TRANSITION

Show and Tell Session 1: Data

6th June 2023

Speakers: Julio Perez-Olvera, Genghao Tian, Daniel Burke

Host: Brian Wann

Agenda

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Topic	Time
Introductions	5 mins
Summary of TRANSITION Project	5 mins
Advanced Network Modelling - Osney Case Study	15 mins
Operational Forecasting and Data	15 mins
Q & A Session	15 mins

TRANSITION Summary

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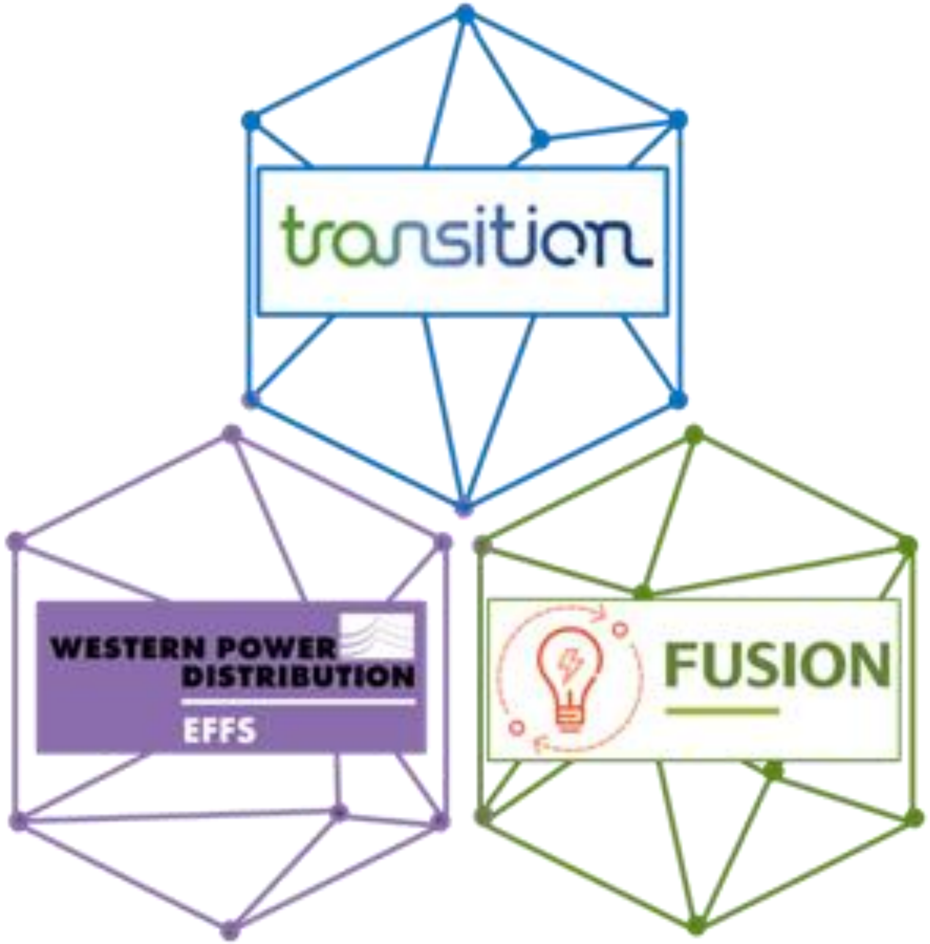
Working on understanding energy flexibility and its requirements for Smart Local Energy Systems. We're exploring the design requirements of a market for trading flexibility locally, understanding the roles of the marketplace and testing these through practical trials.

TRANSITION is working on…

- Market Development; Contracts, Services, Pricing
- Tools and Platforms; Market Platforms, Select and Dispatch
- Recruitment of Flexibility Providers; Aggregators, Assets

Through delivering energy flexibility trials, building system coordination tools and standardised markets.



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TRANSITION Summary

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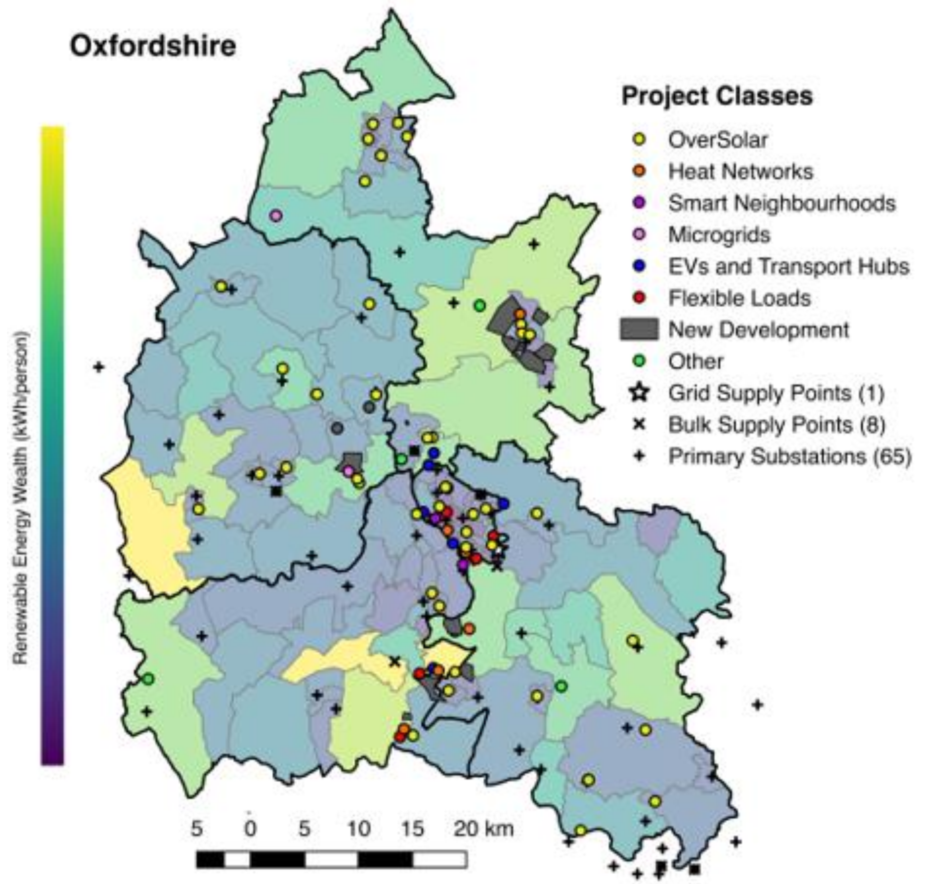
Increasing Complexity

Trial Period 1 (Winter) → Trial Period 2 (Summer) → Trial Period 3 (Winter) → Technical Trials



DSO Functions – Place of Data / Forecasting

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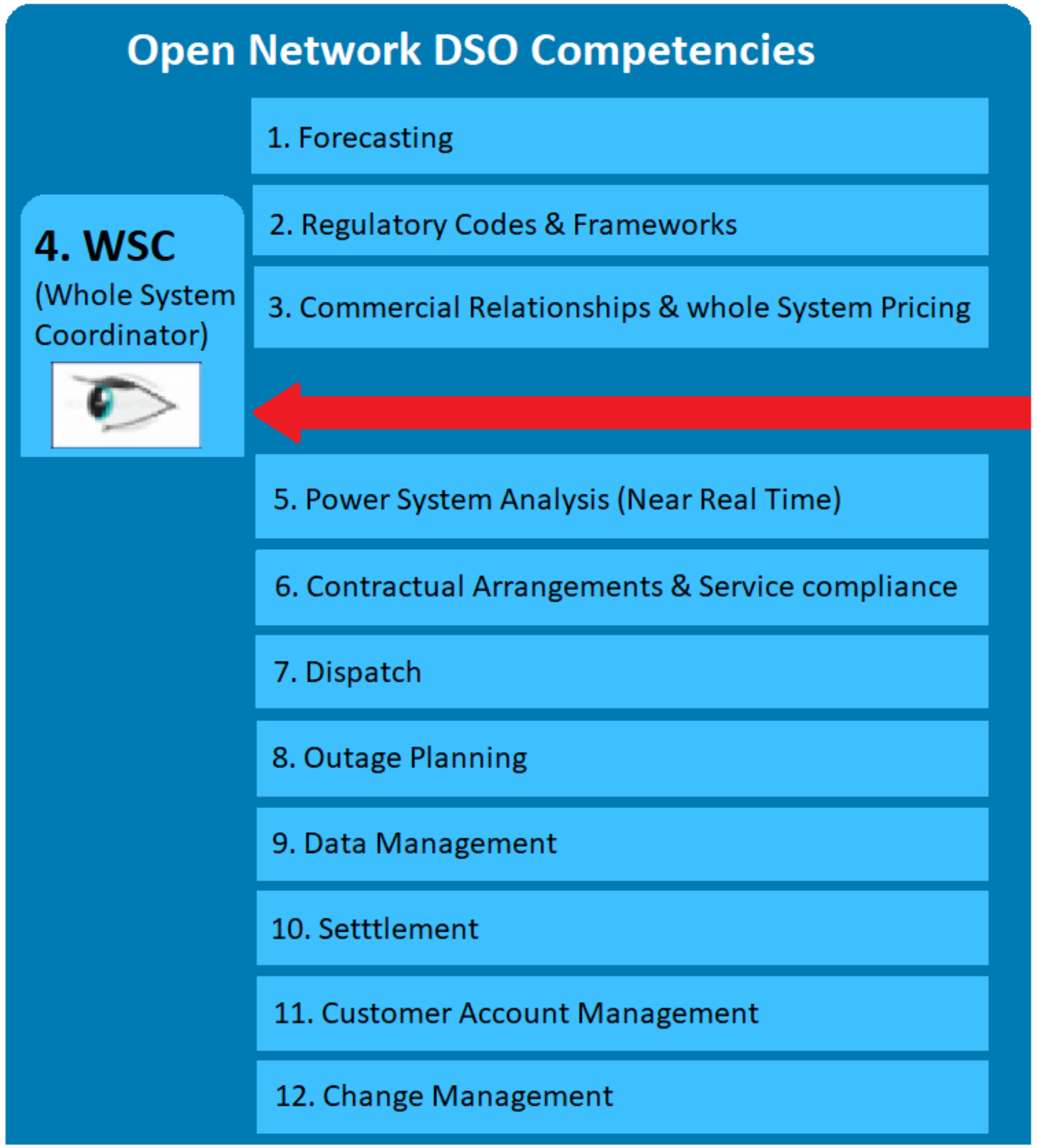
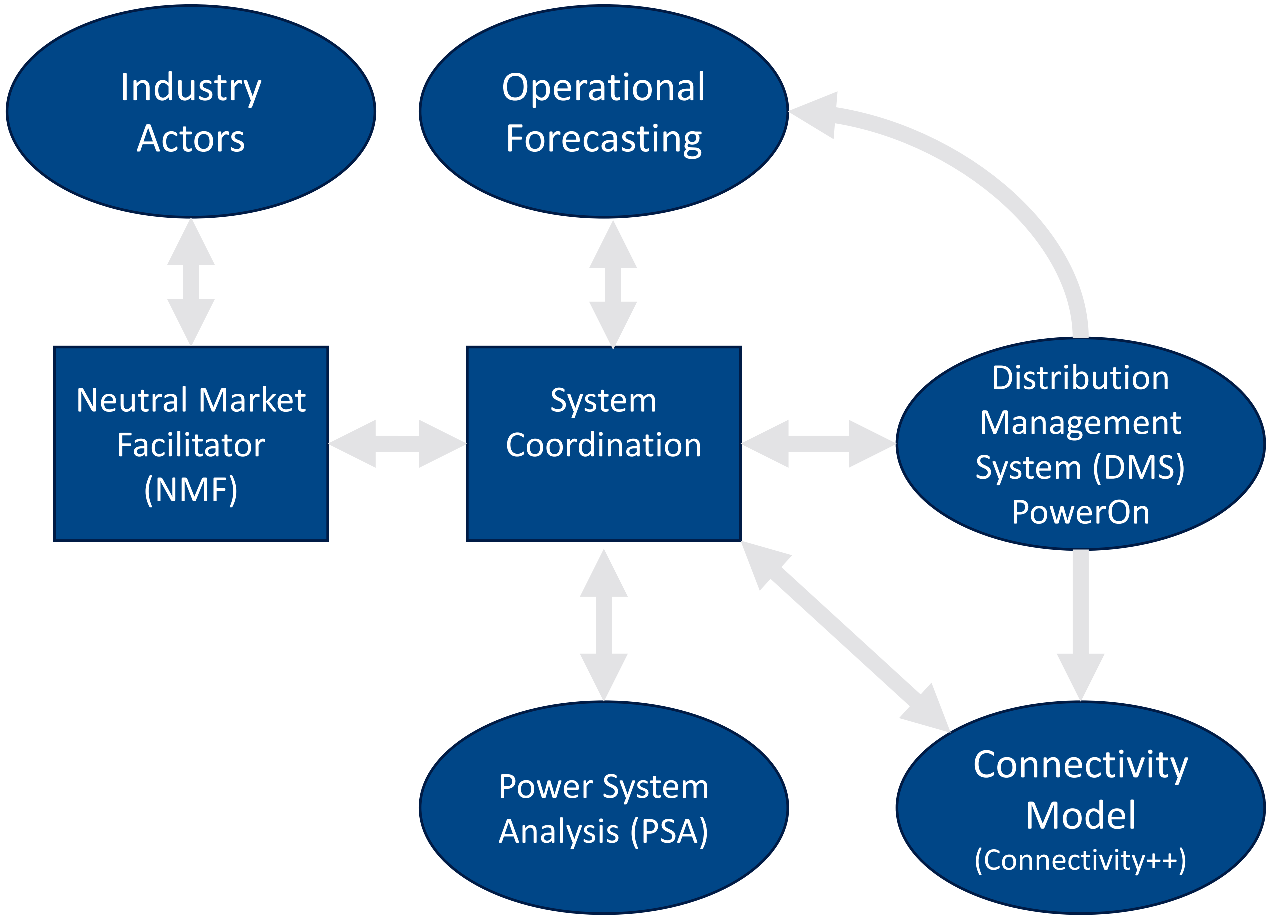
- The ENA Open Networks definitions of DSO functions makes very clear reference to the importance of Forecasting and Data Management
- Greater role for system operation, more heavily constrained networks, and operation of flexibility markets drive much greater need for system observability and analytical capabilities
- There is also a need to improve data coherency at HV and LV network level across the industry, as flex sources may sit at grid edge
- Smart metering initiatives and other advanced technologies are opening up a new data front, though with GDPR concerns
- ED2 Plans for open source / self serve data for customers across all network levels also underline the importance of this area
- TRANSITION has advanced the state of knowledge in these areas with initiatives in network modelling, forecasting and field trials



TRANSITION HLD of Tools



- **Operational Forecasting:** provides a view of **demand/generation** profiles at granular nodal level for 0-10 days ahead of real-time
- **Distribution Management System (PowerOn):** Provides control room view of **live/real-time network connectivity** and power flows
- **Power System Analysis (PSA):** Computes anticipated **power flows** under different near-term topology change and forecast scenarios
- **Whole System Coordinator (WSC):** Provides the core intelligence for **flex market decision making**, allows an input interface for control room, and manages automated data flows between sub-component DSO systems
- **Neutral Market Facilitator (NMF):** Provides a user interface **portal for DSO interaction with the Industry Actors** to enter/accept their available flex service volumes/costs, and for them to request approval for peer-to-peer (P2P) capacity trades
- **Connectivity model (Connectivity++):** The **master model that holds the network** and how customers relate to it and master repository for key **network parameters** (e.g., impedance, ratings and normal running arrangement).

Osney Bridge Island LEO SFN

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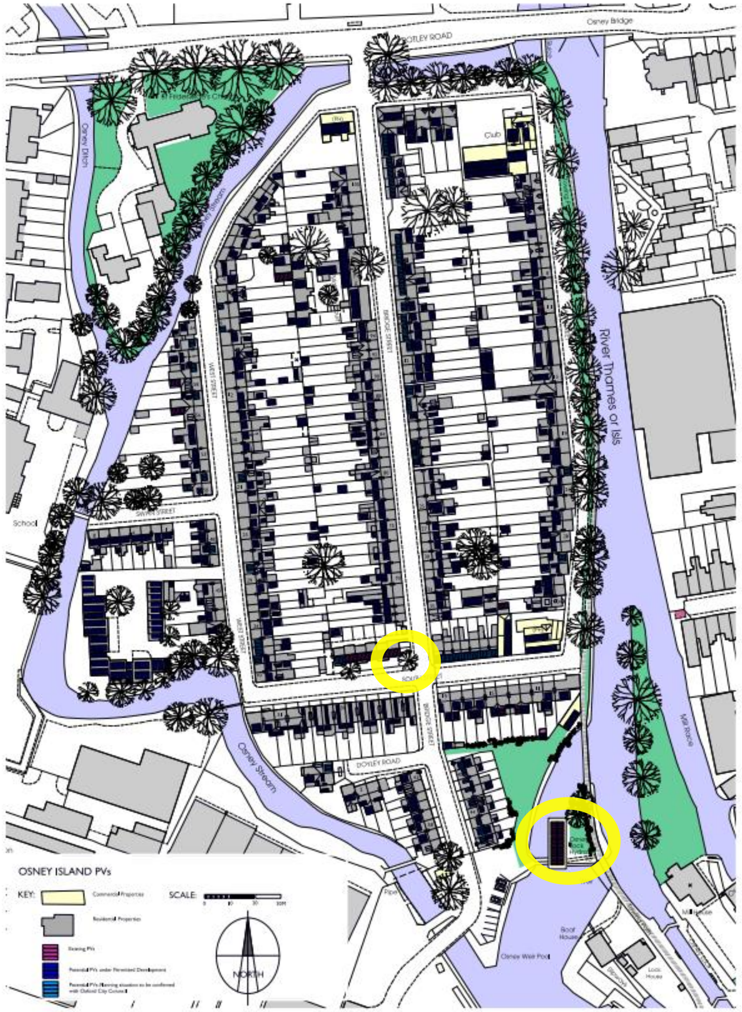
- Osney Bridge Island is one of the local energy schemes being developed for project LEO as part of the Smart and Fair Neighbourhoods
- A ground mounted secondary substation (Osney Bridge Street – **800kVA**) serving the whole Osney island with **approx. 300 customers via 5 LV feeders**
- An 'anchor generator' in **Osney Lock Hydro (50kW)** and its PVs (9kW)
- **15 households** that already have rooftop **solar PV** – one or two also with storage/heat pump/EVs
- SSEN has an **LV monitoring kit at the secondary substation** (i.e., all the feeders are monitored for voltage/current/power)
- LV monitoring data could be useful for **assigning loading to the network model** (with a top down approach)

Develop and test a semi-automated workflow for building PSA models for LV networks using GIS data in CIM format

35 South St, Oxford OX2 0BE



*** Image provided by LEO/LCH**

LV Network Design and Modelling

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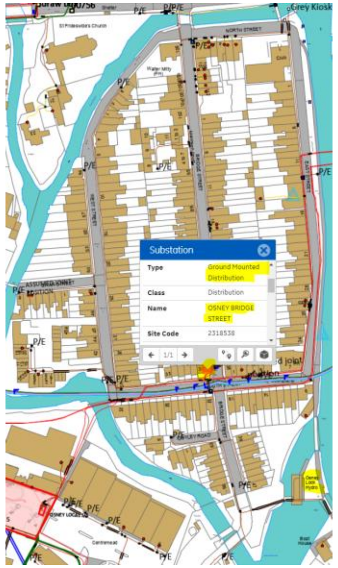
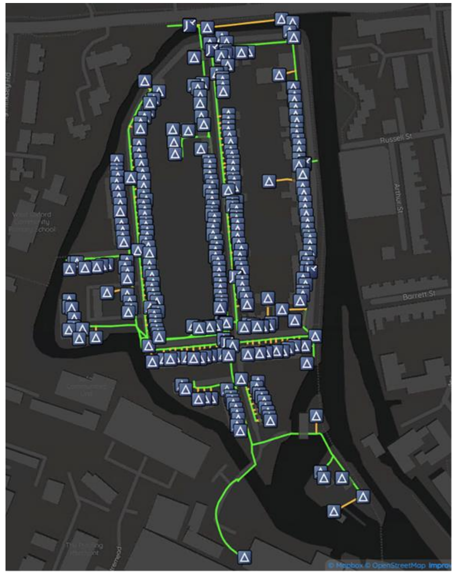
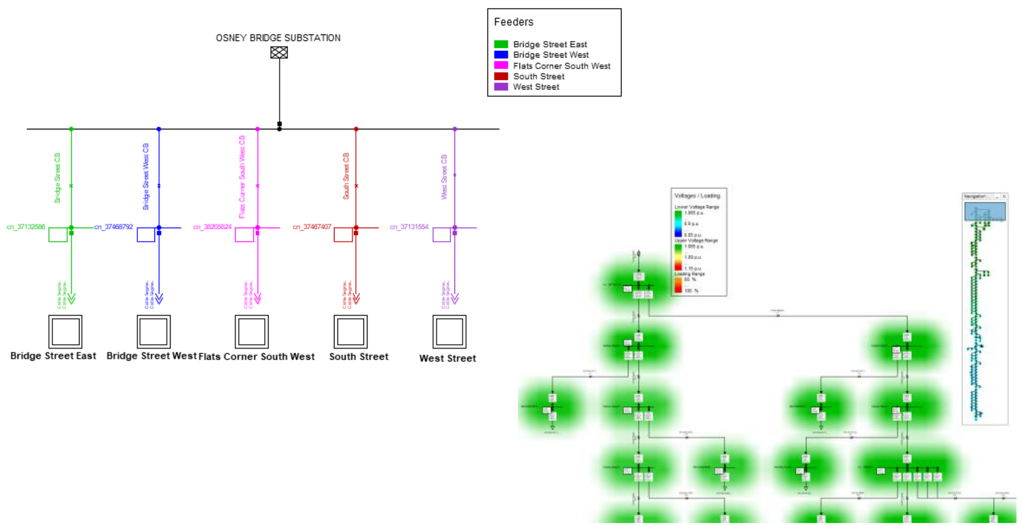
Model development workflow for LV modelling (CIM* <-> PowerFactory)

Start → Get CIM files for individual LV feeders from Connectivity++ → Convert and pre-process CIM files using Cimphony Tool → Add supply points and service cables where required → Export CIM files for individual LV feeders → Import CIM files into PowerFactory, Bundle LV feeders, add LCTs and scenarios → End


Electric Office


Cimphony



PowerFactory

Make efficient use of the GIS data and incorporate external datasets (UPRNs) to augment network models where needed

***Common Information Model** is a standard developed by the electric power industry to allow the exchange of information about an electrical network (from Wikipedia).

Osney Bridge Street – Network Capacity Study

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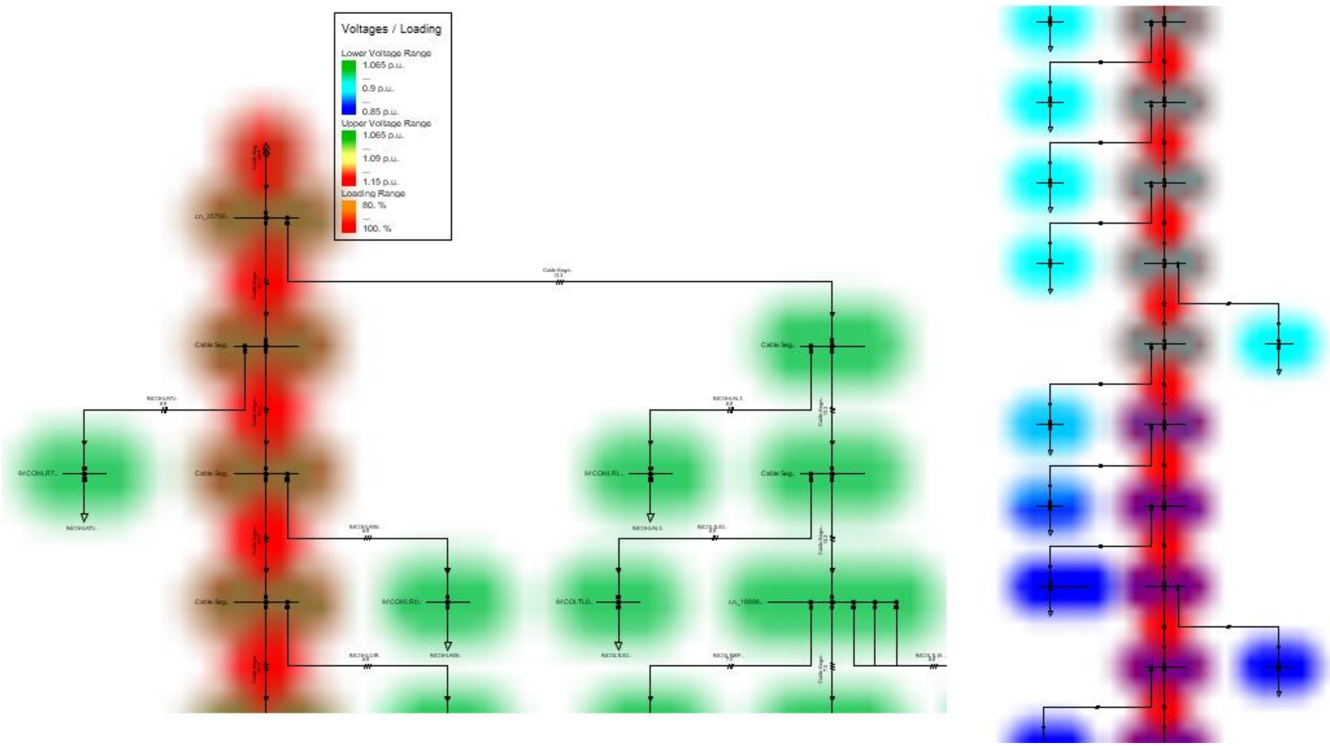
- Assess **present conditions of the network**
  - **Loading** of secondary transformer and LV feeders
  - **Voltage ranges** (min/max) at head/end of feeders
- Estimate **network capacity** for installing additional **LCTs**
  - kW amount of **generation** (e.g. rooftop solar PV, storage)
  - kW amount of **demand** (e.g. EVs and heat pumps, storage)
- Evaluate benefits of enabling **local flexibility market**
  - Demand shifting, energy storage, etc.



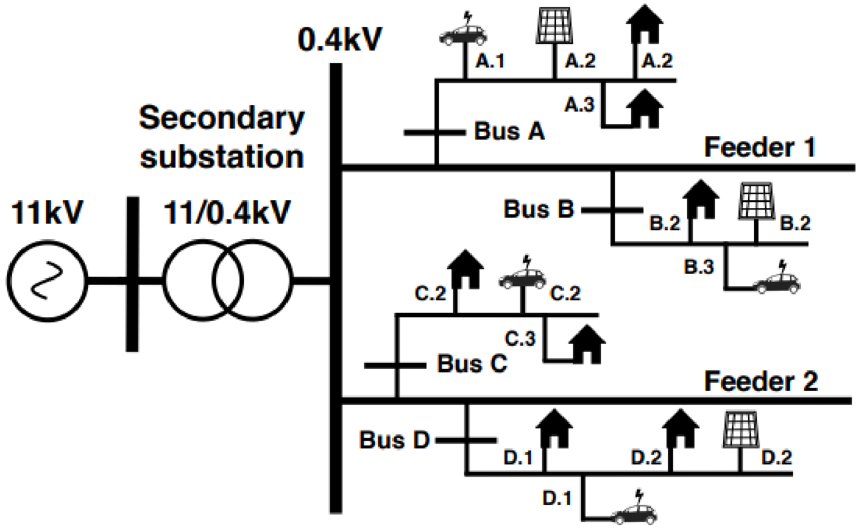
Identify the areas where installation of LCTs on the Osney Island could potentially cause minor network issues

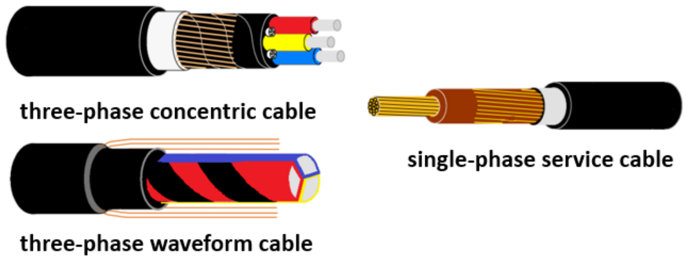
Osney Bridge Street – Connectivity Validation

Customer connectivity
i.e. where exactly customers connect to the network

Feeder connectivity
i.e. validate that customer is connected to the right feeder

Phase connectivity
i.e. validate that customer is connected to the right phase



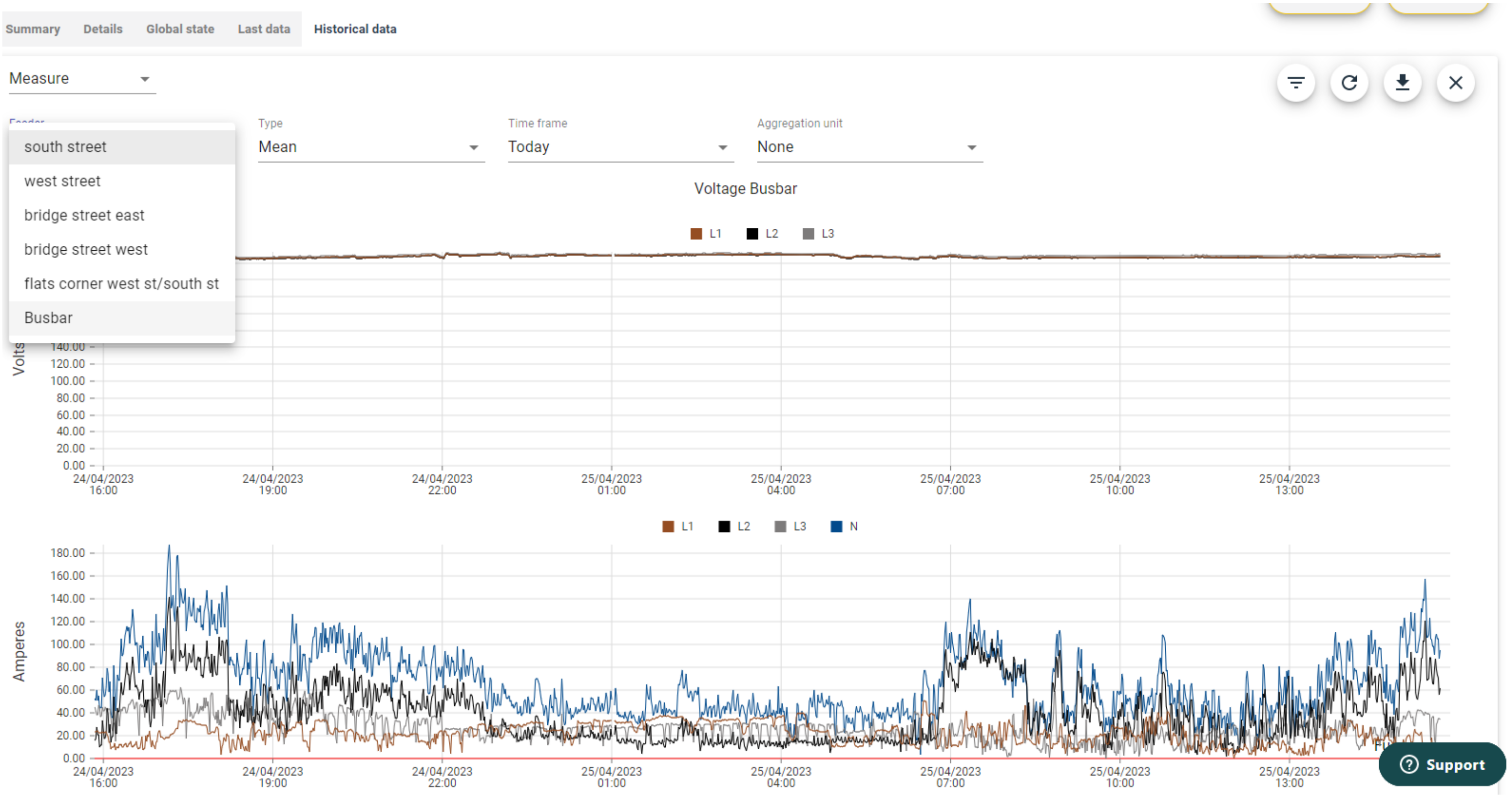


Using accurate connectivity data as input into the models is key to ensure accuracy of the results

Understanding the minimum set of data, and accuracy, required for decision making on where to install a particular LCT

Osney Bridge Street S/S LV monitor

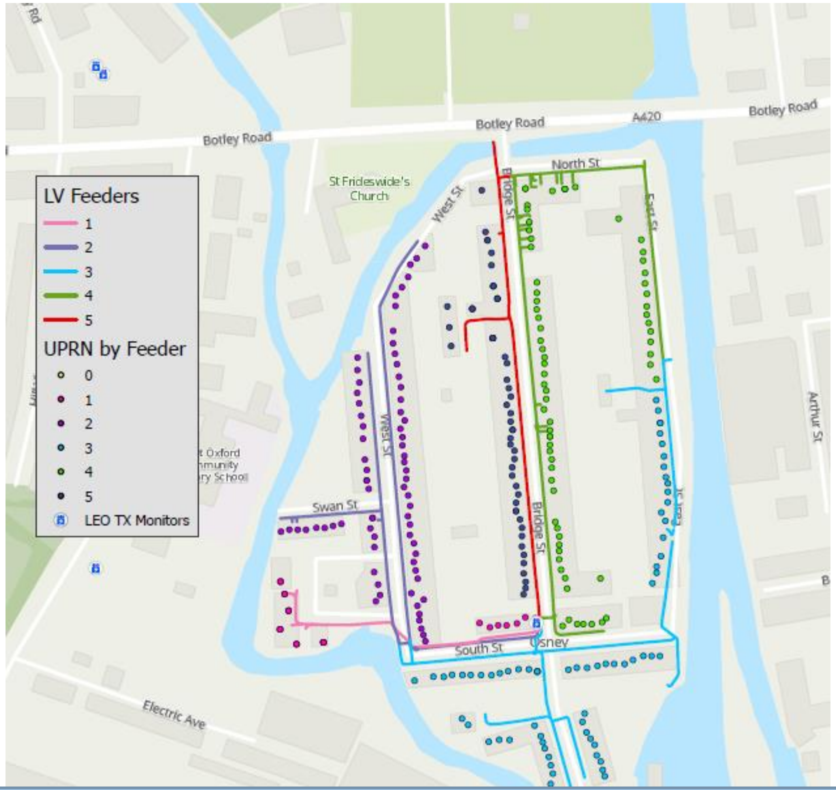
- ENEIDA portal for LV monitoring data



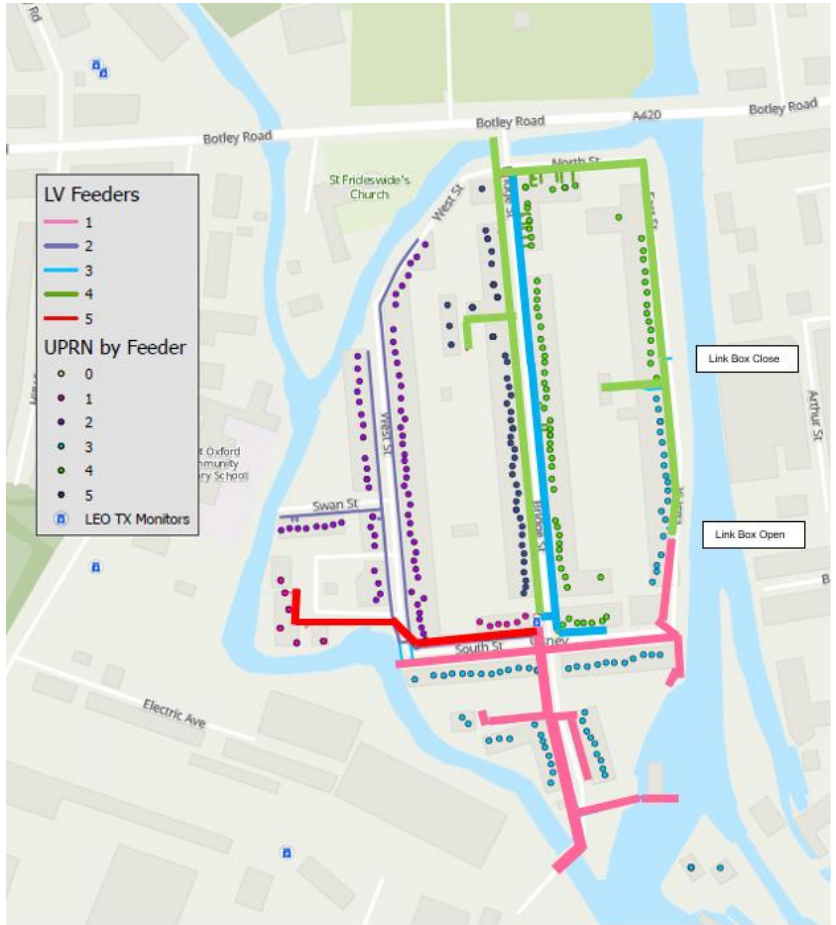
Osney Bridge Street S/S Connectivity Verification

- Kelvatek Trace device was used for feeder connectivity validation

SSEN records



After field validation



Update records

Verifying the connectivity onsite increases DNO confidence in LV network models and helps plan uptake of LCTs.

Osney Bridge Street S/S Connectivity Verification

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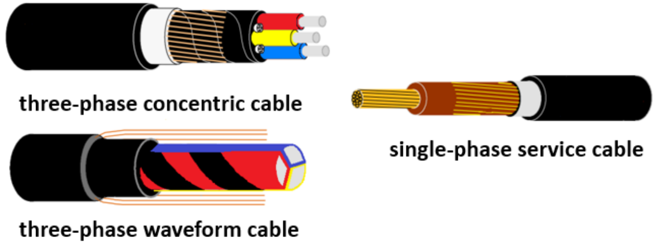
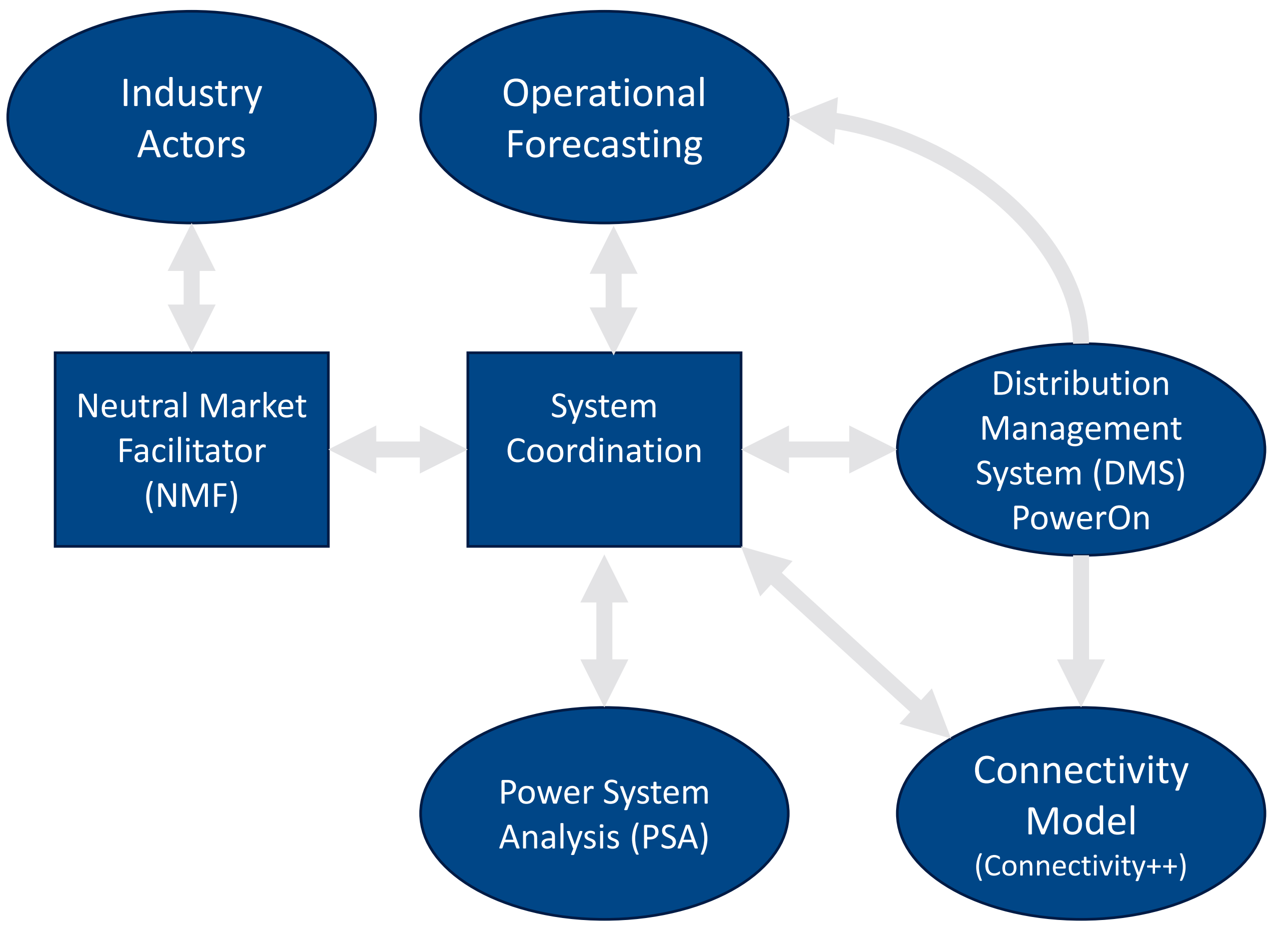
- Haysys Phase Identification Unit device was used for phase connectivity validation



Field work can be used to validate customers connectivity, however it's time & resource consuming. Other alternatives are needed e.g. using smart meter data

TRANSITION HLD of Tools



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TRANSITION Operational Forecasting

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- In order to make good decisions around flexibility market contract selection and dispatch, the DSO tools will need to be fed with accurate forecasts of network injections for horizon of interest.
- TRANSITION project has designed a specification for an Operational Forecasting tool that will provide this 0-10 day ahead view of e.g. demand, wind + solar PV availability, and (likely) patterns of other generation sources.
- Inputs to this tool will be e.g. historical and real time system data, underlying wind speed/solar irradiance/temperature weather forecasts, time of day/week/season/year, generation technology type, etc.
- Operational timeframe forecasting in particular needs to consider the reality that forecast uncertainty and error is an unavoidable issue : TRANSITION has explored the ability of probabilistic forecasting to address this issue.
- TRANSITION team have contracted with SIA Partners to deliver this tool.
- We have also collaborated with another SSEN NIA project NERDA, as well as developing an automated interface with Electralink for real time settlement data of embedded generation, to improve accuracy of forecasts

Outputs for the TRANSITION project

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Communication with other systems

Forecasting Solution → System Coordination

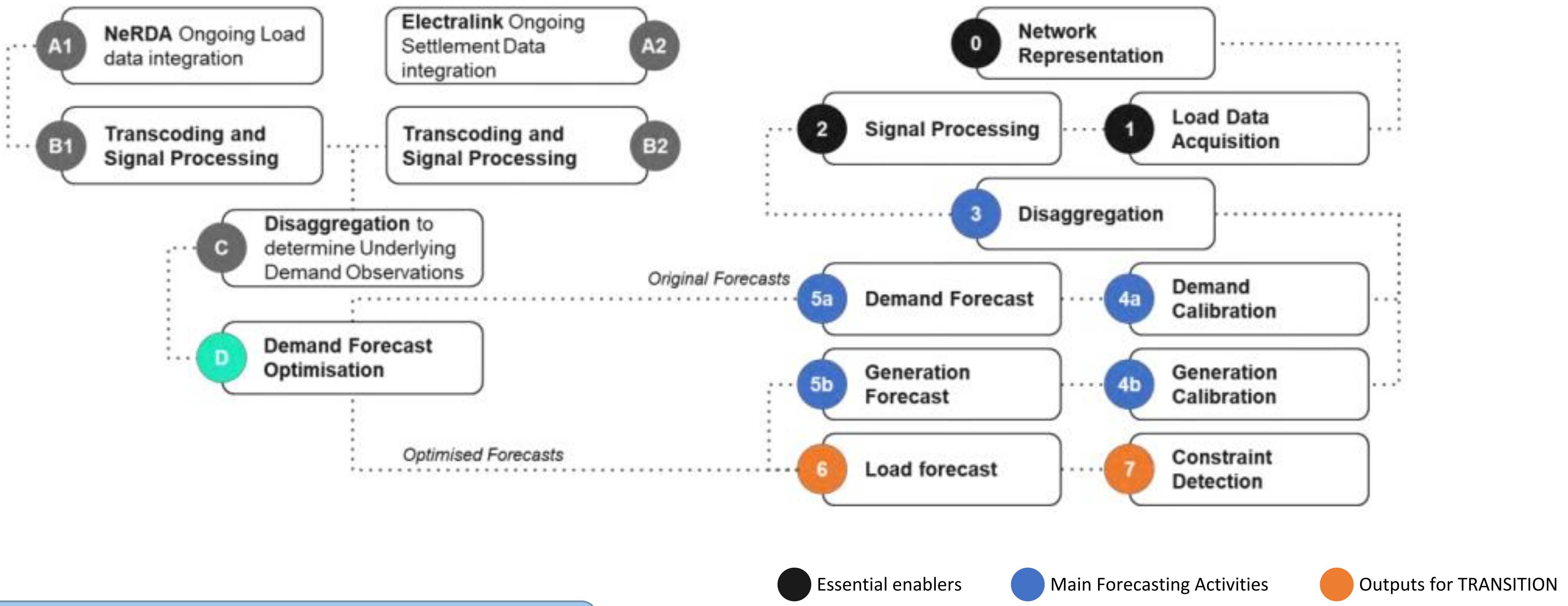
- Communicate forecasts for all substation / feeders / generation assets **8x per day**
- Identify **areas of congestion** on the network

Forecasting needs to deliver a range of outputs, with a mix of automated API supported feeds but also graphical human awareness

Dedicated user interface

- User friendly interface designed for the TRANSITION project, with **inputs from BAU resources**
- Simple features to support the **detection of congestion** within TRANSITION scope

High Level Forecasting Process



Forecasting is a highly numerically intensive process. Critical controls need to filter data and refine models.

Electralink Collaboration Work

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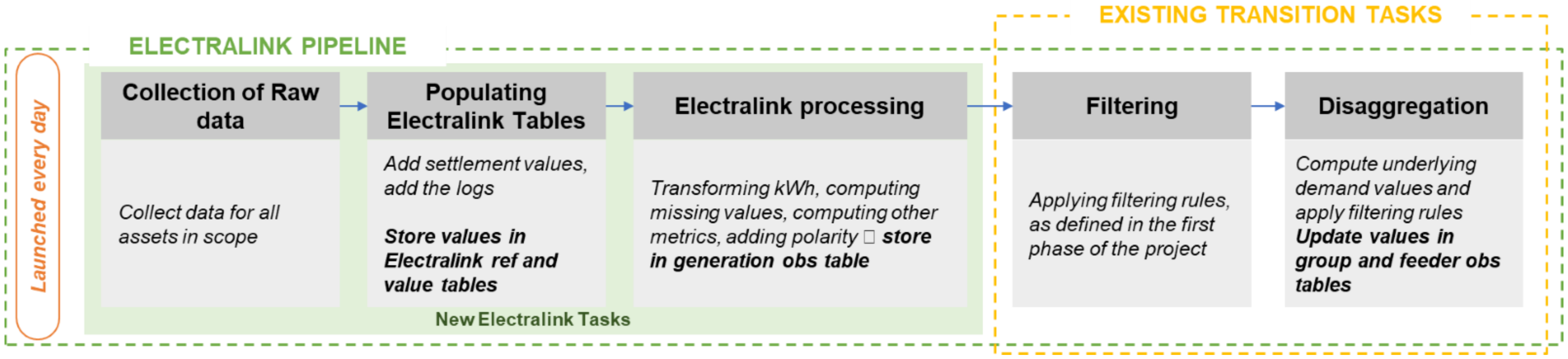

Real time data sources, including external data, supported by APIs, are critical to ensure forecast models are maintained accurate. Privacy controls are essential.

- A significant innovation of this work was to develop a real time connection to Electralink via an API
- Electralink is a special purpose company, steered by the 6 GB DNOs, that is tasked with management of energy meter settlement data activities in support of the wider energy market
- Connecting automatically to this data source allowed a (close to) real time data feed from embedded generation on the distribution network to improve the forecasting capability of such sources, as well as overall net demand
- Special IT architectural provisions were put in place to ensure proper treatment of GDPR sensitive sites, as well as only permitting 3rd party access to a limited subset of the required data

Value of Real Time Data Adjusted Forecasting

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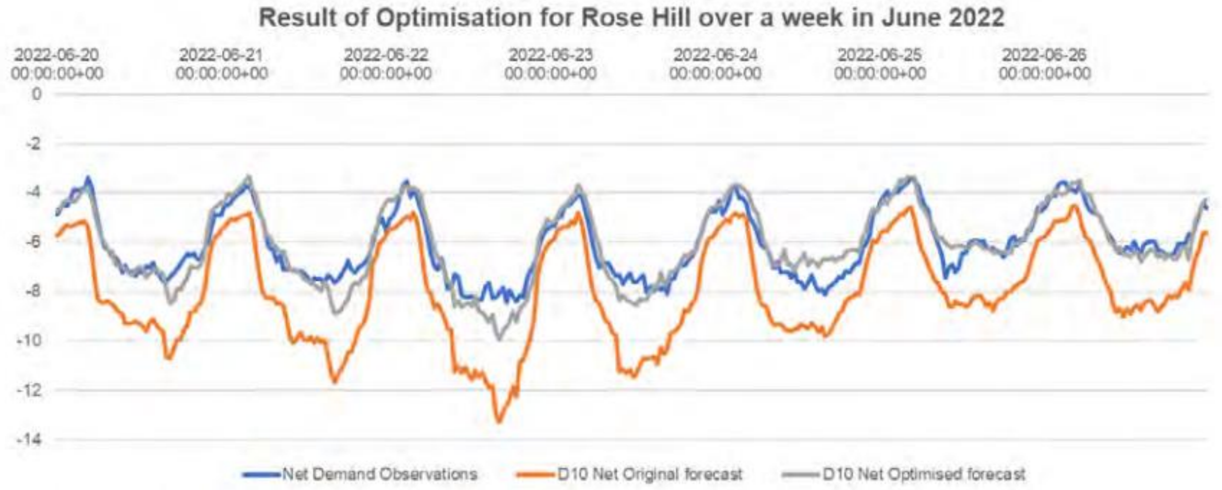
HV Group (Forecast D10)	Original Forecast MAPE*	Optimised Forecast MAPE*
Arncott	31%	21.4%
Berinsfield All Feeders individually	21%	13.1%
Bicester	14%	7.5%
Bicester North Primary	9%	7.5%
Deddington All Feeders individually	10%	9.7%
Eynsham	10%	7.1%
Kennington	19%	12.0%
Milton	32%	21.3%
Oxford Primary	15%	6.3%
Rose Hill	20%	7.7%
University Parks	6%	4.7%
Yarnton Primary	9%	7.9%



MAPE* - mean average percentage error with 0 values removed

Capturing Forecast Uncertainty for Flexibility Decisions

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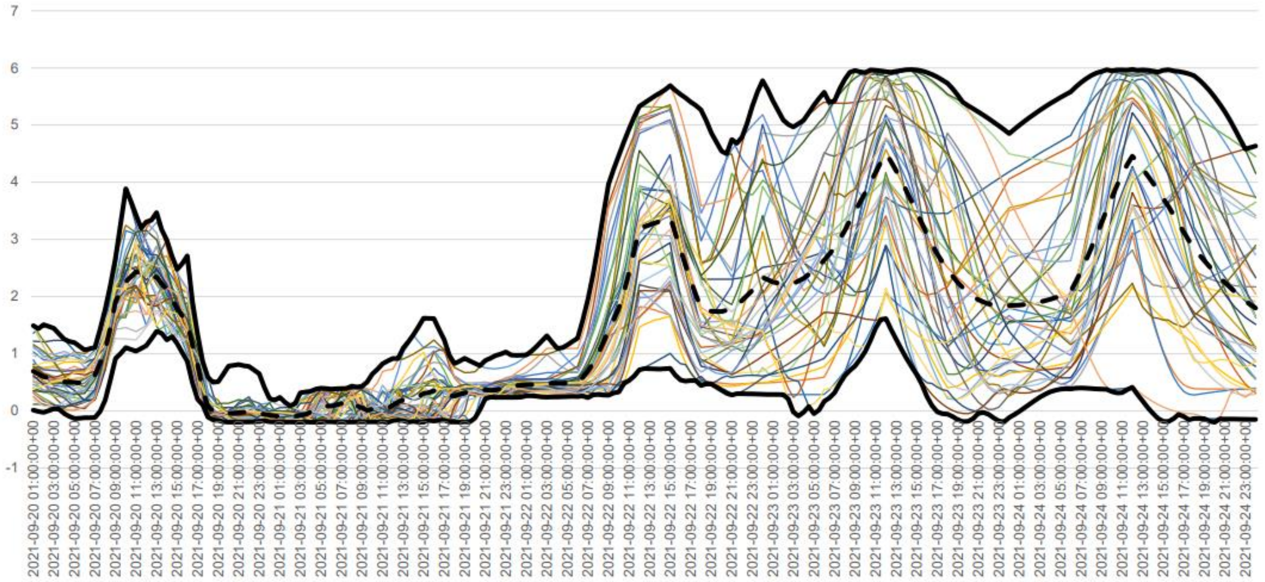
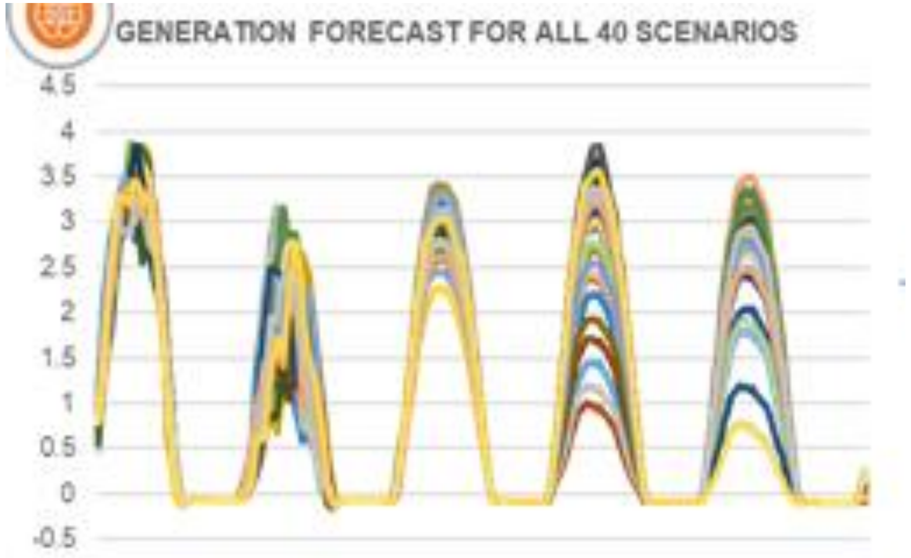
- With the models fitted above, they can then be applied to the forecast meteorological data
- The weather data provides a range of scenarios to capture the uncertainty in the forecast – clearly, for operational purposes, capturing this uncertainty is critical for variable renewable energy modelling
  - Multiple scenarios effectively capture the probabilistic envelope of uncertainty

Oxfordshire Wind Farm 4-Day Example



Oxfordshire Solar-PV Farm 4-Day Example



Forecasts, and (flex market processes) in areas of the network dominated by renewables need to capture uncertainty.
Forecasting non-renewable generation output has inherent challenges that may challenge baseline definition.

Key Take-Away Points

1. LV modelling in advanced real-time PSA tooling is possible and reveals useful network insights at community level – data is key to the quality of models

2. Data from the field can support/improve view of network connectivity, though it needs to scale efficiently across customer base – advanced new sources of data may unlock benefits

3. Accurate operational forecasting tools are necessary in support of automation in flex markets

4. Using real time information to improve/adapt forecasts is essential, and forecasting for "closer to real time" flex markets needs to account for inherent decision making uncertainty in the problem

Q&A Session

For more information or to access our extensive learning reports; please visit www.ssen-transition.com

Annex

References

- TRANSITION website / other reports : Library | SSEN Transition (ssen-transition.com)
- Project LEO website : Home - Project LEO (project-leo.co.uk)
- Transition original tools HLD : Requirement Specification (ssen-transition.com)
- Phase 1 Forecasting report : TRANSITION-Load-Forecasting-Dissemination-Report-Final-V3.pdf (ssen-transition.com)
- Phase 2 Forecasting report : TRANSITION-Real-time-Forecast-Optimisation-Report-Compressed.pdf (ssen-transition.com)
- LEO SFN report on PSA : LEO Smart and Fair Neighbourhood LV Modelling report on Osney : *Due for publication on Project LEO website in ~ June 2023*

Osney Bridge Street – Data Augmentation

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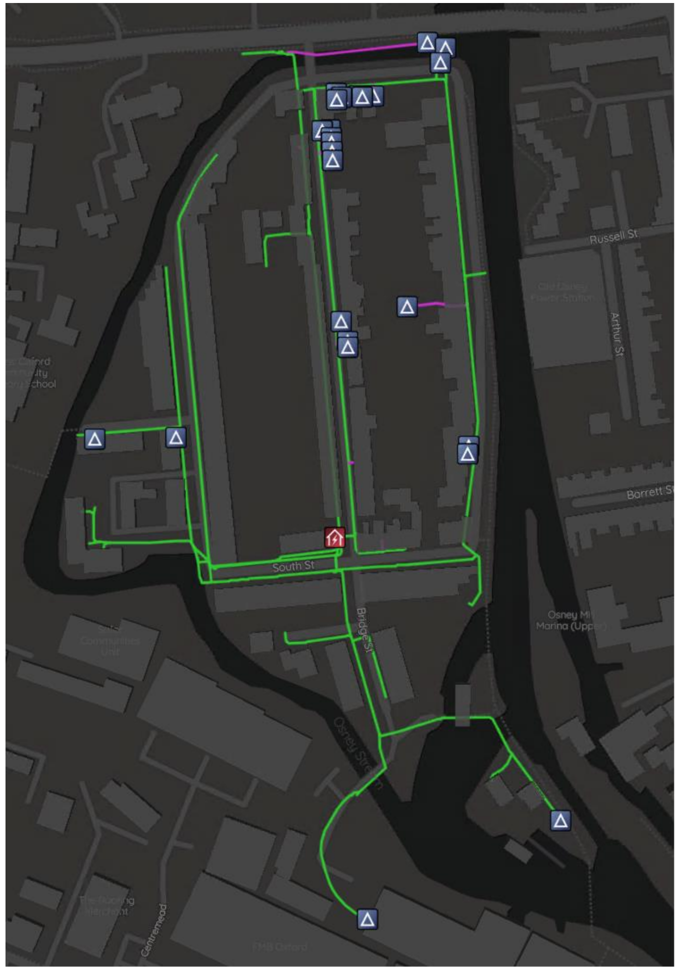
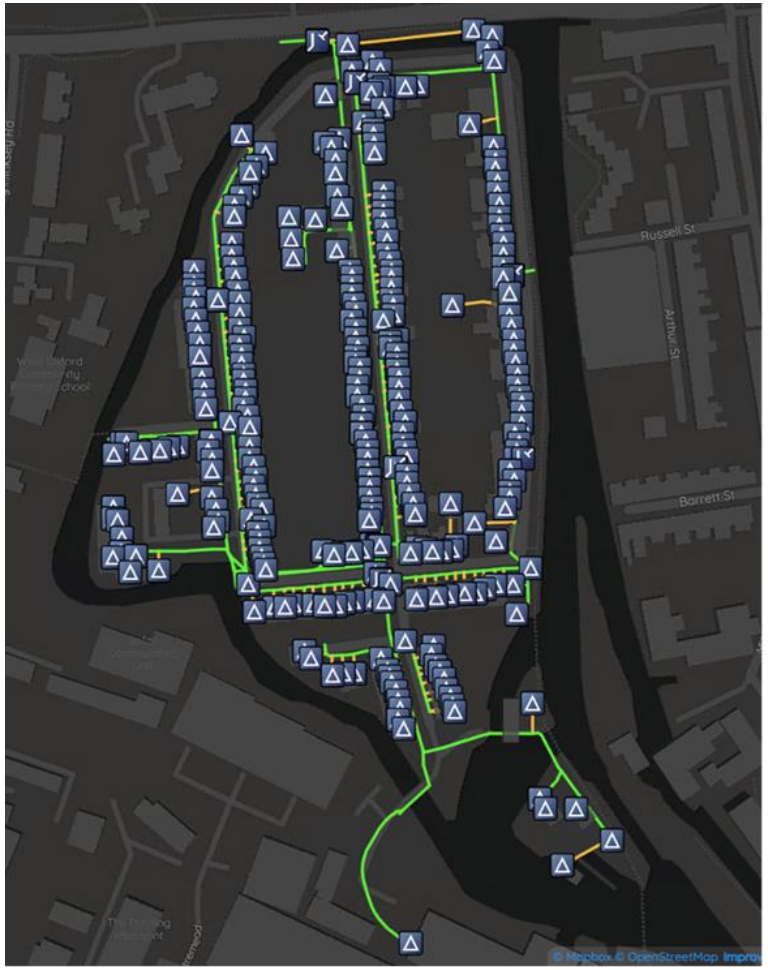


Initial network model coming from GIS data

UPRN dataset



Final model with all customer points and service cables

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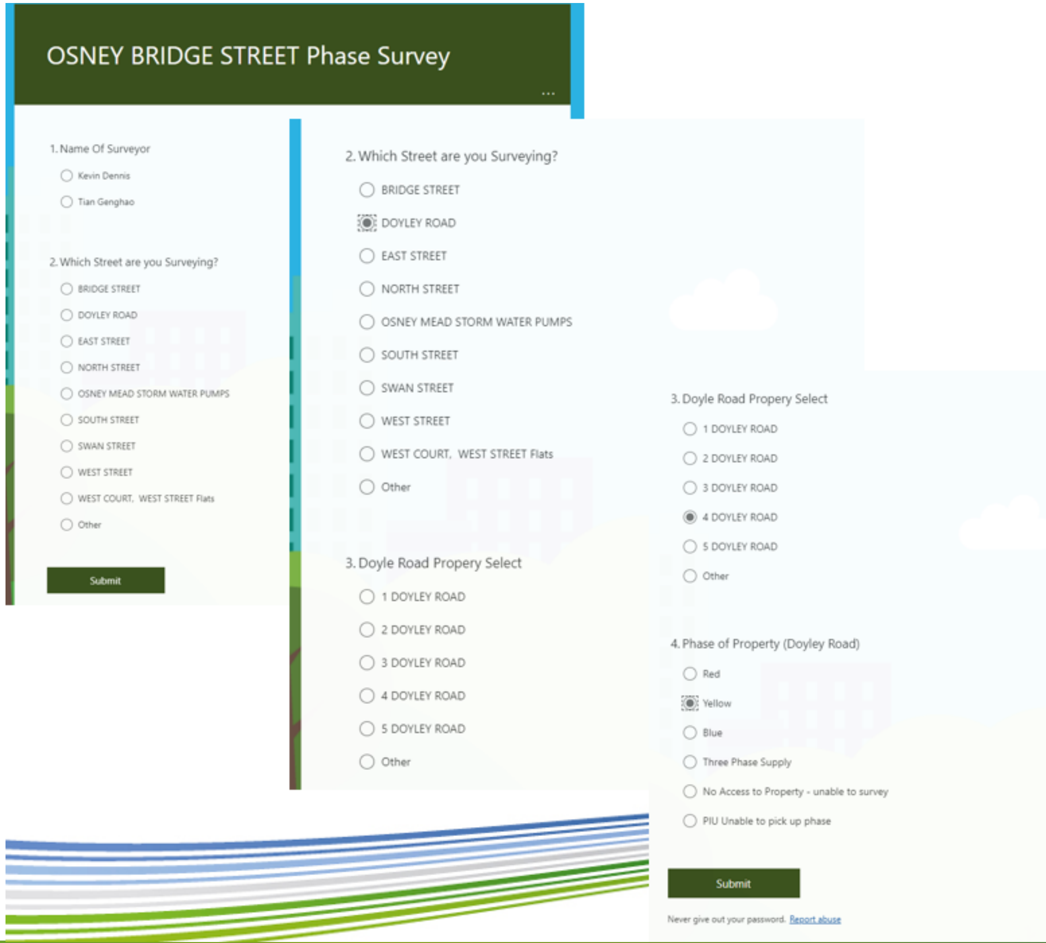
Osney Bridge Street S/S Connectivity Verification

- Haysys Device for phasing identification – 2nd visit

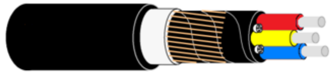


		PIU SURVEY				NOT SURVEYED WITH PIU					
Transformer Name	LV Feeder NRN	Red	Yellow	Blue	Three Phase Supply	Three Phase Supply;No Access to Property - unable to survey	No Access to Property - unable to survey	PIU Unable to pick up phase	Not Surveyed		Property's Phases not captured
OSNEY BRIDGE STREET	1	17	19	14	1	0	5	1	6	63	19%
OSNEY BRIDGE STREET	2	21	17	22	0	23	2	3	9	97	38%
OSNEY BRIDGE STREET	3	23	21	14	0	0	3	4	4	69	16%
OSNEY BRIDGE STREET	4	5	5	4	2	0	2	1	0	19	16%
OSNEY BRIDGE STREET	5	12	9	14	1	0	12	0	5	53	32%
										301	

		Properties with Smart meters									
Transformer Name	LV Feeder NRN	Red	Yellow	Blue	Three Phase Supply	Three Phase Supply;No Access to Property - unable to survey	No Access to Property - unable to survey	PIU Unable to pick up phase	Not Surveyed		Properties surveyed with Smart meters
OSNEY BRIDGE STREET	1	5	6	7	0	0	1	0	2	21	86%
OSNEY BRIDGE STREET	2	9	10	8	0	11	1	1	6	46	59%
OSNEY BRIDGE STREET	3	12	9	7	0	0	0	1	1	30	93%
OSNEY BRIDGE STREET	4	2	4	2	1	0	0	1	0	10	90%
OSNEY BRIDGE STREET	5	4	7	7	0	0	5	0	1	24	75%
										131	

Osney Bridge Street S/S Connectivity Verification

- Haysys Device for phasing identification – 1st visit



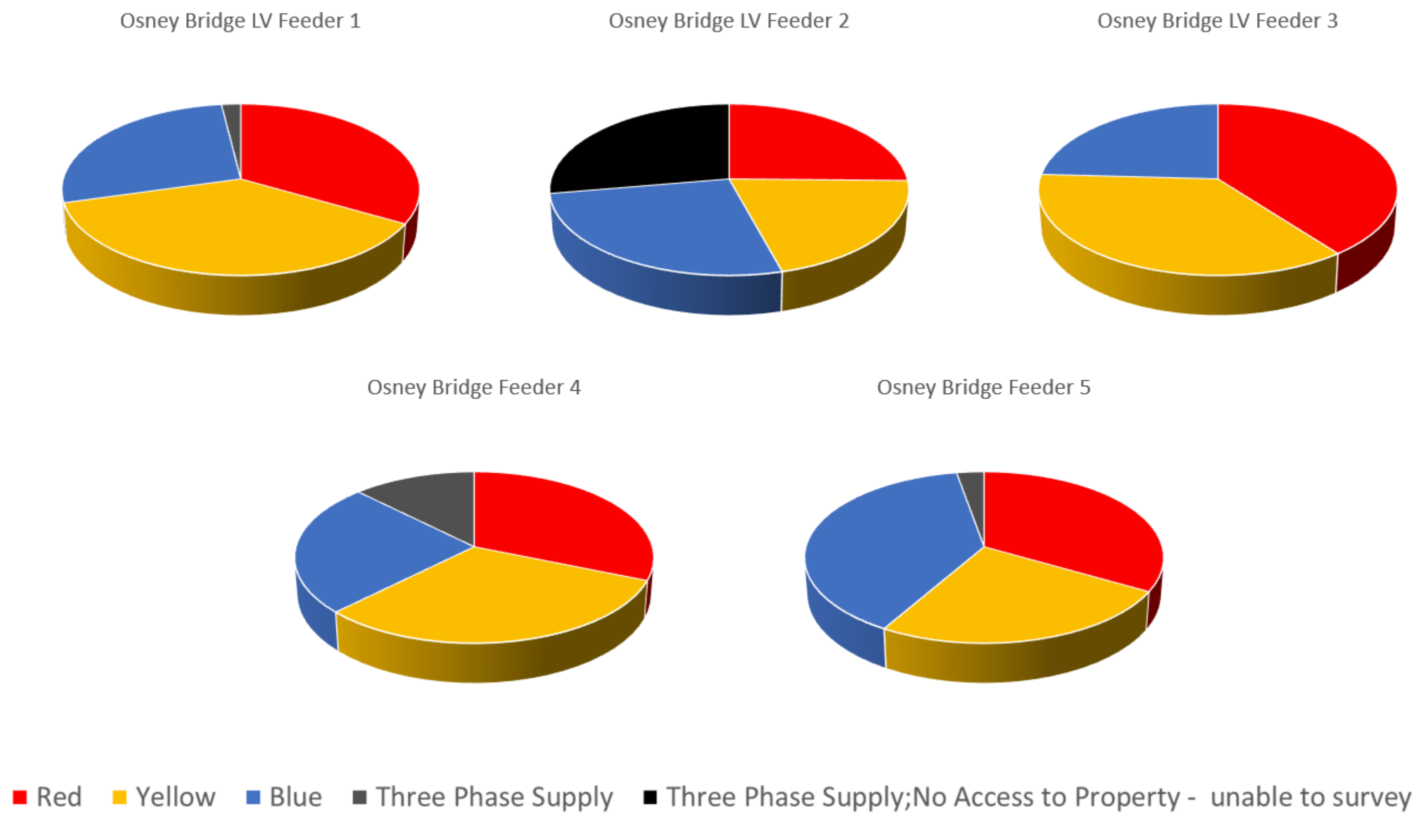
three-phase concentric cable

single-phase service cable

three-phase waveform cable

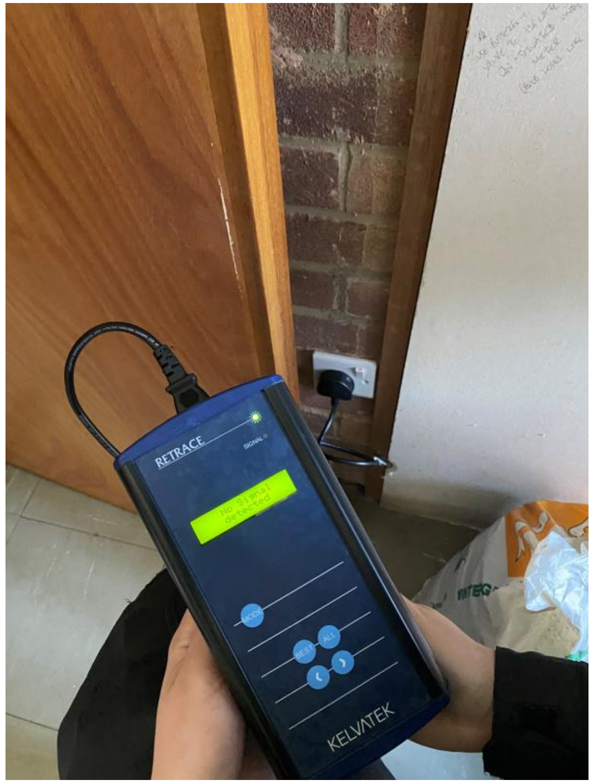
Osney Bridge Street S/S Connectivity Verification

- Haysys Device for phasing identification – 2nd visit



Osney Bridge Street S/S Connectivity Verification

- ❑ Kelvatek Retrace



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Osney Bridge Street S/S
Connectivity Verification

- Kelvatek Trace Result – LV Feeder Name Misalignment

SSEN Record LV Feeder Number	SSEN Record LV Feeder Name	Site Visit Result LV Feeder Number	Site Visit Result LV Feeder Name
01	SOUTH STREET	01	SOUTH STREET
02	WEST STREET	02	WEST STREET
03	BEIDGE STREET EAST	03	BRIDGE STREET EAST
04	FLATS CORNER SOUTH ST	04	BRIDGE STREET WEST
05	-	05	FLATS CORNER SOUTH ST

Forecasting Use : Network Models

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Development of an integrated network model including:

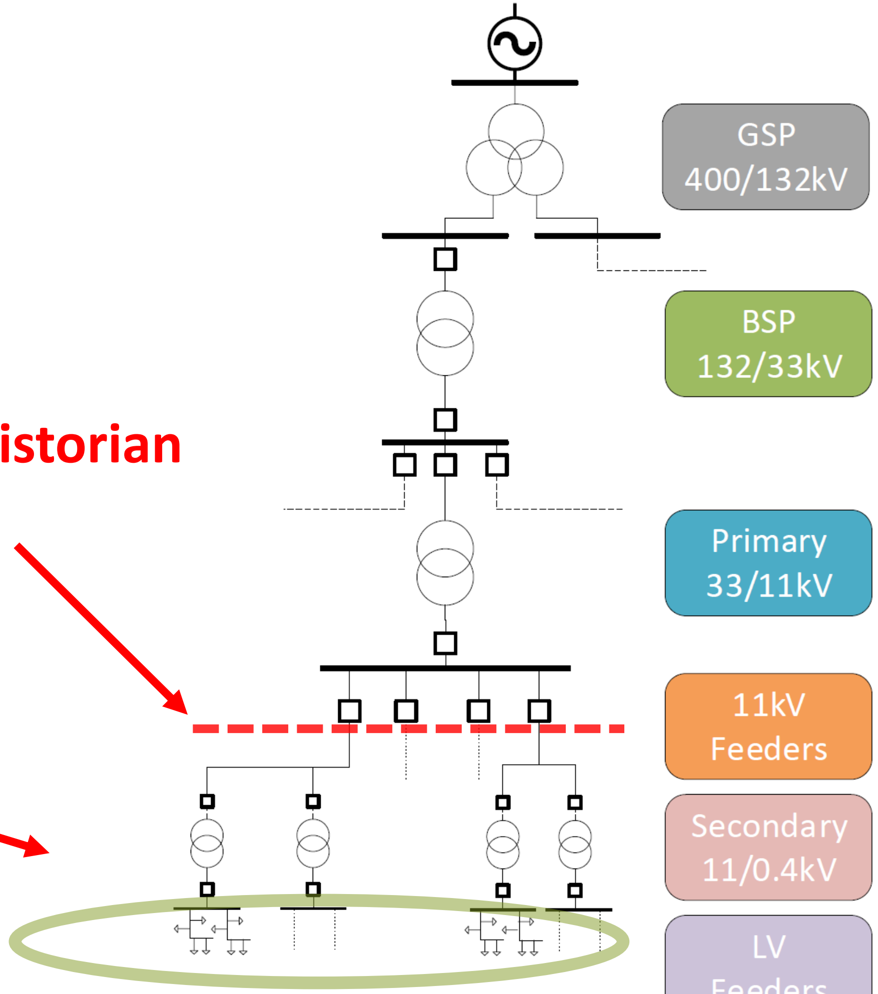
- 132kV
- 33kV
- 11kV
- LV as required

TRANSITION area of interest

- 2 GSPs
- 6 BSPs
- 13 Primaries
- 125 HV Feeders

SCADA/PI historian stops here

Up to 100 LV substations have ENEIDA LV monitors



Procuring flexibility from LV-connected customers