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OPEN LV

OPENING UP THE SMART GRID

Identification of the LV Trial Networks

ea technology

RIIO NIC NETWORK INNOVATION COMPETITION

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July 2017	2.1	Richard Potter
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1. Introduction

1.1 Background

OpenLV is a Network Innovation Competition (NIC) research and development project (the "Project") that will trial and demonstrate the LV-CAP™ platform developed by EA Technology and Nortech Management Limited within an InnovateUK project.

The OpenLV Solution (LV-CAP™) is a software platform that operates on off-the-shelf commodity hardware and is designed to be an open, flexible platform that could ultimately be deployed in every HV and LV substation in Great Britain. The LV-CAP™ solution is analogous to a smartphone. In the case of the smartphone an open platform has led to a rapid acceleration in Applications (Apps) provided by a wide variety of organisations, covering a huge array of services. The Project will trial a similar, open platform, but for a substation. It will act as an interface between LV substation assets and the customers that it serves. The project will demonstrate that the Solution can:

- **Provide a platform** to deploy a workable open substation platform for both monitoring and control of the LV network;
- **Create an Eco-System** to provide third parties, including community groups with access to network data; and
- **Stimulate the Market** to facilitate a common platform with low cost entry for a range of new App developers.

To test these aims, the project will apply three Methods, together with a common set of enabling works as shown in Figure 1.

LV-CAP™ will be installed in 80 LV substations located in the WPD licence area. The Project will use three Methods to demonstrate the platform's ability to provide benefits to the network owner, customers, and service providers. The three Methods are as follows:

- **Method 1: LV Network Capacity Uplift** - 60 units - This will perform measurements and control within the substation. The Project will deploy proven techniques - 'Dynamic Thermal Ratings App' and 'Network Meshing App'.
- **Method 2: Community Engagement** - 10 units - The platform can be used to provide data to customers or groups of customers. The project will work with community groups to understand whether Apps for their benefit can be developed and installed on the platform and work to identify funding sources that can be used to develop specific Apps for their benefit.
- **Method 3: OpenLV Extensibility** – 10 units - This method will provide a platform for third parties to develop and release their own Apps to provide benefit to DNO and customers alike.

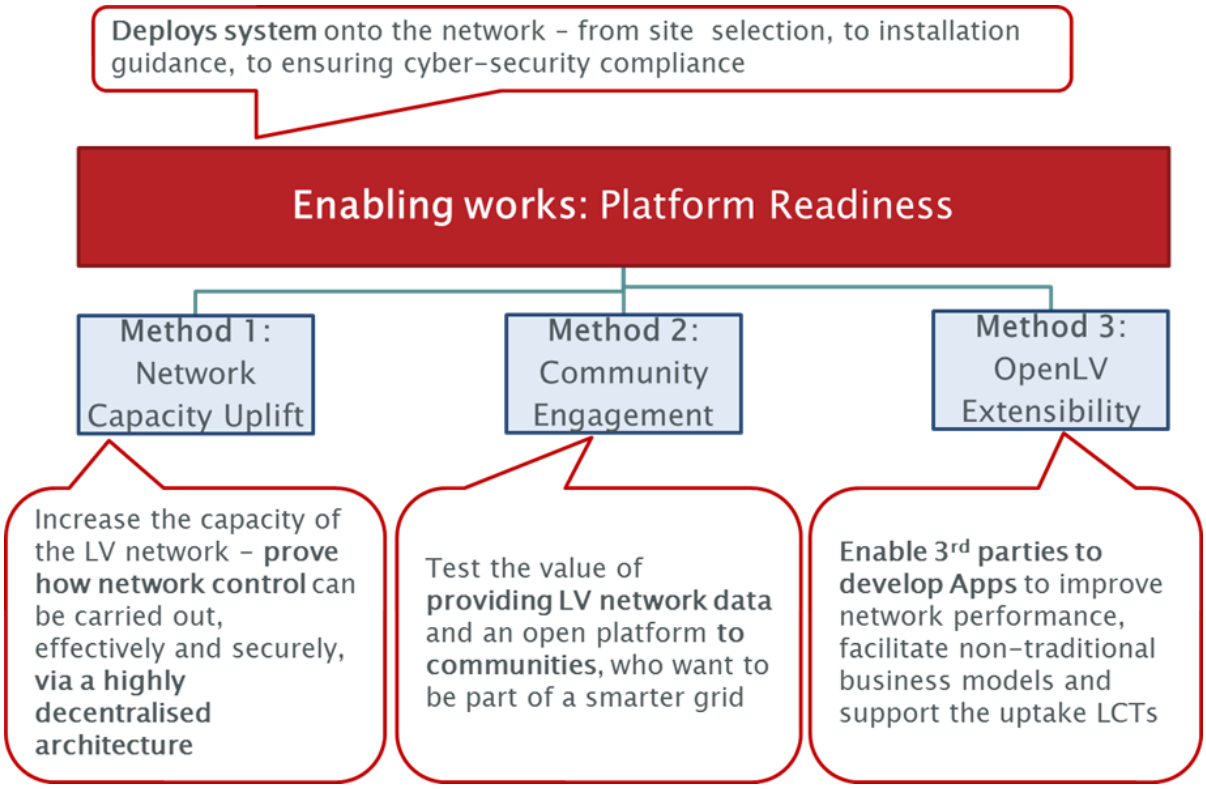

Figure 1: Overview of the three methods being used in the project

1.2 Purpose

The purpose of this document is to outline the process for identifying trial networks for use within the Method 1 network capacity uplift trials as part of the OpenLV Project. This is a 'live' document and in addition to detailing the process being followed, this document will be updated to include information on the networks selected for use within the trials.

1.3 Equipment

The trial equipment in the substation consists, at a high-level, of two elements:

- The 'OpenLV solution' comprising of an enclosure containing the LV-CAP™ processing hardware and an adjacent Lucy Electric Gridkey (MCU520) platform; and
- ALVIN Reclose™ devices in a subset of selected substations to implement meshing between adjacent LV networks under the control of the LV-CAP™ platform.

ALVIN Reclose™ devices are fully self-contained automatic reclosers capable of operating with 315A and 400A BS88 fuse characteristics.

They can also be controlled directly, and hence under the OpenLV Project, will perform the role of a controllable circuit breaker, in addition to fuse replacement circuit protection.

2. Method 1 – Network identification

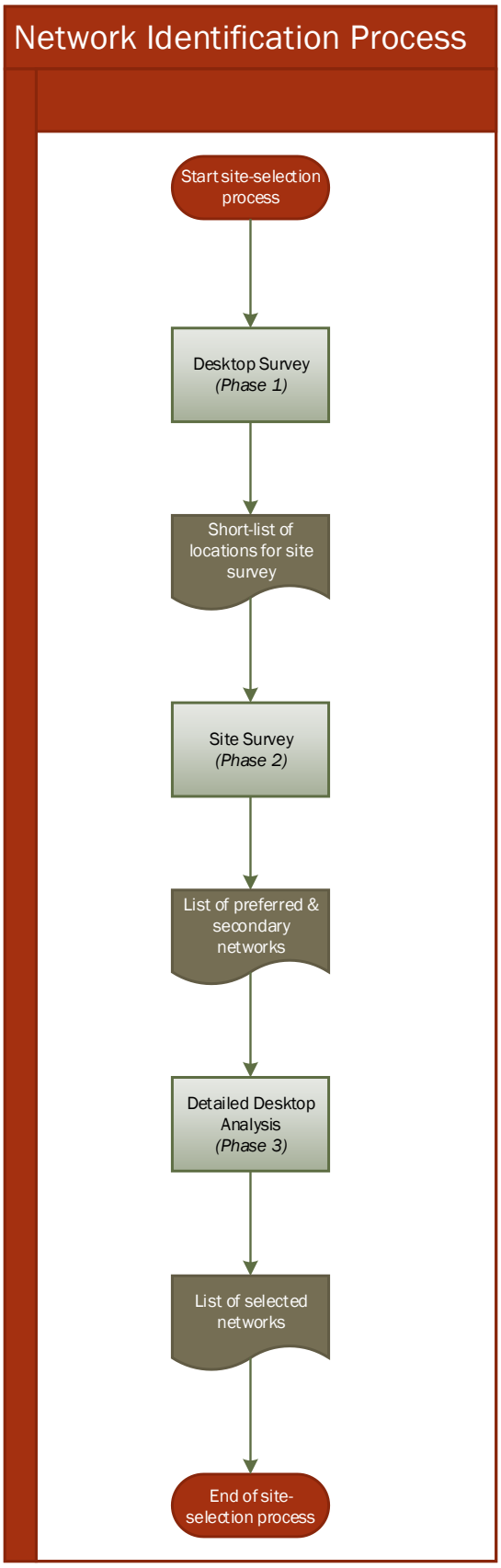

Figure 2 – Overall LV Network identification process

To trial the methodology proposed for Method 1, specifically utilising real-time monitoring of the LV network to inform an automated network meshing process. Selection of suitable LV networks is essential. Method 1 will include the use of dynamic thermal rating (DTR) as an input to the implementation of the network meshing. However, DTR has been trialled before and is not therefore, the purpose of these trials.

2.1 Considerations for network selection

Identification of potential sites will be undertaken utilising a combined desktop survey and on-site evaluation process. Sites shortlisted via desktop survey will be visually inspected before being subjected to a final, detailed network analysis. The overall process is depicted in Figure 2 – Overall LV Network identification process.

The considerations for network selection include technical and commercial requirements and are covered below, separated by the desktop survey and on-site inspection criteria.

2.1.1 Desktop survey (Phase 1)

The flow diagram for Phase 1 is located in Figure 3 – Desktop survey (Phase 1) process.

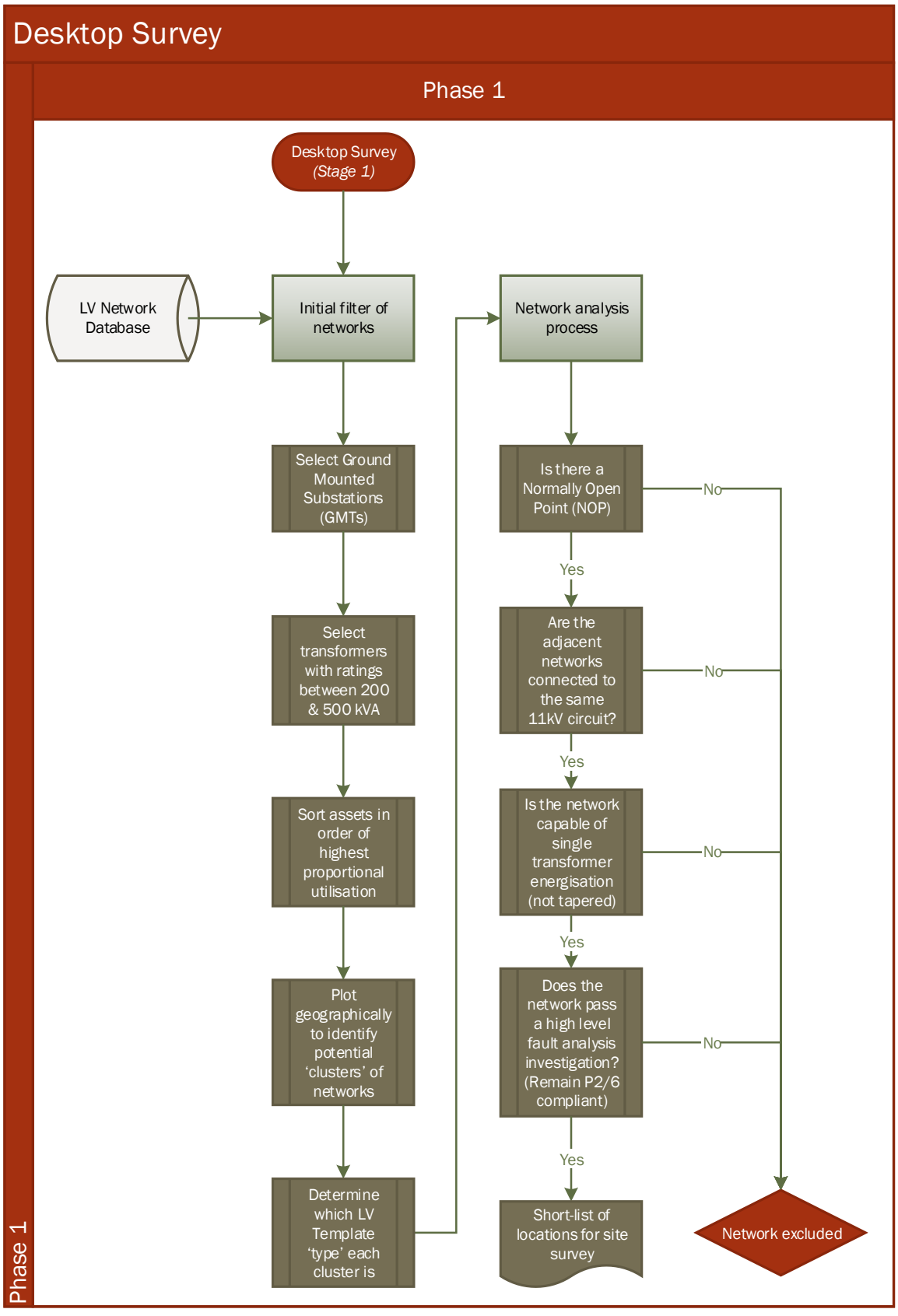

Figure 3 – Desktop survey (Phase 1) process

Network locations

The project has been given network data to allow identification of potential networks to be undertaken.

The range of geography and customer profiles within the four licence areas will ensure the OpenLV Project could select the best networks for use in the trials.

This maximising the opportunity to gather a rich data set from across the networks available to the Project.

Figure 4 - Map of the UK with WPD's 4 licence areas listed - East and West Midlands, South Wales, and South West

Transformer type

Whilst it is a business-as-usual practice to deploy Smart-Grid enabled equipment at pole-mounted substations, for the purposes of the OpenLV Project, only ground-mounted substations will be utilised.

This decision was based on:

- Simplification of installation for the trials:
  - The same work crews would be able to install the necessary equipment in all trial locations;
  - The range of required mounting arrangements will be limited, minimising variations to equipment and method statement requirements.
- Equipment can be accessed without specialist equipment / training.

Any network locations identified as part of the process that consist of either overhead-line mounted transformers or private network transformers will be disregarded as will any transformers servicing less than 10 customers.

Furthermore, preference will be given to indoor substations to provide additional security and protection from the elements to the trial equipment. Indoor substations are also more likely to have capacity for the installation of ALVIN Reclose™ devices on the fuse board in the latter stages of Method 1.

Transformer rating

The ALVIN Reclose™ equipment will be utilised in Method 1 to demonstrate automatic control of network assets by an LV-CAP™ platform, this equipment can only replace fuses rated at 315A or 400A.

The desktop survey stage will initially disregard any transformer with a kVA rating that does not fall between 200 and 500 kVA to provide a more manageable list of potential sites. This does not preclude identified sites connecting to a substation with a larger transformer rating. If enough suitable sites are not identified from the first desktop survey, then expanding the search criteria to include higher rating transformers will be undertaken to increase the number of potential sites.

This requirement applies to both transformers at either end of the potential ‘link’ to be established under Method 1.

Ratio of transformer rating vs loading

The OpenLV Project has been provided with a significant volume of LV network data from previous projects undertaken by WPD. The data, implemented in 'Distribution Substation Estimates', ranges across all four of WPDs licence areas although it does not include every network that exists.

This data relating to the transformers, includes 'Name Plate' details, whether it is a pole or ground-mounted and information relating to the loading.

Comparing the Name Plate details with the loading of the asset provides a loading ratio for the asset. The OpenLV Project is focussing on locations where one asset is operating, proportionally, at a greater loading than the other to have a level of load reliability from day-to-day.

Clustering

Logistically, it will be far more efficient to install, commission, maintain and decommission the trial hardware if the selected locations are in reasonable proximity. This will reduce travel costs and the eventual duration of all activities necessitating a presence on-site.

This consideration will not be implemented in preference to all others; selecting of networks based on learning to be generated and technical feasibility will take precedence, but where multiple locations are deemed suitable, clustering of trial sites will be undertaken as far as possible.

Network arrangement

There are several considerations for the specific arrangements of each identified network.

1. The presence, or otherwise, of a Normally Open Point (NOP). If there is no NOP that could conceivably be 'closed' to link adjacent networks, then the network will be removed from consideration at this stage. It will be assumed at this point that the NOP can be closed if required, although this will require verification at the site-survey stage.
2. The two adjacent networks must be energised from the same HV network to avoid the potential for an inadvertent connection between HV circuits through the LV network; if not then they will be removed from consideration.
3. The network cables on either side of the NOP must be capable of sustaining the energy transmission if the entire length were to be energised from a single transformer at one end or the other. Therefore, where a network is tapered, initially it will be removed from consideration; if additional networks are required, potential sites disregarded at this stage will only be reconsidered following network analysis to determine the network is capable of safely maintaining the load.

Network type

It was confirmed within the OpenLV Project Bid Submission that network selection would include consideration of the similarity to LV Network Templates, previously developed by WPD. Of the ten templates identified, two (Industrial Flats and Streetlighting) are inappropriate for the OpenLV Project and the demonstration of the LV-CAP™ platform's capabilities and consequently any networks of this type will be disregarded as part of the identification process.

2.1.2 Site surveys (Phase 2)

The flow diagram for Phase 2 is located in Figure 5 – Site survey (Phase 2) process.

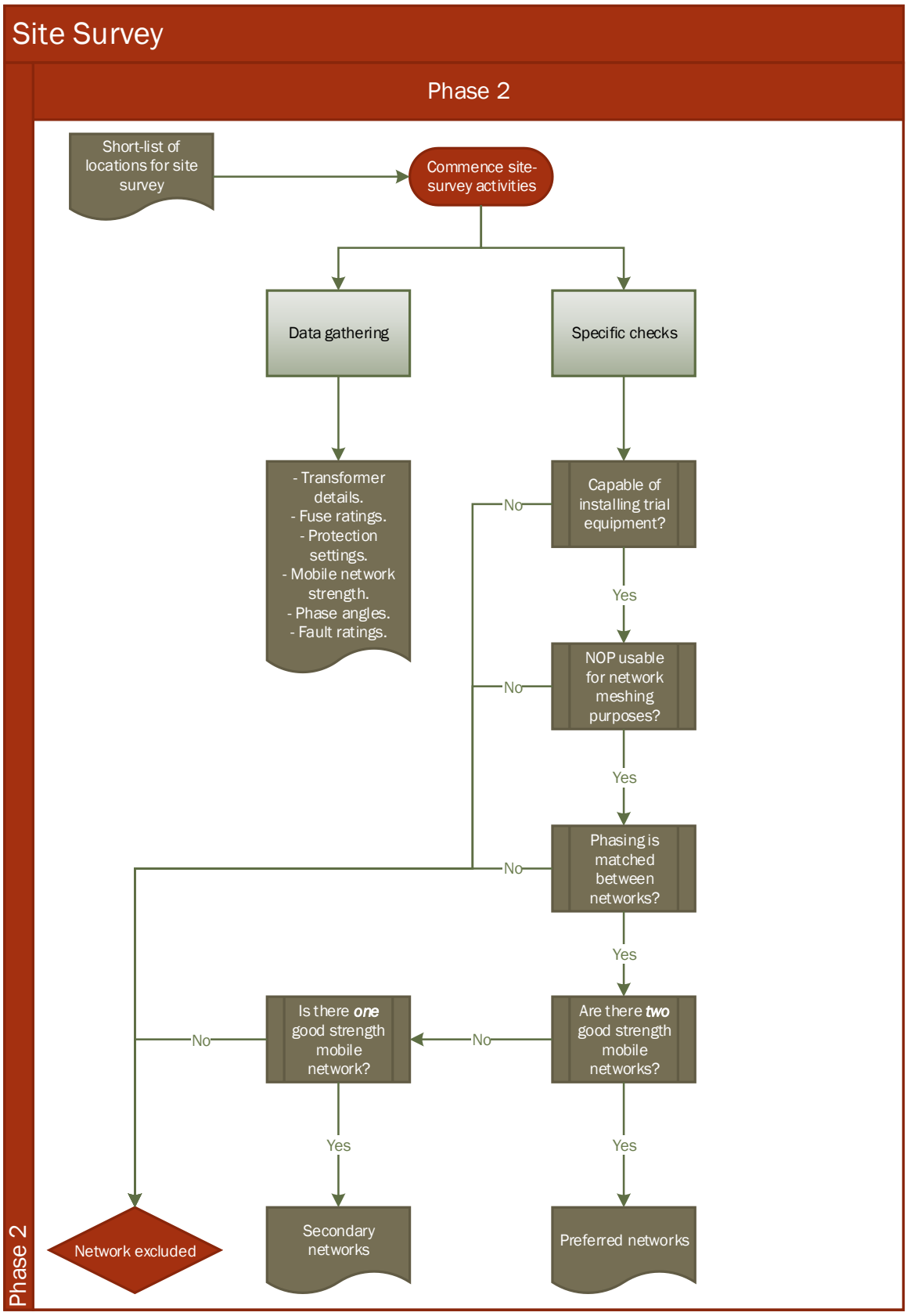

Figure 5 – Site survey (Phase 2) process

Space to install OpenLV trial equipment

The ability to install the project's equipment within the specific substation is a critical factor that can only be verified via a site inspection. Consideration must be taken of available space to safely install a cabinet containing the LV-CAP™ platform within the substation, and connection of the monitoring devices (current transformers to bus bars, temperature probes to the transformer).

If there is insufficient space to safely mount the necessary equipment, the site will be disregarded for the purposes of the trial.

Fuse ratings

The ALVIN Reclose™ equipment to be utilised in Method 1 to demonstrate automatic control of network assets by an LV-CAP™ platform, can only replace fuses ratings of 315A and 400A.

Therefore, any networks that do not have fuse ratings of either 315A or 400A will be disregarded at this stage.

Fuse board

The ALVIN Reclose™ devices are larger than a standard fuse and consequently a fuse board capable of having them fitted will be essential and any locations where this is not possible will be flagged at the site survey stage and taken into account during the final selection process. Not all locations will have ALVIN Reclose™ devices installed but a reasonable proportion need to be capable of this at the start of the project, although ALVIN deployment will not be determined until later.

Furthermore, the presence of an unused set of fuse sockets on the fuse board is preferred to make connection into the LV network by the LV-CAP™ platform and monitoring equipment significantly easier to achieve.

Normally Open Point & Phasing

Verification of the NOP is required and will be checked during the site-survey stage to confirm the links can be physically closed.

At this point it will also be necessary to confirm that the adjacent networks are 'in-phase' to each other and consequently, can be connected through closure of the links in the NOP.

It is possible, although unlikely, that some networks might be found to be already running 'meshed' as a consequence of previous network operations such as fault restoration.

If the adjacent networks cannot be meshed, then they will be initially disregarded, although may be useable for 'virtual meshing' if sufficient sites have been identified to provide actual autonomous meshing tests.

Communication capabilities

The final consideration for each network location considered is that of communication viability. Trialling the platform necessitates a reasonable communication capability for monitoring, over-the-air updates if needed and minimising site-visits as far as possible.

Consequently, the final stage of site selection shall be an evaluation of the mobile signal strength across all available networks at each short-listed location.

If there is not a sufficiently strong signal strength across ***two*** mobile network providers, but has met all other requirements, then the network shall be considered a lower priority potential site. If there is not a sufficiently strong signal strength across even ***one*** mobile network then the site shall be disregarded entirely.

Fault history

It is anticipated that the site crews from each of the relevant WPD depots will be able to identify networks under consideration that have a history of fault occurrence. It is preferred that the OpenLV Project avoid utilising networks that are known to experience faults due to the impact this may have on the project findings.

2.1.3 Detailed desktop analysis (Phase 3)

The flow diagram for Phase 3 is located in Figure 6 – Detailed desktop analysis (Phase 3) process.

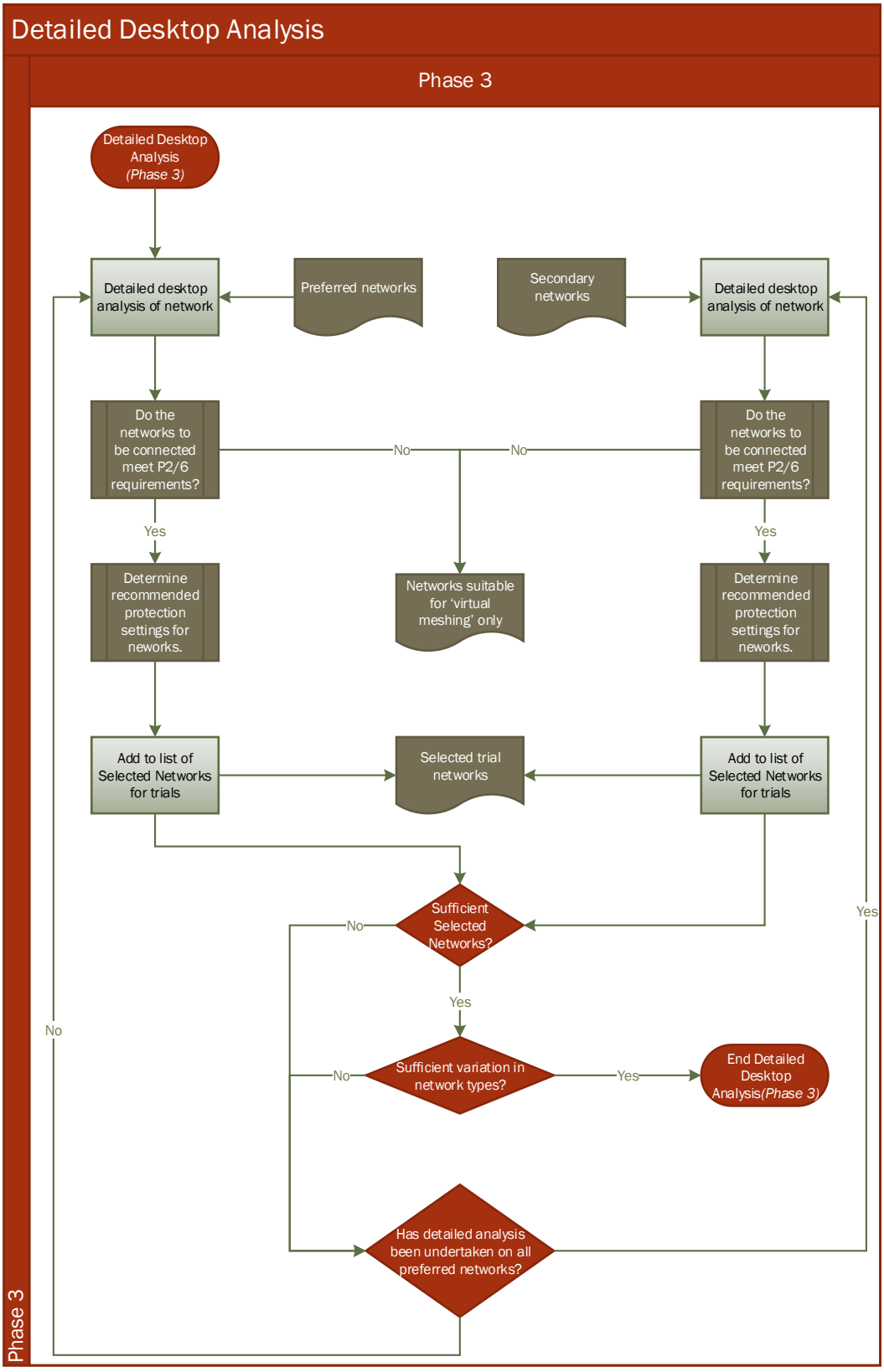

Figure 6 – Detailed desktop analysis (Phase 3) process

Fault analysis

Post-successful site-survey, a detailed fault analysis will be undertaken on networks still under consideration, including calculation of recommended protection settings for the networks if automated network meshing were to be implemented.

Only sites where meshing will not cause problems for the network's protection settings can be considered for deployment of the ALVIN Reclose™ devices for the autonomous meshing trials. Sites that cannot safely be meshed can still be utilised as a 'virtual meshing trial', if sufficient alternative sites have first been identified capable of implementing the full trial.