GR-22-03 – Short-Term, Operational Reliability Evaluation of HVDC/MVDC Networks Considering Real-Time Influence of Power Electronics

1. Company or University Name, as well as partnering organizations

University of Wisconsin-Milwaukee partnering with SPP.

2. Project Title

GR-22-03: Short-term, Operational Reliability Evaluation of HVDC/MVDC Networks Considering Real-time Influence of Power Electronics

3. Project PI/Contact

Dr. Lingfeng Wang (email: wang289@uwm.edu)

4. Technology Roadmap Target Area

Power Electronics Reliability; Distributed Energy Resources.

5. Project Summary

In existing research, there has been a lack of focus on real-time or operational reliability evaluation of HVDC systems. For instance, the deployment of HVDC transmission systems to interconnect wind farms with the main grid poses challenges due to the volatile output of wind farms, which can impact the availability of power electronic devices in real-time, subsequently affecting the overall reliability of the HVDC transmission system. This project aims to address this gap by evaluating the operational reliability of HVDC networks while considering the real-time impact of power electronics. A comprehensive range of scenarios will be studied to demonstrate the real-time operational reliability of HVDC systems, along with the influence of power electronics.

6. Technology Gap/Market Need

This project will specifically address the operational reliability of HVDC networks, which is different from the traditional planning, long-term reliability.

7. Target Application (where does it fit in?)

Power Transmission Systems.

8. Accomplishments/Deliverables

Key accomplishments: 1) Real-time failure probabilities of critical components were estimated using both conventional and novel robust models. 2) Five HVDC topologies, including point-to-point and multi-terminal configurations, were tested and compared in terms of probabilistic reliability indexes. 3) A data-driven, intelligent, real-time reliability assessment procedure was developed and implemented.

Specific deliverables: Probabilistic reliability modeling and evaluation methods.

9. Impact/Benefits

The proposed research aims to facilitate the broader integration of advanced power electronic devices into the modern power grid, thereby enabling more secure, cost-effective, reliable, and environmentally conscious grid operations.

10. Images

The figure below illustrates a radial HVDC system, highlighting the necessity for efficient operational reliability evaluation to ensure their proper operations amidst changing operating environments.