Northern Ireland Electricity Networks

STATCOM

Innovation Project

September 2020

Contents

1. Background

Growing demand, penetration of distributed generation *(DG)* and low carbon technologies *(LCTs)* present significant challenges to the Northern Ireland distribution network. Maintaining voltages within statutory limits with the existing voltage control techniques is increasingly challenging and one of the main network constraints.

Traditionally, distribution networks were designed and operated with voltage control capability at selected locations within the network. Voltage control is limited to Primary substations and locations where NIE Networks has already taken action by installing new Supertapp relays to provide enhanced voltage control and resolve some issues. However, further issues arise on specific circuits for which alternative voltage control solutions will be required. Presently voltage regulators are used on long, rural circuits to maintain voltage at the end of feeders within statutory limits but they are limited in operation.

The problem is exacerbated due to the connection of DG which introduces voltage rise, and hence the option to mitigate low voltages when there is high customer demand by increasing system voltages at the control points is limited. Network thermal capacity is also an issue as power flows at times of peak demand exceed the network's capability.

The previous approach has been to reinforce the network, but this is costly and often takes a considerable amount of time. A low cost and quickly deployed alternative to traditional reinforcement is needed. One of the possible methods is the integration of Static Synchronous Compensators *(STATCOMs)* in distribution networks. STATCOMs are power electronic devices which absorb and produce reactive power at times of high and low voltage to maintain the network voltage within tighter boundaries.

2. Project Summary

The STATCOM innovation project seeks to demonstrate how STATCOMs applied to existing networks have the potential to manage voltages and reduce demand, and hence unlock network capacity, and defer traditional reinforcements, ultimately reducing customer bills. They may also allow increased penetration of micro generation, for which the associated network reinforcement costs are not attributable to the generator.
The integration of STATCOM technology in distribution networks looks to control network voltages within tighter boundaries and provide a more efficient use of the existing network assets. STATCOMs have the ability to control the voltage at their connection points. NIE Networks do not currently operate any STATCOMs so there is a need to investigate the integration and the extent of the benefits of this technology to NIE Networks and customers.

3. Objectives

The lessons learned in GB projects will be useful to accelerate the integration of STATCOMs in NIE Networks' system; however there is still a need to trial in the NI context before rolling out to Business as Usual *(BaU)*. The key objectives of the STATCOM project are to:

- Understand the effectiveness and benefits of STATCOMs in distribution networks.
- Integrate STATCOMs within NIE Networks' existing IT and control systems.
- Assess the impact to customers and quality of supply.
- Assess the impact on existing assets, including lifespan and maintenance requirements.
- Develop a cost benefit analysis of deploying STATCOMs on the distribution network.
- Integrate into Business as Usual.

4. Project Technique

Where there are both voltage rise and drop issues, STATCOMs will be used in key distribution locations at 11kV to improve voltage control and to facilitate further demand and generation connections.

The trialling technique shall allow for automated operation of the STATCOM depending on the network voltage conditions. The STATCOM will receive a voltage set point from NIE Networks' Distribution Control Centre *(DCC)* and will automatically adjust its contribution to maintain the voltage around this set point.. Monitoring of the network parameters will be required and appropriate communications and controls will be deployed to ensure reliable and accurate operation of the STATCOM.

A trialling period shall allow for comparison between network operation with and without the STATCOM for distribution networks. For instance, the system could be operated with alternating combinations of days or weeks off and on. In addition this will allow the monitoring of any impact on customers by reporting any complaints, and therefore it is deemed appropriate that a constant pattern is not followed throughout the trial to prevent the placebo effect.

STATCOMs are built with semiconductor technology; this means that the STATCOMs have a fast response speed, beneficial behaviour under extreme low voltage conditions such as faults, and low harmonic emissions, which gives them an advantage over voltage regulators and Static VAR Compensators *(SVCs)*.

5. Method

The STATCOM project aims to address the aforementioned problems and meet the key objectives outlined by focusing on lessons learnt from previous innovation projects and their transition into BaU. This will be carried out through a number of key tasks detailed below.

5.1 Technology Assessment

A desktop assessment of the available off the shelf equipment, including the communication system, will be conducted and included in the technology assessment along with a brief description of potential devices; design life, weight, enclosure, positioning of the device *(ground mounted or pole mounted)*, protection, maintenance and production times. A review of the safety case and public risk with STATCOMs will also be completed at this stage, including risk of explosion, EMF emissions and noise from the system.

5.2 Site Selection

NIE Networks will complete preliminary site selection; excluding sites due for upgrade during RP6 and identifying those with generation connections and voltage drops. These preliminary circuits will be modelled to identify any voltage, power flow, fault level or protection issues as a result of integrating the STATCOM. Circuits which experience any of these issues will be discounted. NIE Networks will carry out network modelling on potential circuits and this will influence the final circuit selection.

It is expected that rural areas will be identified as suitable locations as they are prone to observe larger voltage drops and generator connections, with the STATCOM to be trialled on one 11 kV overhead circuit.

5.3 Material Procurement

A procurement specification will be developed in conjunction with the modelling outputs to determine the theoretical limitations of the equipment for a particular location. Both technical and functional specifications for the STATCOM equipment and any required software, data systems, communication systems and interfaces will be developed.

A contingency plan will be developed for returning to conventional operation in the event that the STATCOM is not operational, potentially through the use of a bypass switch. In addition, a failsafe mechanism will be established to prevent voltage run off.

The procurement of the equipment will follow a tender process, and an evaluation of the technical proposals against the technical requirements together with the commercial evaluation will identify the most cost-effective solution.

5.4 Installation

Prior to delivery to site, Factory Acceptance Tests *(FATs)* of the STATCOM equipment will be conducted in an environment that replicates the network conditions in which the equipment will be installed.

Installation and commissioning will take into account the lessons learned from previous similar projects and will aim to eliminate or mitigate risks. Installation will involve establishing communications between the STATCOM and NIE Networks' NMS as required, and with all monitoring equipment for enhanced visualisation of network parameters for analysis. The appropriate user interfaces will be developed in order to provide the appropriate visibility and control to the operational engineering team.

All systems will be commissioned and Site Acceptance Tests *(SATs)* will be carried out. Tests will confirm that the system performance meets the requirements and the technical specifications.

5.5 Trial

NIE Networks will develop a testing schedule for the trial to ensure all possible outcomes are tested, in line with current standards. The testing schedule will include provision for maintenance to assess the requirements in terms of outage planning for maintenance and repairs.

The STATCOM will be trialled for one year on the network to test operational performance and the

impact on network assets. Trials can be performed via the activation of the STATCOM through an operator command or through an automated signal generated via the controls, depending on the network operating conditions monitored as part of this project.

5.6 Analysis of Results

The results of this trial will be used to complete a detailed assessment of the STATCOMs impact on quality of supply, losses and existing plant and fault level contributions and will feed into the cost benefit analysis *(CBA)*. The CBA will be completed for the roll out to business as usual across the 11 kV network.

5.7 Customer Experience

Understanding the impact of deploying a STATCOM on quality of supply is important to determine the effect on customer experience. This task will include a survey of all customers affected before the trial and on completion of the trial. Any findings will be included in the relevant reports.

A close down report at the end of the trial will encompass all work including analysis of results, impact on losses and quality of supply, CBAs, circuit selections criteria, effect on asset life etc. NIE Networks will host dissemination events for internal and external stakeholders to present the findings of the trial.

5.8 Transition to Business As Usual

Provided the trial is successful and the CBA is in favour of using STATCOMs on the 11 kV network, NIE Networks will roll out into Business as Usual *(BaU)*. This will include training and support of staff and updating policies and specifications.

The transition to BaU comprises three key tasks:

1. Making a fully justified business case in order to demonstrate the benefits of the STATCOM project and the knowledge that stemmed from the integration project.
2. Preparing the necessary documentation that would cover planning and operation policies and the specifications of the systems.
3. Determine the ownership of the STATCOM technology within NIE Networks and provide NIE Networks' staff with appropriate and sufficient training and support.

6. Project Timeline

START DATE

TRIAL START

EXPECTED COMPLETION