POWER NETW0RKS

Power System Innovation

Overview

The energy industry is continuously changing to take advantage of new technologies and developments that reduce costs to consumers, ensure reliability and minimise the impact on our global environment. PSC work globally with regulators, developers and utilities to identify innovative ways to ensure an affordable, reliable and efficient energy system into the future

PSC bring together worldwide experience and global leaders in their field to develop innovative solutions that allow utilities and energy companies to thrive. This allows PSC to provide excellent value to our clients whilst working to deliver our vision for a sustainable power system whilst improving the quality of human lives.

We combine power network experts, operational technologies experience and extensive knowledge of distributed energy resources to address challenges facing the industry. As a vendor-neutral and independent consultancy we can develop and deliver truly pioneering solutions with a sole focus on meeting our clients' needs.

Key capabilities

- Multi-year network development plans based on deterministic or probabilistic criteria

- Automated power system analysis

- Multi-year network planning for future energy scenarios

- Grid connection compliance and flexibility requirements

- System stability and power quality assessments

- Distributed energy resources

- Power system optimisation

- Grid outage planning and constraint resolution

- Active network management schemes and constraint analysis

- Python tool development for batch power system analysis and data processing

- Harmonic distortion and non-traditional mitigation options

PSC projects

National Grid Electricity Distribution - Virtual Statcom

As an increasing number of low carbon technologies (LCTs) connect to distribution networks, technical constraints arise that can limit the total amount of generation or load a network can host. To overcome the challenges associated with LCTs and continue to operate a safe, secure and reliable network, National Grid undertake traditional network reinforcements as well as initiating and leading innovation projects to develop new solutions.

PSC developed the Virtual Statcom algorithm and through this project demonstrated that it can enable DNOs to increase the capacity of their networks to host more low carbon technologies with reduced losses and better utilisation of their assets.

The system study specialists at PSC have extensive experience in the modelling, analysis, and planning of transmission and distribution networks and identified this innovative approach to network management. The global nature of our business means we can provide our clients with the right project solution anywhere in the world.

National Grid Electricity Distribution – Electricity Flexibility and Forecasting Systems (EFFS)

National Grid had a system to forecast the demand on their system based on weather and historic profiles and a system to interact with aggregators to provide Distributed Energy Resources (DER) services in the form of demand / generation reduction and increases. PSC developed a tool to integrate these systems and on the week ahead timescale carry out automated system analysis to identify; constraints on the system, flexible services that could resolve the constraint, the optimum customer dispatch to resolve those constraints, the specific contingency configurations for which services would be required.

PSC's extensive experience in power system analysis and distributed energy resources allowed the development of the EFFS tool as the core of the system. The tool developed in Python to interface with various data providers and carry out power system analysis in PSSe allows for flexibility as new providers and services are introduced. This innovative approach to managing constraints on the system allows National Grid to support the energy industry in its transition to NetZero.

National Grid Electricity Distribution – Energy Planning Integrated with Councils (EPIC)

Project EPIC explored how DNOs and local authorities could work more effectively to create local energy plans based on the impact of fundamental 'building blocks' within DFES. These building blocks - including EV chargers, domestic PV systems, heat pumps, and new housing developments or industrial centres - all impact network demand profiles. Although EPIC was a trial to explore and develop a process to deal with different data sets from various partners and stakeholders, one of the key deliverables was the High Voltage Network Analysis Tool (HV NAT).

HV NAT had to be developed from scratch because no such tool was previously available. HV NAT, which was developed by PSC as part of the EPIC project, is a Python-powered module that allows network operators to feed all the relevant data into conventional and commonly used network planning software, in this case, the Siemens PTI's PSS SINCAL platform. The HV NAT considered both the top-down and bottom-up analysis of the network. The top-down approach is how the TNOs and DNOs conventionally conduct planning. It typically considers impacts as far as 33 kV and above.

The novel bottom-up elements consider what goes on at the local distribution levels and then build up detail to determine the load pattern up to the HV feeder.

HV NAT allows network operators to develop reasoned decision-making based on specific primary inputs. It reveals whether it will be beneficial to execute upgrades and what the most favourable outcomes will be if adopting the 'fit-for-future' or 'just-in-time' approach.

National Grid Electricity Distribution

Harmonics It is expected that due to the increasing number of non- linear devices being connected to the distribution network, the harmonics in the network can become a challenge for Distribution Network Operators (DNOs). Existing solutions for managing harmonics are not suitable for dynamic networks with varying operating conditions or can be very expensive. Therefore, it is important to find alternative solutions to be able to manage harmonic levels in the network in a cost effective way. To investigate a solution to this, National Grid have undertaken a Network Innovation Allowance funded project to develop an algorithm that can improve the network's harmonic levels by controlling existing Distributed Generation inverters.

PSC was tasked to perform technical reviews of the power system models used and all work undertaken by Swansea University in the execution of the National Grid's Network Innovation Allowance (NIA) project on harmonic mitigation. The project will provide an alternative to existing solutions that are either very expensive or not suitable for the dynamic nature of modern networks. As part of this work, power system studies will be performed so that an algorithm will be developed, tested and implemented by Swansea University to control existing distributed generation (DG) inverters in order to improve the network's harmonic levels. The initial major review is on active filter design and algorithm including documentation, code and study results with the use of a single inverter and then moving into multiple inverters.

PSC would also support in the preparation/planning of Hardware in the Loop testing of the algorithm that will be done at Swansea University, witnessing of the testing and review of the results.

National Grid Electricity Distribution - Harmonic Compliance Management

The existing harmonic compliance management is based on the "polluter" being responsible for "cleaning" or minimising voltage distortion. The current approach might lead to a big challenge to maintain harmonic compliance in a rapidly changing energy environment, where it may be hard to attribute responsibility for harmonic distortion to an individual customer.

PSC discussed the different approaches being taken by system operators globally with UK stakeholders to determine if an alternative approach may be more sustainable. These alternative options focussed on developing a harmonic management approach which allows for optimised harmonic mitigation solutions to be implemented.

PSC as leading experts in power quality and working with developers, network operators and regulators globally were able to provide an independent view on the most appropriate solution. This took into consideration the differing approaches taken by system operators in each region along with the requirements it places on the new connectees. This recognised experience in harmonic distortion ensured proposed approaches were well reasoned and justified to support further discussions with Ofgem and grid code panels.

National Grid Electricity Distribution – Asset Data Analysis

National Grid are carrying out a project to integrate multiple datasets for their network as part of the Integrated Network Model. As part of the integration process National Grid require an independent method to confirm that the updates are correctly identified between the different datasets.

PSC as experts in distribution and transmission networks globally were able to develop an automated analysis tool to carry out this comparison. The tool allowed National Grid's three datasets from their asset management, graphical information and network management systems to be combined and compared in an efficient process. The automated tool allowed quantitative analysis to be carried out identifying the discrepancies and highlighting areas for consideration. This included applying engineering logic to determine acceptable reliable ranges to highlight those datasets which needed further checking or refinement.

National Grid Electricity Distribution – Network Events and Alarm Transparency (NEAT)

Distribution Network Operators like National Grid are experiencing an increasing number of new and unfamiliar types of alarms in their control rooms as new functions for real-time dynamic network management and optimisation schemes are introduced. The new alarms require significant analysis to address and resolve them, which increases the complexity of overall network management.

This project's goal is to develop a robust tool for the analysis of alarms and events so that by understanding the root causes and interactions, they can be managed efficiently and effectively. PSC has been engaged, along with Harmonic Analytics, a leading data science company based in New Zealand, to help develop a software tool that will be analysing the relationship(s) between alarms and other system events to provide clear conclusions on the root of the various issues raised by the alarms.

By supporting National Grid with its innovation projects, PSC is helping develop critical knowledge and expertise which is shared with other network operators to help deliver potential environmental benefits, make the electricity networks smarter, reduce costs and maintain security across Great Britain.

Other considerations

- PSC specialists active in industry working groups
- Published research at leading conferences and journals (IEEE, CIRED, CIGRE, etc.)
- Advanced Python analytics skillset
- Automated and experienced analysis in PSSe, PSS SINCAL, PowerFactory, PSCAD, ATP-EMTP, CDEGS

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