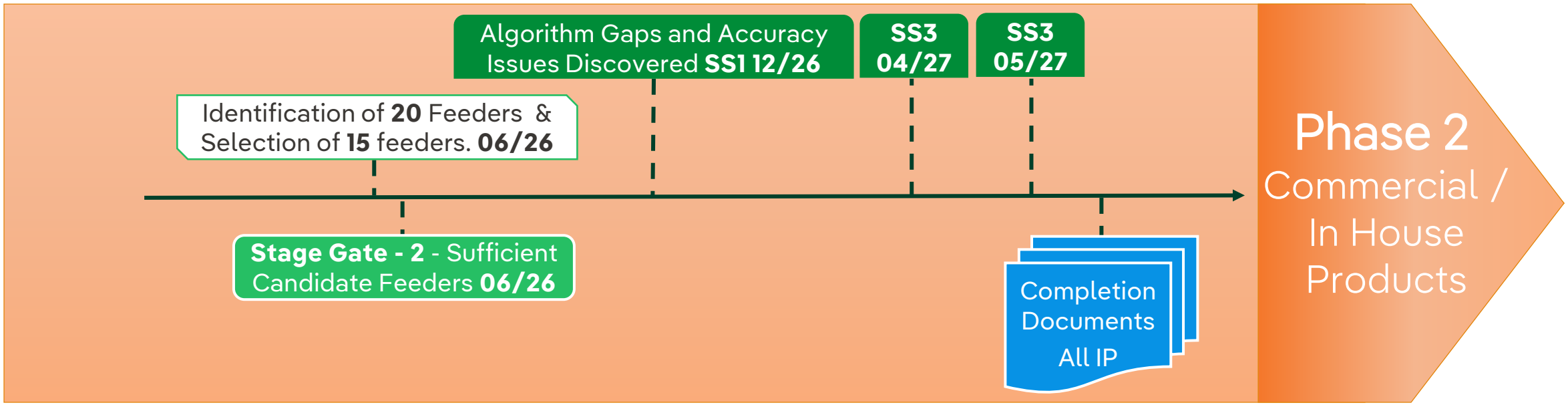
3 **Use Machine Learning**

- Begin development of a deep learning model using the labelled data from the algorithm.

Key Dates and Milestones – Next Steps

Route to Commercialisation

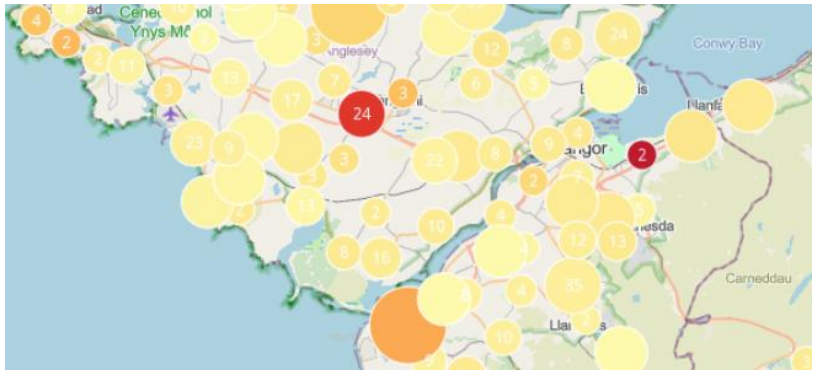
Next Steps Key Events



Stage Gate 2: Trial design requires LCT clustering and onsite LCT verification.

Algorithms and Accuracy: Feeder data collected in 3 periods. Dec 26 to May 27. Algorithm enhanced between each period.

Documentation: All foreground IP passed to Phase for marketisation of technique



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Questions?