Date of Submission

2017

Network Innovation Allowance Project Closure Report

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Project Progress

Project Title

LV Connectivity Modelling

Project Reference

NIA_SSEPD_0015

Funding Licensee(s)

Scottish Hydro Electric Power Distribution, Southern Electric Power Distribution

Project Start Date

October 2015

Project Duration

9 Months

Nominated Project Contact(s)

David MacLeman

Scope

This project will develop a LV connectivity model using software to align meter supply points with local substations so that the links between substation feeders and user premises can be shown. These results can then be compared with the existing LV model, to give a level of confidence in using data analytics for this requirement.
The project will use a small section of the LV network in Bracknell, 10 Substations with approx. 2000 connected properties, so that we can compare the data analytics model, with that obtained by manual means.
Data from the Metering Point Registration System and the Geographical Information System will be provided to Bit Stew Systems for them to produce the LV connectivity data.
The area of the network to be analysed, has already been mapped as part of the Tier 2 New Thames Valley Vision project being undertaken by SEPD.

Objective(s)

The output of the project is to produce LV connectivity diagrams, using software, for the trial area which is within an acceptable level of accuracy when compared with the manually derived diagram.

Success Criteria

The project will have been a success if the end conclusions are able to make a justifiable statement that the use of data analytics techniques with the available data are either 1) able to make an accurate LV connectivity model, or 2) not able to make an accurate LV connectivity model.

Performance Compared to the Original Project Aims, Objectives and Success Criteria

The output of the project is to produce LV connectivity diagrams, using software, for the trial area which is within an acceptable level of accuracy when compared with the manually derived diagram. There were 2 sources of data provided to Bit Stew. A GIS data extract for the area that included Substation, Link Box, Supply Point, Polyline and joint information; and the NTVV data from the substations comprising substation identifier, feeder numbers, and total number of connections. This enabled Bit Stew to both create the model, and then run it to produce the visualised output. The NTVV data was deliberately reduced in quantity and quality. This was done to provide the company with a reasonable assurance of the ability of data analytics to produce a good output from a poor input. The proposal that an analytics engine would produce a good output from good input data was assumed to be true. However, the purpose of this project was to see if the analytics engine could also produce a good output from a poor level of data. This is important to DNO's as there is invariably areas of the distribution network where the connections data is not as good as it needs to be for modern network management. This would be due to historical reasons, where connections diagrams were not constructed in the early part of the 20^{th} century, as the focus was on the needs of the transmission network, and all generation followed the top down delivery model, from centralised power stations through the transmission network to local distribution networks. Now the need for more precise data on local connections is driven by the increasing prevalence of distributed generation, and new loads, such as electric vehicle chargers.

The LV connectivity diagrams produced by the project have been compared with those developed by the Tier 2 New Thames Valley Vision project and the results have been tabulated. There is some variation in the results, as can be seen.

Table 1: Number of supply points accurately matched to Substation feeder.

Substations	Manual Survey Results		LV Connectivity Model Connections Results			LV Connectivity Model Connections Accuracy		
Substation Name	Feeder	Connections	Connections	% by Feeder	% Delta	Connection Matches	% Connection Matches	Reason for Mismatch between survey and model
Jennets Park No 1	1	105	104	99.05	0.99	104	99.05	
Jennets Park No 1	2	39	39	100	0	39	100	
Jennets Park No 1	3	11	11	100	0	11	100	
Deepdale	1	56	25	44.64	55.36	25	44.64	31 Supplied from MV frame
Deepdale	2	21	16	76.19	23.81	16	76.19	Associated with different feeder
Deepdale	3	0	5			0	0	Associated with different feeder
Deepdale	4	22	21	95.45	4.55	21	95.45	
Walsh Avenue	1	23	21	91.3	8.7	21	91.3	

Walsh Avenue	2	41	41	100	0	41	100	
Simmonds Close	1	36	30	83.33	16.67	28	77.78	Associated with different feeder
Simmonds Close	2	33	31	93.94	6.06	25	75.76	Associated with different feeder
Simmonds Close	3	0	0					See Note below
Simmonds Close	4	20	27	135	-35	19	95	
Radcliffe Way	1	8	9	112.5	-12.5	5	62.5	Associated with different feeder
Radcliffe Way	2	40	40	100	0	40	100	
Radcliffe Way	3	0	1			0		Associated with different feeder
Radcliffe Way	4	31	29	93.55	6.45	24	77.42	Associated with different feeder
Jennets Park No 3	1	104	98	94.23	5.77	98	94.23	
Jennets Park No 3	2	0	1			0		See Note below
Jennets Park No 3	3	6	10	166.67	-66.67	6	100	
Jennets Park No 3	4	53	37	69.81	30.19	37	69.81	Link box connections
Jennets Park No 3	5	0	5			0		See Note below
Sovereign Fields	1	37	33	89.19	10.81	33	89.19	Link box connections
Sovereign Fields	2	13	13	100	0	10	76.92	Link box connections
Sovereign Fields	3	70	46	65.71	34.29	46	65.71	Link box connections
Sovereign Fields	4	43	43	100	0	43	100	
Julius Hill	1	56	53	94.64	5.36	53	94.64	
Julius Hill	2	109	104	95.41	4.59	99	90.83	
Julius Hill	3	8	3	37.5	62.5	3	37.5	Model Error
Priory Lane	1	29	18	62.07	37.93	18	62.07	Missing GIS records
Priory Lane	3	40	37	92.5	7.5	37	92.5	
Priory Lane	4	23	21	91.3	8.7	21	91.3	

Note: Where there are no connections to a feeder, the model can give either an accurate response, or due to the assumptions made about Link Boxes, discussed below, can give an inaccurate response. Either way, the zero connection feeders are included to provide completeness to the substation data.

The errors found by the analysis of the effectiveness of the model can be explained by the limitations from the provided data. The errors being due to the GIS data, where some forms of joints were mislabelled as Pot Ends, when they should have been Inline or Tee, and some connections were outside of the models range to connect to a Polyline. The model has shown that it is possible to build a LV connectivity map within software; and from the visualisations created from the model, the Network Operator is able to see where the GIS data provided to the model needs to be reviewed. Only in one instance did the model fail to provide a reasonable connection mapping due to errors with the model. There are two main causes of inaccuracy, both shown to be with the GIS data provided to the model. The first is due to the assumption that link boxes are always open, whereas in reality, there are often link boxes that are permanently closed. Link boxes are used to enable the LV network to be configured to allow planned work and fault outage repairs to be carried out with minimal effects on customer supply. By assuming that a link box is open, when it is closed, the model may try to allocate connections to the wrong side of the link box. Further refining of the input data would militate against this. The other main cause of error is the way in which the connection to a feeder is established. Further work to refine the model, and to confirm the feeder connections would be necessary to establish just where the model has failed.

The project can be considered to have met the requirements of the objective , as it has delivered a LV connectivity map covering the substations defined as within scope, using only software, to a level of accuracy that would be acceptable to the company.

The project can also be considered to have met the requirements of the success criteria, in that the company is able to make a justifiable statement that the use of data analytics techniques with the available data is able to make an accurate LV connectivity model.

Required Modifications to the Planned Approach During the Course of the Project

The numbers of substations was reduced to nine, from the initial 10 due to a lack of accurate comparison data for one of the substations. A consequence of this is that the number of overall connections was also reduced.

Lessons Learnt for Future Projects

It is possible to create a valid and useable LV connectivity map using data analytic techniques, with a minimal amount of data.

Note: The following sections are only required for those Projects which have been completed since 1st April 2013, or since the previous Project Progress information was reported.

The Outcomes of the Project

The project delivered a web based visual representation of a connectivity map that covered LV connections from nine secondary substations in the Bracknell area. Analysis of the connections from substation feeder to user premises was carried out. The analysis showed that the model was 89.5% accurate in mapping substation feeder to user premises. The analysis also showed that the model was able to map a user's premises to the correct feeder with 90.6% accuracy.

These results would be improved upon by providing the model with more data types, but show that even with a poor level of initial data accuracy, and missing data types (this was deliberate to investigate just how the data analytics can perform) a good model can be produced. This will show the DNO where further work to improve data quality is needed, so that a highly accurate full LV connectivity model of the distribution network can be produced, and maintained.

Planned Implementation

The project was carried out so that the company could consider the data analytics methodology as one of a number of processes that could be used to determine an accurate connectivity model for LV distribution networks. The final decision on which of the viable methods that are available has not yet been taken, so it is currently not possible to define the implementation into business as usual.

Other Comments