

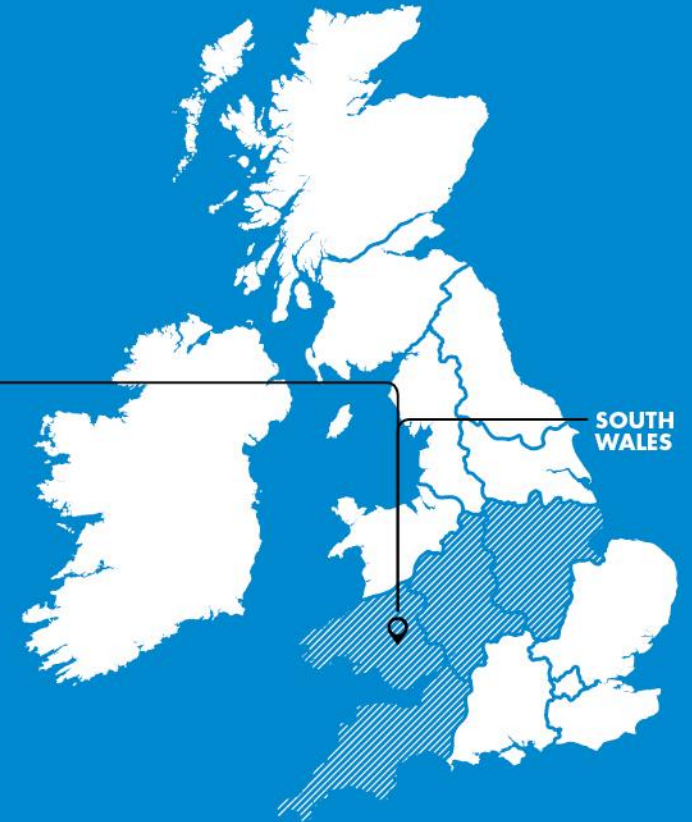
LV NETWORK TEMPLATES FOR A LOW-CARBON FUTURE

Voltage Reduction Trial

22nd September 2015

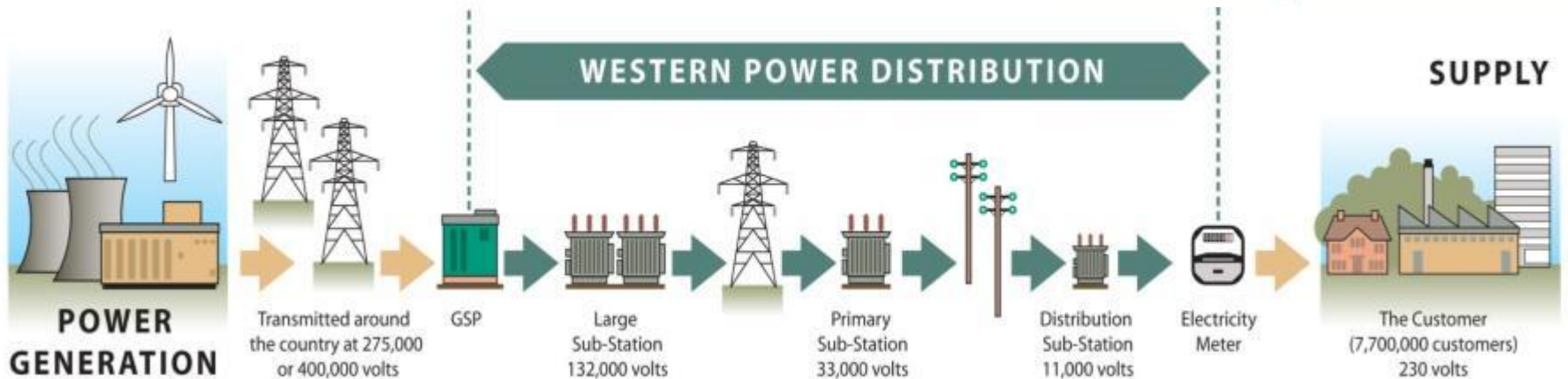
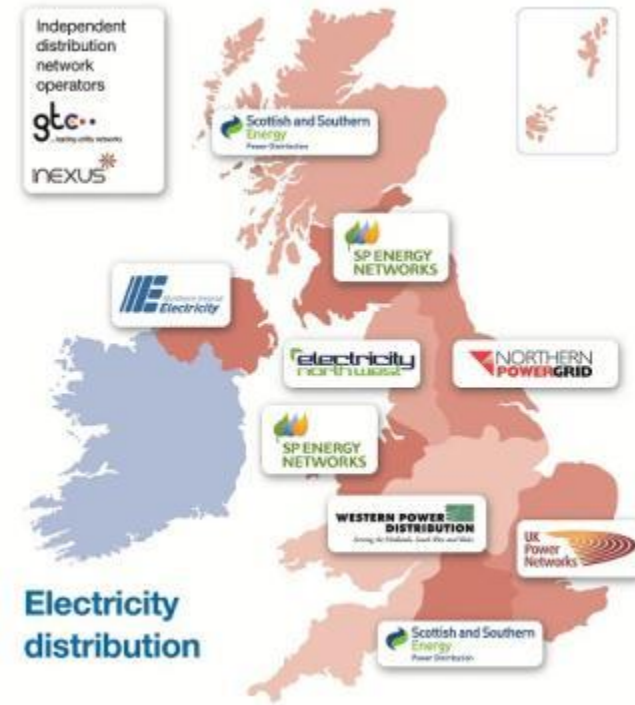
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KEY FACTS:

- Wholly owned by Pennsylvania Power & Light (PPL - NYSE listed)
- 4 UK Distribution Licences
- 7.7 million customers
- 55,000 sq km area
- Largest length UK network 216,000 kms of overhead lines and underground cables, and 184,000 substations



Templates Overview

What we said we would do

- The main aim of the LV Templates Project is to provide visibility of the LV Network by monitoring at both the substation and the associated feeder ends. In addition to this, data on installed Low Carbon Technologies, particularly PV installations, will be incorporated to identify stresses caused, and voltage headroom available

What we have done

- Successful installation of 824 substation monitors giving detailed load profiles, and 3,600 voltage monitors at feeder ends giving detailed voltage profiles
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Outputs from Templates (South Wales Voltage Reduction)

If Target voltage was reduced from 11.4kV to 11.3kV

(reduction of 0.88%)

The proposed reduction in HV and LV system voltage will reduce Customer bills by a calculated £9.4 / €13 million each year, based on current unit charges (2013)

- Projects completed to date make use of existing UK voltage levels set within the ESQCR
 - LV customers – 230 volts with tolerance +10% or -6%
 - HV customers – voltage with tolerance +/- 6%
- European Voltage Levels (EN 60038 - 2011) allow a greater band
 - LV customers – 230 volts with tolerance +/- 10%

11KV Settings Changes

- Policy **ST:TP50F** Was written on 11kV Tap Change Control Settings in East Wales, Cardiff and Swansea Areas.
- The changes were made at Primary Sub-station level, reducing from 11.4 kV (+/- 200V) to 11.3 kV (+/-165V) and were made in a selection of substations in the South Wales area in the latter part of 2014.

Outputs from Settings changes

Summary of findings:

- Demand analysis was performed on over 700,000 data points from over 600 substations. Voltage analysis used over 10 million data points from substations and over 27 million from voltage monitors. Using 10min averages.
 - A statistically significant reduction in demand was associated with substations that had changes in 11kV AVC settings. No significant change was found in substations that did not have changes in settings.
 - Using all available daily data, the reduction was estimated to be 1.5% in average demand with a 95% confidence interval of (1.1% - 1.9%). This reduction was found to be robust to changes in the temporal resolution used for the analysis; 1.6% for monthly data.
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Benefits from Settings Changes

- Using the methodology established in the LVNT project (LV Templates Closedown Report, Appendix B: South Wales Voltage Reduction), a 1.5% reduction would equate to an estimated reduction of 158.8GWh over a year, worth £16 / €22 million p.a. if all substations in South Wales were changed.
 - The proportion of voltage measurements outside the statutory limits was very small, for example in November 2014 only 0.22% of ten minute measurements at feeder end monitors were above 253V and 0.04% were below 216.2V.
 - WPD have:
 - reduced peak network demand,
 - reduced energy consumption, and
 - optimised losses in South Wales
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