



**Center for Advanced Power Engineering Research
2021-2023 Research Project Report**

Developing a Large DER Protection and Settings for Mitigating System-wide Impacts across Transmission and Distribution Systems

Project Status Summary:

In this project, the team is investigating the ability to develop a strategy for evaluating protection device operations, recloser settings, and mitigation strategies for ride-through operation of Distributed Energy Resources (DERs) at the distribution level in response to faults at the transmission level using an integrated T&D simulation model. The tool that the team is using to develop the integrated T&D setup is called PSS®SINCAL, which is a power system planning and analysis software tool developed by SIEMENS. The first phase of this two-phase project includes tasks such as collection of transmission, distribution, and key substation network data, integration of these models into PSS®SINCAL, and evaluation of developed T&D setup under multiple fault scenarios to understand system wide impacts on the DERs.

The team has accomplished the task of identifying, modeling, and integrating the necessary power system networks in PSS®SINCAL. Currently, the team is working on the evaluation of the system wide effects on the DERs due to multiple fault scenarios. The goal of this analysis is to develop protection guidelines and settings for the DERs to minimize the impact of system-wide events. The case-study that was used to evaluate the aforementioned effects includes application of multiple faults on the transmission network. The voltage profile at the distribution-connected DER (PV farm) locations was monitored to observe variations in the voltage sag for different transmission level event locations. In total, there were five fault locations and each of these fault locations were chosen in such a way that it resembled a transmission level event located farthest, closer, and closest to the substation/distribution network where the monitored DERs are located. Although the initial results of this analysis were promising, the team experienced certain challenges mostly due to the shortcomings of the software tool (PSS®SINCAL).

Generator model import was one of the major issues/challenges that the team had to overcome. Unlike PSS®E, PSS®SINCAL has one standard generator model that is used to map the generator dynamics, because of which, the team experienced data import non-convergence for some of the units (while importing data from PSS®E). To overcome this issue, some simplifications (reduction techniques) were applied to the imported (transmission) network. As a consequence of these simplifications, some discrepancies in the simulated results vs the observed (PMU data) results were observed.

The team is currently working with SIEMENS to get these data import issues sorted out. Meanwhile, the team is also working on a parallel approach which is a decoupled T&D framework development approach that uses PSS®E for modeling the transmission and reduced (relaxed) distribution network. The details of this approach are being finalized and will be shared with the team and the advisors in due time.