Future Networks Newsletter Spring 2017

WESTERN POWER DISTRIBUTION INNOVATION

New Projects

Following the success of last year's external Network Innovation Competition (NIC) bid challenge, where two third party bids went through the full submission and one, OpenLV, was successfully awarded, we decided to run two separate bid challenges, one focussing on Networks and the other on Systems.

The Networks challenge focussed on three key technical areas on the 132kV system; Management of Real Power Network Peaks, Optimisation of Reactive Power across Networks and Voltage and Phase Angle Stability. The Systems challenge purported to find processes and tools for the future Distribution System Operator (DSO) requirements to enable short and long term flexibility services whilst enabling data exchange with other flexibility service providers.

Following a selection process whereby entries were scored and following review a number were approached to attend face to face interviews, seven for Networks and five for Systems. Following these interviews Mott MacDonald were taken forwards for the Networks challenge, with a proposal to install a 132kV Unified Power Flow Controller (UPFC), however, for the Systems challenge we decided to develop an internal Systems NIC bid that will be produced with support from one of the challenge submissions, AMT Sybex.

Networks Challenge:

The **Holistic Active and Reactive Power (HARP)** project will install a "Unified Power Flow Controller (UPFC)" into an existing 132kV circuit. As a result of the increase in renewable generation the direction and magnitude of power flows on the 132kV network, and the interface with the transmission network have become more difficult to predict and manage. UPFCs are part of the family of Flexible AC Transmission System (FACTS) devices and have been installed previously in the US, Korea and China.

UPFC devices provide the greatest range of control amongst FACTS devices. As such, they are able to influence and divert real power to improve load profiles at either end of a circuit and to remain within the rating of the existing line; to improve power factor and thereby release capacity; to provide reactive power; and to react dynamically to dampen voltage variations which may otherwise cause connected generation to trip. The project proposes to install the UPFC to support a 132kV overhead network and to provide reactive power to the System Operator (National Grid).

Should the project be successfully award it will be a four year project involving the design and procurement activities during 2018, construction during 2019 and early 2020, and trials during 2020-2021 to demonstrate the benefits of the technology.

Systems Challenge:

Electricity Flexibility and Forecasting System (EFFS). The transition from DNO to DSO will involve performing new functions and these new functions will in turn require new systems to support them. We are bidding for NIC funding for a project that will explore in detail the additional functionality required as a DSO, to evaluate the potential options and implement systems that provide that new functionality.

This will include;
(i) Creating weather adjusted forecasts for load and generation at different time-frames, in order to determine the nature, duration and frequency of expected constraints.
(ii) Evaluating the suitability of flexibility services to resolve those constraints.
(iii) Communicating flexibility services requirements to the market and creating commercial agreements for those services.
(iv) Executing flexibility services including arming, execution, validation of delivery and payment.
(v) Sharing information with interested parties to avoid conflicts in flexibility service use.

The project will consider the optimum degree of integration with existing systems and whether simplified alternatives to full optimised powerflow analysis can provide sufficiently reliable information. Having determined the optimal configuration the final stage will be to implement and test these systems.

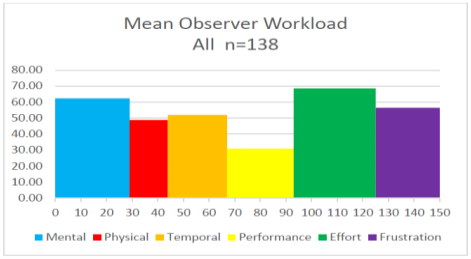
We are partnering with AMT Sybex for this bid who already have experience in this area and existing software that can be further developed. In order to test the functions we'll also be looking to include other parties such as National Grid, aggregators and suppliers within the project.

The project, if awarded by Ofgem, will start in February 2018 and finish in July 2020.

Assets

WPD are undertaking a Network Innovation Allowance (NIA) project named **Airborne Inspections.** The overall aim of the project is to produce a helicopter based system to semi-autonomously assess overhead line condition, report defects and pass the appropriate information regarding the assets quickly and concisely back to Network Services, the end user.

Towards the end of 2016 WPD commissioned 'Scimiter' who are 2Excel Aviations research, development, test and evaluation arm to work alongside WPD's policy and helicopter unit to deliver the project which was split in to six work packages;



- **Work Package 1** – Baseline existing helicopter operators workload when conducting visual observation and when operating the sensor workstation to allow quantification of the effectiveness of any developed solution.
- **Work Package 2** – Assess existing technologies and produce firm recommendations for a helicopter mounted setup.
- **Work Package 3 to 6** – Installation, Flight Trial, Analysis and Demonstration of chosen solution.

Work Package 1 and 2 are now complete. Total mean observer workload associated with each source be it Mental, Physical, Temporal, Performance, Effort and Frustration for all use cases is shown in the graph above.

The exercise has allowed for trends and potential issues, particularly around mental effort and frustration, to be identified which could potentially be addressed in the short term.

Work package two has identified the key requirements for a helicopter mounted sensor which includes thermal, UV and visible light based sensors; these recommendations will be used to inform a tender exercise. Based on the reports, workload findings and operational comments, the decision has been made to explore the use of a third person in the rear of the helicopter to act as the sensor operator. Whilst increasing the overall hourly cost it is expected that the increase in efficiency will bring down the cost per kilometre flown whilst also reducing individual workload. The third operator will control the chosen sensor suite and oversee reporting of defects in the asset management system through the on board mission management system. The operator shall be guided to potential defects from an automated notification system using the inputs from both thermal and UV helicopter mounted sensors. Additional work is ongoing to supplement this data with Light Detection and Ranging (LIDAR) and hyperspectral helicopter mounted sensors.

The main aim of the **Network Equilibrium** project is to release network capacity through intelligent voltage and power flow control in 33kV and 11kV networks. The project is taking place in WPD's South West network and commenced in March 2015.

System Voltage Optimisation (SVO) is the centralised voltage control system, which will optimise the network voltages in real-time by managing the voltage control settings of 16 substations. It will achieve that by receiving network monitoring information from WPD's Network Management System (NMS) in real-time and then calculating and sending the optimised voltage control settings to the substations' Automatic Voltage Control (AVC) relays through the NMS. SVO will be based on Siemens' Spectrum Power 5 Technology. Through close cooperation between the Equilibrium team, WPD's NMS team and Siemens, the design phase of SVO is now complete. Additionally, the IT preparations for the SVO installation have been finalised, ensuring that the hardware is in place and ready for the system installation (picture right). The site works at the substations that require replacement of the AVC relays are underway and the Equilibrium team has started the preparations for the testing that will take place in the following months.

Above: photograph of the SVO Hardware installed in WPD's Central Server Room.

The Flexible Power Link (FPL) is a back-to-back voltage source converter to be installed between two independent 33kV networks with the aim to enable active power transfers across the two networks and provide reactive power support. An external Control System is also being developed independently by Nortech. The control system will be communicating with the NMS in real-time to receive network monitoring information used to assess the state of the network. Then, it will be calculating the required active power transfers between the two networks and the reactive power support needed at the two ends based on the real time operating conditions. These calculated active and reactive power control set points will then be sent from the Control System to the FPL through the NMS. The FPL device is being manufactured by ABB and the design stage is now complete and construction has commenced while the design of the Control System will be finalised in June 2017. Furthermore, the civil works at the substation where the FPL will be installed are in progress. The following months will focus on the production of the testing and trial plans of the FPL.

Customers

LV Connect and Manage is funded through Ofgem's NIA. It was registered in April 2016 and will be complete by March 2019.

The project aims to demonstrate and prove that LV Active Network Management (ANM) can be used as a short-term measure, whilst network reinforcement takes place, to facilitate the timely connection of customers. The solution can then be redeployed to another area when the need arises. The ANM solution can also provide a long-term alternative to network reinforcement in cases where the investment in traditional assets is not economically viable or other reasons (such as the disruption to customers) prevents reinforcement taking place. In order to maintain the highest standard to service to its customers, WPD plans to connect them as quickly and cost effectively as possible and then actively manage them, once connected.

The project aims to recruit 50 customers for the Electric Vehicle (EV) charger trial Nottingham and 50 participants for the battery storage trial in Milton Keynes.

In April 2017 the first installation of LV Connect and Manage project technologies took place in WPD's Hereford Operational Depot: A Tesla PowerWall battery and SolarEdge inverter (for photovoltaic systems), an ICU fast charger for electric vehicles, two domestic load control (DLC) boxes, a broadband-over-powerline (BPL) communications system and LV substation monitoring equipment.

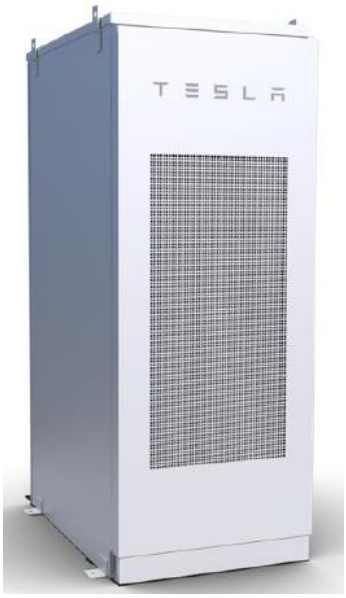
The aim of the installation was to establish an end-to-end transfer of data over the communications system using Broadband-over-Powerline. The results showed a stable communication with substation equipment through 4G. At the same time limitations of Broadband-over-Powerline technology for industrial environment were found. This will be improved during the second installation of additional repeaters later this spring.

Industrial & Commercial Storage (I&C) is an NIA project aimed at investigating the feasibility of the use of Energy Storage Systems (ESS) on WPD's network. The contract for this project has been awarded to Tesla.

With the growth in low carbon generation, such as wind and solar PV, and the introduction of new demand technologies such as EVs and heat pumps to facilitate the electrification of heat and transportation systems, WPD's electricity network is expected to see unprecedented swings between peaks and troughs of energy usage in localised areas. Part of WPD's approach to this challenge has been to look at new and more flexible ways to design, optimise and manage the network for the future. Low voltage networks will need to be upgraded to cope with the additional demands of electricity distribution. In the past, network operators have used conventional reinforcement to deal with constraints. The deployment of an ESS provides one solution to avoid network reinforcement.

Surveys for the deployment of ESS were carried out at five WPD sites, namely, Hereford, Boston, Lamby Way, Taunton and Vale Road, but the ESS trial will initially be conducted at only four sites, carefully selected to conduct experiments in a controlled environment and to test different system configurations. The four locations were selected with consideration of size and the availability of rooftop Solar PV.

This project will deliver more options for customer connections, design new technical policies and render grid services. Through this project WPD will develop an alternative connection agreement for behind-the-meter storage for customers. The customer will still be able to opt for a standard connection giving unconstrained usage of their import and export together with the standard engineering recommendation, G59, settings for a generator and where applicable investigate the technical design requirements for export limitation under engineering recommendation G100. The sites will be assigned a unique project reference depending on the type of experiments and trials that include but are not limited to peak shaving, load shifting, distribution and transmission support, reverse power flow mitigation and emergency backup. We have contracted Tesla to deploy four units rated at 50kW and 210kWh but subject to the demand profiles and other considerations it may be possible to tailor the battery size according to site conditions. In addition, we have also submitted the G59 Application forms to facilitate the necessary connections to these sites.



Right: illustration of the Tesla Storage Systems to be deployed at 4 WPD sites.

Customers

The **NEXUS Project** sought to complete a global analysis of proposed and deployed Smart Grid Telecommunications solutions.

By better understanding the latest developments in Smart Grid applications and supporting communications, informed decisions can be made regarding how these will interact with or replace legacy communications systems within Distribution Networks. Making the grid smart will encompass changes to infrastructure, operations and customer relations.

Communication networks are an essential element upon which to build smart grid capabilities. Network complexities mean there is no one-size-fits-all for communication solutions. NEXUS has addressed the selection of the communication technologies that meet the requirements of a given smart solution through the creation of "Communication Templates". For each smart grid solution, a set of "Use Cases" has been developed. Each Use Case outlines the actors, subsystems, information, data and communication requirements needed for each smart solution to effectively operate within a smart grid. Output from the analysis of each Use Case is then used to develop a Communication Template.

The main outputs from the NEXUS report are:

- Establish telecoms network management processes for the public-private infrastructure in a multi-vendor and operator context;
- Implement new processes in order to comply with the integrated management service vision;
- Configure the supporting tools to the newly introduced operations;
- Review the organisational model by aligning it to an integrated management of services;
- Overall service can improve by managing the use of independent networks;
- The electricity networks of the future will become more digital with increased control, supervision, volume of information and connectivity;
- Dependency on connectivity will increase, requiring coverage, resilience, new practices, imposing a strong evolution from today's BaU operations;

The **FlexDGrid** project was awarded funding of £17.1m, through Ofgem's Low Carbon Networks Fund Tier -2 mechanism, in late 2012. The project has now been successfully delivered and completed in March 2017. The project focussed on one main area of the network, 11kV fault level issues, and was made up of three independent but overlapping methods, Enhanced Fault Level Assessment, Monitoring and Management and finally Mitigation. The project was based in Birmingham where previously there had been a significant number of, mainly generation, new connection requests that had been expensive to deliver as well as taking a significant amount of time, based on the network upgrade requirements needed to facilitate the new connection requested. In order to support Birmingham City Council's commitment that Combined Heat and Power (CHP) plants should be installed for all new commercial and some domestic developments; therefore new techniques to solve the existing fault level issues was required.

Throughout the delivery of the FlexDGrid project the key aim was to provide solutions useable to new network customers as well as existing customers connected to the system. The first method was to develop an Enhanced Fault Level Assessment tool; this is about providing more detailed inputs in to the system to reduce assumptions and variances when modelling the capability accept new connections on to this network. This was successfully delivered in the first stages of the project to ensure that a robust modelling system could be used to determine and analyse the benefits of the two other methods. The next method was Monitoring and Management; this involved rolling out 10 Fault Level Monitors (FLM) which has been developed in a previous WPD innovation project. Following the install of these 10 devices, at 10 different substations it enabled, for the first time, real-time make and break fault levels to be calculated and used for historical trending analysis or real-time decision making. The final method was Mitigation; as the two previous methods provide greater clarification and detail on the existing fault level situation of the network this method focusses on mitigating existing fault levels to a value suitable for the connection of additional generation, in the form of the installation of a number of Fault Current Limiters (FCL).

The project has now been successfully delivered and the key outputs are; the installation of three FCLs, potentially releasing over 50MW of generation connection capacity; installation of 10 FLMs to enable real-time fault level soft-intertrip connections to be realised in line with WPD's existing alternative connection offerings and enhanced modelling which has enabled greater detail to be understood as to the fault level contribution of different types of network connection to more robustly understand their effects on the network. The next phase of the project is to produce the Closedown Report which will be made available towards the end of June with a dissemination event planned for the 12th July in Birmingham City Centre.

Find out more

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Registration is now OPEN to our Balancing Act Conference on 11th May 2017. Topics will include DSO Transition and the potential for network flexibility**.**
Click here for more information.