KAHRAMAA's experience in installing Wide Area Monitoring System (WAMS) into the Transmission Network

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Overview

Qatar General Electricity and Water Corporation "KAHRAMAA" (KM) is the sole entity for transmitting and distributing electricity and water in the state of Qatar, which was established in July 2000. KM witnessed remarkable development in the electricity network in recent years. Therefore, it becomes necessary to enhance the power network visibility and enable power system operators to acquire high-resolution data with real-time synchro-phasor measurements at a high sampling rate instead of depending on low-resolution data in the current SCADA/EMS system.

The project was initiated, due to the challenges faced in the current SCADA/EMS by system operators and operation planning engineers, such as the acquired data from the field in SCADA is limited by amplitude only. Also, the maximum sampling rate in SCADA is limited to 2 samples/sec, which does not provide the actual behaviour of the system, especially during incidents. Additionally, in most cases, with crucial disturbances in the system, the SCADA lost part of the significant data during the faults, which challenged engineers in analysing the faults. Therefore, this paper presents the following:

- ✓ Main challenges faced in the current SCADA/EMS system along with the main benefits of installing Wide Area Monitoring System (WAMS) in the transmission network by presenting a comparison of both systems with previous incident data to encourage other Transmission System Operators (TSOs) to start moving forward to develop their electrical system visualizations in order to assist their engineers to enhance their analysis.
- ✓ WAMS architecture, consists of (Phasor Measurements Unit (PMU), GPS, Phasor Data Concentrator (PDC), super PDC, and WAMS master).
- ✓ The criteria for choosing the locations for installing PMUs.
- ✓ Main challenges faced during the integration of WAMS in the transmission network, such as coincidences of the project timeline with both the COVID-19 period and the outage programs in the critical locations in the network, along with solutions that were used to overcome these difficulties.
- ✓ Next step, after the success of implementing WAMS into KM's transmission network.

Methods

KM implemented WAMS into the transmission network by installing 28 (PMU) into 7 substations covering 75 circuits, mainly at power plants substations, effective High Voltage (HV) substations, and interconnector network with Gulf Cooperation Council Interconnection Authority (GCCIA). The main advantages of WAMS it can capture up to 50 samples/sec and provides phasor measurements data as well, which helps system operators and operation planning engineers to have deep data analysis in both real-time monitoring and in analysing previous incidents through providing a wide visualization of the dynamic state of the grid than SCADA/EMS. The parameters configured in the PMU are the following:

- ✓ 3 Phase Voltage Phasor Magnitude and Phase Angle
- ✓ 3 Phase Current Phasor Magnitude and Phase Angle
- ✓ Frequency
- ✓ Rate of Change of Frequency
- ✓ Real and Reactive Power
- ✓ Harmonics Distortions

Results

This paper presents a previous incident in both SCADA and WAMS, which is a tripping of 220 kV Doha Road Super (DRS) – Bani Hajer Super (BHS**)** circuit no. 1 on 6th, October at 08:59:16.50. This part aims to focus on the difficulties faced during post-fault analysis in retrieving the data in SCADA compared with the main advantages of the retrieved data in WAMS.

During the trip, there was a significant voltage dip occurred at the HV network. However, SCADA did not capture the exact value of the voltage dip, since the sampling rate is 1 sample per 2 seconds. Consequently, SCADA system was unable to capture the exact time of the tripping, which was at 08:59:16.50. Moreover, it has been noticed that during the trip, there were some data lost in the SCADA system, which adds an extra difficulty for the operation planning engineers in analysing the fault. For example, the actual dynamic behaviour of the system frequency during the trip was unclear due to the low sampling rate and missing data.

On the other hand, due to the high sampling rate in WAMS, it was easy to capture the exact tripping time, it showed that the voltage dip reached to 247.479 kV at the 400 kV Busbar and 13.554 kV at the 220 kV Busbar at DRS substation. Additionally, since the PMU is measuring the three-phase voltage, it was also easy to identify in which phase the trip occurred, which is occurred at phase A (Va). Moreover, the frequency behaviour during the trip in WAMS Master (WAMS Software) showed that the minimum frequency reached during the trip was 49.64 Hz, while the maximum frequency reached to 50.33 Hz (variation in frequency was within the acceptable normal operation limits).

Conclusions

In conclusion, WAMS provides many advantages that are unable to be provided by the SCADA system, such as providing real-time synchrophasor data with a high sampling rate in order to have a deep data analysis, especially during post-fault incidents. This project has been implemented as a pilot project by installing PMUs into seven HV substations only to test the effectiveness and benefits of the system, and to train KM engineers with the latest technological tools in this field. This project proved its efficiency in monitoring and analysing the grid, which encourages others (TSOs) to start moving forward to develop their system visualizations in order to assist their engineers in system analysis, along with keeping up with the latest technological developments in this field.

On the other hand, this project will help in achieving Qatar National Vision 2030 (QNV), especially under the Human Development pillar, by train KM Engineers with the recent technological tool. Moreover, this project will accelerate the achievement of the corporate's objective, especially in "Promoting and deploying smart technologies, promoting innovation and R&D, and Building on attracting, motivating, developing, and retaining talent".

References

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