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Reactive Technologies Pty Ltd

REACTIVE TECHNOLOGIES, SYSTEM INERTIA MEASUREMENT DEMONSTRATION

Lessons Learnt Report # 1

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Project Details

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The views expressed herein are not necessarily the views of the Australian Government, and the Australian Government does not accept responsibility for any information or advice contained herein.

This project also received cash funding from the Department of Energy, Environment, and Climate Action (DEECA) state department of Victoria as well as In-Kind contributions from all project partners DEECA, Australian Energy Market Operator (AEMO), Neoen (Owner/operator of Victorian Big Battery - VBB), Melbourne Energy Institute (MEI) University of Melbourne.

Contents

1. Executive Summary

This report covers the progress of activities completed to achieve milestone 1 i.e. deployment of XMUs (eXtensible Measurement Units) across 15 DEECA offices in Victoria state. Further, this report also covers the lessons learnt in the accomplishment of different project stage activities.

2. Background

Maintaining inertia levels is critical to any power system's secure and stable operation. If a power system operates with insufficient inertia, it is susceptible to rapid deviations in frequency when there is a sudden loss of generation. Similarly, a region that contains low inertia can become unstable should it become islanded from the rest of the grid. Inertia is typically provided by the kinetic energy stored in the momentum of rotating thermal and hydropower generation turbines but is absent in generation that is connected through power electronics such as wind and solar PV and battery storage. In Australia, as renewable generation is rapidly replacing thermal generation, the inertia level of the whole system is rapidly reducing, and some regions are experiencing critically low inertia levels. This trend will almost certainly increase as the transition continues. These challenges will require new and advanced tools and solutions to manage system stability cost-effectively.

Reactive Technologies is an innovative energy technology company bringing expertise and know-how from telecommunications and applying them to the energy industry. Various innovations have been proven in the UK with National Grid which has wide applications in other power systems.

Reactive Technologies, AEMO, DEECA, Neoen (Victorian Big Battery), and MEI are working together on this pilot project providing measurements of inertia in the NEM as a proof of concept. The campaign will focus on demonstrating the existing technology for whole system inertia measurement and trialling regional inertia measurement within the state of Victoria. Although proof of concept, the project will deliver immediate benefits by enhancing the current methodology which AEMO has developed to calculate inertia requirements. In the future, wider deployment of the technology will enable TNSPs to efficiently manage inertia which promises significant benefits to the Australian power system.

Reactive’s technology measures system inertia by injecting power modulations from a power source (modulator) and measures the resultant change in the grid frequency. For this pilot project, Victorian Big Battery (VBB) will provide the required modulations, which will result in small but measurable changes in the grid frequency. The change in frequency is measured at different locations across Victoria using multi-function measurement units (XMUs). The XMUs accurately measure the power system metrics such as voltage phase and frequency.

3. Milestone 1 - XMUs Installation at DEECA Offices

3.1 Category

Supply and Installation

3.2 Objective

The first phase of the pilot project was to install and configure the XMUs across 15 DEECA office locations in Victoria. The XMUs were distributed in a manner to cover all regions of the Grid to obtain an overview of the frequency behaviours e.g., locations with higher penetration of Solar and Wind generation, coal power plants, and closer to large load centres.

3.3 Detail

The XMU devices were built in an industrial panel containing 2 XMUs in each panel, a mobile router, a GPS antenna, and other components. All these XMU panels were manufactured at a Melbourne-based electrical panel builder facility in Victoria to Australian standards. The XMU panels were tested for both physical and functional checks. After the FAT (Factory Acceptance Tests) the XMUs were configured by Reactive's operations team remotely and a series of functional and electrical tests were performed before dispatching the panels to DEECA offices.

An installation instruction guide was shared with all installation locations for hassle-free installation, and training was provided to the persons responsible for the installation of these panels at each DEECA office. The panels were made Plug N Play devices, which were only required to be placed in a secure location on an office desk facing a North window (recommended) and plugged into a domestic 230V wall socket. As soon as the panels were plugged in and turned ON, they automatically start to report frequency measurements from each location to Reactive's secure cloud GridMetrix ®.

All 15 panels were installed at DEECA offices without any issues, and remote and on-site assistance was provided to the hosts of these devices by a Reactive team member based in Melbourne. Currently, the XMUs are reporting useful frequency data, which is a very important input for analysis by the Reactive team. Reactive has enabled two modules, i.e., GridMetrix ® Frequency Visualisation and Event Analysis, which provide very useful insights to the AEMO operations team on the frequency events on the grid.

4. Lessons Learnt

4.1 Site selection for XMU deployment

During the planning phase before funding approval from ARENA, Reactive's Power System Engineers performed studies of the Victorian Grid models. Based on the outcomes of the analysis 15 DEECA offices across Victoria were selected to host the frequency measurement panels. An important element of the deployment was that the hosting selected sites, support an appropriate geographical spread within the region and cover key strategic grid infrastructure locations (generation/demand). Once the locations for the hosting sites were known, talks were held with DEECA in the early project stages to confirm that the marked public offices can host the XMU panels for the duration of the pilot project and that the sites are well located to have access to WIFI and Cellular/4G internet as well as good reception of GPS signals. Accurate time

stamping is an important requirement of our measurements so reliable WIFI/4G is required for the panels to send the frequency measurements to Reactive's secure cloud.

4.2 Access to sites for XMU panels installation and troubleshooting

Requiring office staff to carry out complex installations working with electricity would have been an issue. Therefore, early in the project this problem was addressed by building XMU industrial frequency measurement panels as 'plug & play' devices that are completely safe to be plugged into 230V wall sockets in the offices. The XMU frequency measurement panels were configured and tested before shipment to each site, with 4G SIMs inserted.

An installation instruction guide was provided with each XMU panel showing all steps from unpacking the panel to installing it in an office and turning it ON using user-friendly pictorial instructions. In addition, to this, training was also provided to all hosting offices staff on the installation of the panels. XMU frequency measurement panels have been installed successfully and frequency data gathered. Reactive has been monitoring system performance and any Internet connection or power supply issues have been addressed with hosting department team members.

4.3 Internet availability and IT security

Industrial XMU frequency management panels have multiple options for internet, i.e. site fixed LAN, WIFI, and Cellular 4G. All XMU frequency measurement panels have been configured in the factory to work with all types of internet connections and have redundancies set. If there are issues with site WIFI the panels will change over to the use of 4G and continue to work. Initially, the default internet type was set to site Guest WIFI, but due to intermittent issues with connectivity now the priority is given to Cellular 4G, and failover redundancy is set to site WIFI. The hosting site's internet setup and configuration of company-specific access and cyber-security required meaningful effort from both DEECA and Reactive IT teams to complete.

4.4 Project stakeholder discussions and forums

Reactive organised regular stakeholder meetings to ensure ongoing engagement and positive momentum. Project stakeholders convened on a regular basis, i.e. weekly during the initial stages and bi-weekly towards the end of this project phase due to reduced activities while resolving technical and commercial issues with the BESS selected to be used as a Modulator for this pilot demonstration project.

4.5 Modulator requirements

During the initial project planning phase before signing the agreement with ARENA for the funding, studies and analysis were carried out to confirm the requirements for a modulator specific to the size and geographical spread of the Grid. Once the technical specification for the Modulator was finalised it was shared with the System Operator AEMO for them to carry out their own modelling and confirm there would be no adverse impact on the Grid or nearby generators when the Modulator will operate with recommended signal parameters. Early in the project, the specifications (i.e. signal amplitude, frequency and waveform, and interface requirements) were shared with Neoen to make sure the selected BESS can provide this functionality. This allowed Neoen (BESS operator) to scope and plan activities in terms of the implementation of modulator control logic with Tesla (BESS supplier). The BESS supplier performed tests in the lab and confirmed that the functionality of the modulator can be achieved with their BESS.

4.6 Site selection – BESS

Neoen's Bulgana Battery was initially planned to be used as the Modulator for the Inertia Measurement pilot demonstration, and all studies were carried out by AEMO, Reactive and the University of Adelaide (UoA) who confirmed no adverse impacts on the grid. Later in the project, due to some technical limitations identified by the Bulgana wind farm, it could not be used as a modulator. These limitations were out of Reactive's influence.

Therefore, negotiations were held with Neoen, and they agreed to offer services of their Victorian Big Battery (VBB) to be used as a valid modulator alternative option. This change of asset caused a significant delay of almost 1 year to the start of the project testing phase for three reasons. 1) VBB was engaged in other contracts and could only be used during the winter season. 2) Repeated studies/modelling for the new asset location was required. 3) VBB was required to have modulation functionality tested and confirmed by its supplier (Tesla) before it could provide the modulator services for the pilot demonstration project.

4.7 Grid consultancy studies

A part of the Grid studies was outsourced to the University of Adelaide to carry out small-disturbance studies on the NEM system to assess the likely impact of proposed tests of an Inertia measurement system on the grid. This activity was carried out in the early stages of the project to avoid any technical issues in the later stages of the project once testing is started. The results of these studies showed no adverse impacts on the Grid operations which paved the way to navigate to the next phases of the project.

4.8 Regulatory requirements for the use of BESS as a Modulator

At a later stage in the project phases, a new requirement raised by the VBB lenders was to get approval from the Australian Energy Regulator (AER) for VBB to be used as a Modulator. Preparing the documentation for submission to AER to request approval and them performing its due diligence was a lengthy and time-consuming activity. As this approval was not envisaged in the early stages of the project, this task added to the delay in the start of the project testing phase for measuring Real-Time Inertia in the NEM.

4.9 Regular meetings with BESS supplier/operator

Throughout the project period, regular meetings were carried out with the VBB supplier and operator to discuss the logistical and technical issues and work together for their timely resolution. During the technical discussions, it was confirmed at every stage of the project ahead of time that the BESS will function as a modulator according to the specifications shared with the Neoen. Lab tests were performed in advance to confirm the functionality of the BESS by Tesla. The engagement with the BESS supplier and operator from the start of the project proved very effective and efficient in confirming the working of the modulator.

5. Next Steps

In the project's next phase, VBB will perform a modulator function to send pulses into the grid and real-time inertia measurements will be provided by Reactive Technologies to AEMO. As mentioned above for VBB to participate in the project and provide the modulation function, it required approvals from the AER, all project partners worked closely together to provide the required documentation to AER for their due diligence and formal approval is now in place. The next phase of the project will involve the testing campaign for up to 250 hours to measure inertia during different grid scenarios such as high and low solar and wind penetration, high and low load, and different weather patterns. Test scenarios will be executed in close collaboration between AEMO, Neoen, Tesla and Reactive Technologies.