

Impacts of DERs on Transmission Systems: The Distribution/Transmission Interface

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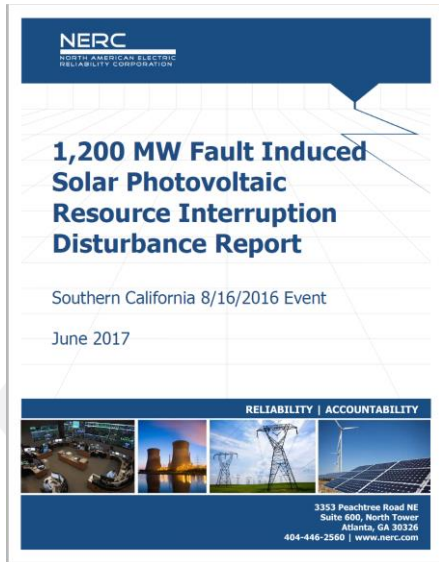
What do I mean by DER impacts on transmission?

DER Impacts on Transmission: Synchronized actions taken by DERs which result in a transmission operational or reliability impact.

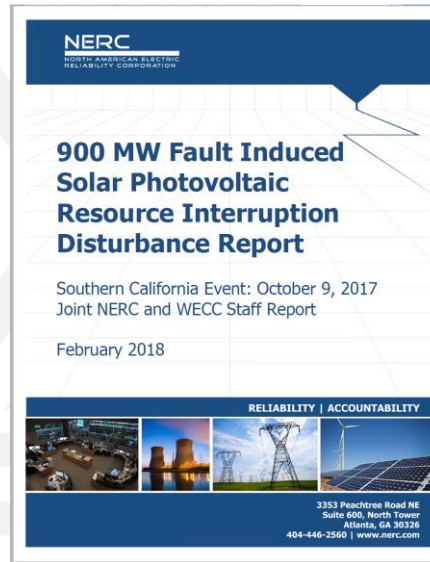
Examples of potential impacts

- Loss of generation impacts due to frequency tripping
- Loss of generation impacts due to high/low voltage tripping
- Ramping impacts in the morning and evening (PV)
- ...

PV Reliability Impacts in the US Western Interconnection

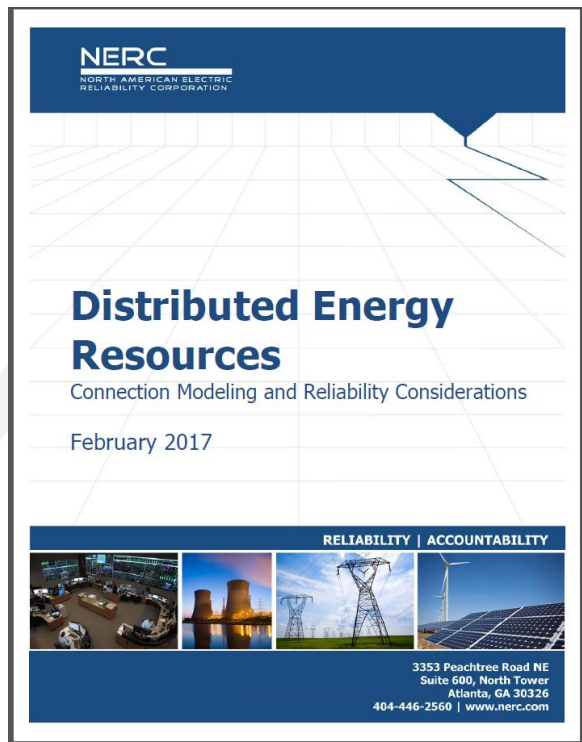


Findings: mis-measurement of system frequency and momentary cessation on low voltage, inconsistency in requirement interpretation



Findings: no erroneous frequency measurements, continued use of momentary cessation, interpretation of voltage trip requirements, PLL operation...

NERC DER Task Force Report

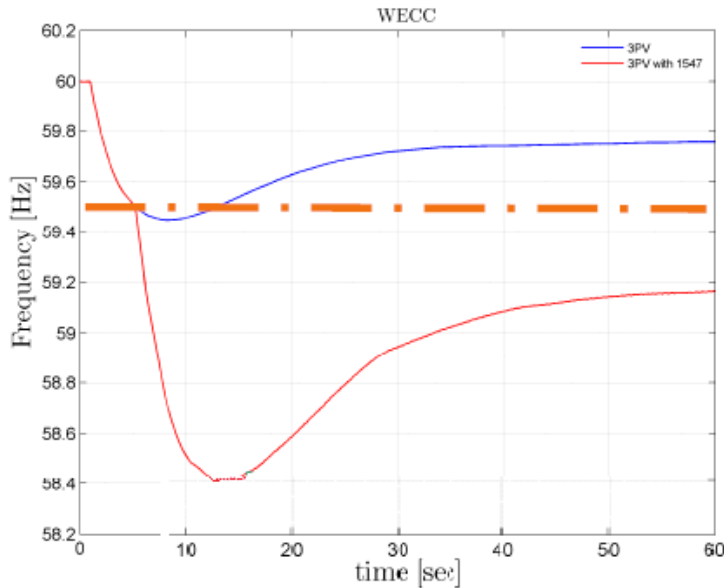


- Report released in February 2017 outlines potential impacts of DER on the bulk system reliability
- Recommends specific modeling methods and data requirements for DER
- Work of this group continues...

http://www.nerc.com/comm/Other/essntlrbltysrvctskfrDL/Distributed_Energy_Resources_Report.pdf

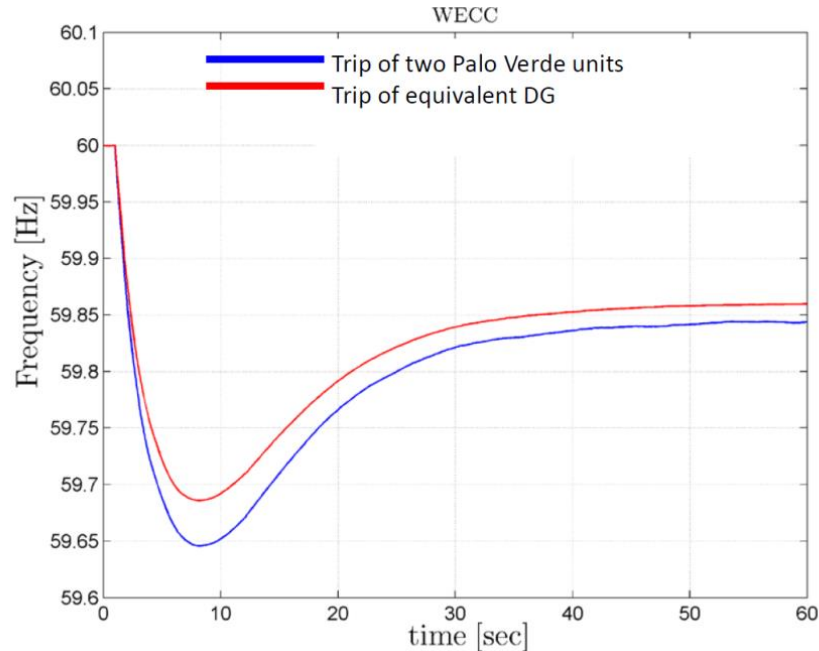
DER Loss Due to Frequency Tripping

WWSIS Phase 3 – Bookending the Potential Impact of DER



- With extreme loss of conventional generation the system nadir crosses the instantaneous low frequency trip point of IEEE 1547:2003 compliant DER.
- This is a good example of a “coordinating event”, albeit extreme.

WWSIS Phase 3 – Demonstrating the Difference between Central Unit and DER Impacts



- Modeled the difference in frequency response of a generation loss of two Palo Verde units (about 2.7 GW) and losing the same amount of DER across the entire Western Interconnect.
- Demonstrated that locality matters but not as much as many thought.

DER Loss Due to Voltage Tripping

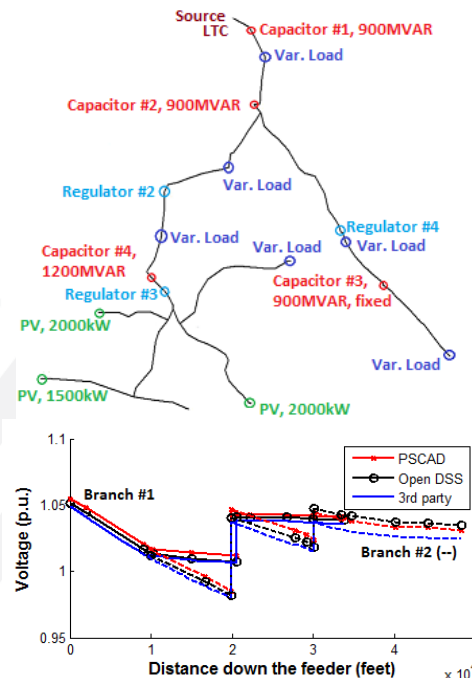
What About the Distribution Part of the Discussion? – Voltage Matters

- Most distribution-connected PV drops off-line at 0.88 pu

Voltage range (% voltage)	DG Operation
$V < 88$	disconnect
$88 < V < 110$	may operate
$V > 110$	disconnect

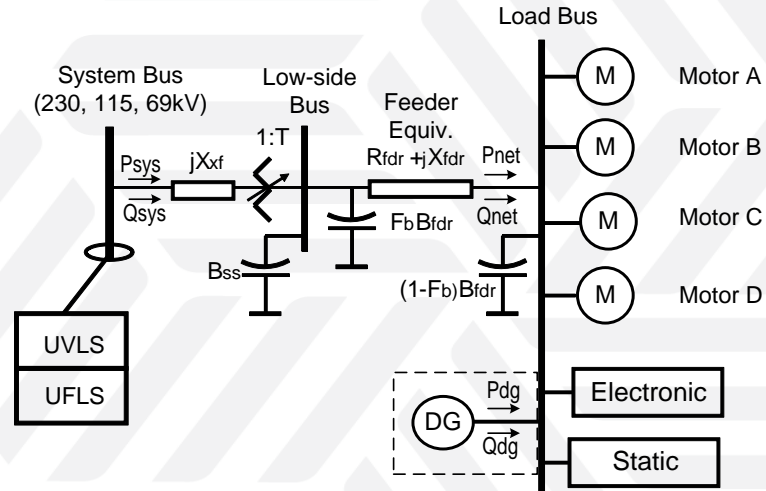
From: IEEE 1547:2003 – default voltage trip settings for DG (i.e. PV).

Voltage diversity on the distribution system will impact DERs voltage-related response



Modeling Distribution Diversity in Transmission Systems

WECC Developed CMPLDW + PVD1

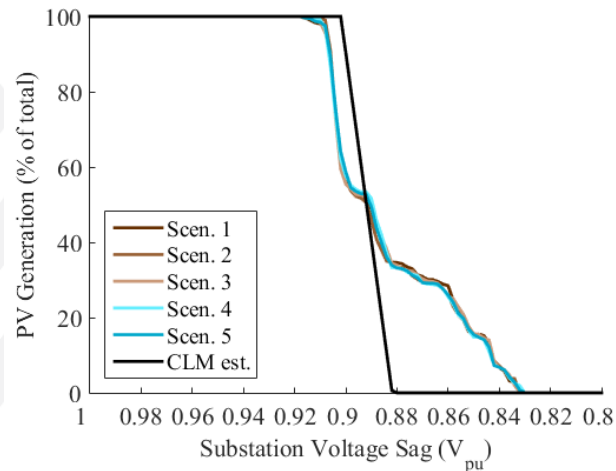


From: W.W. Price, "WECC Specifications for Modeling Distributed Generation in Power Flow and Dynamics," WECC Dynamic Model Specification, 27 Feb 2015

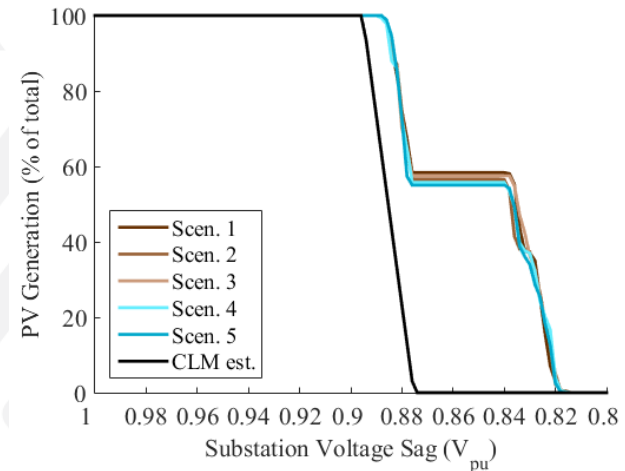
- This model captures the aggregate impact of the voltage diversity, and potentially different DER responses, for whole sets of distribution systems (i.e. substations worth of distribution-connected load and generation).

Tuning the Parameters of the Composite Load Model for Hi-Pen PV Scenarios

Peak Daytime Loading (40 % PV Penetration)



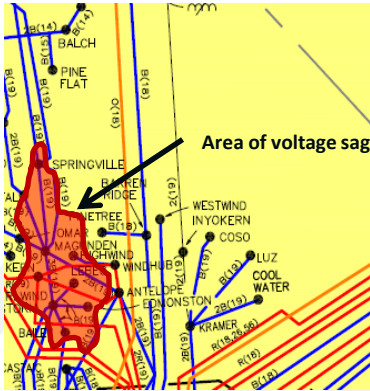
Minimum Daytime Loading (40 % PV Penetration)



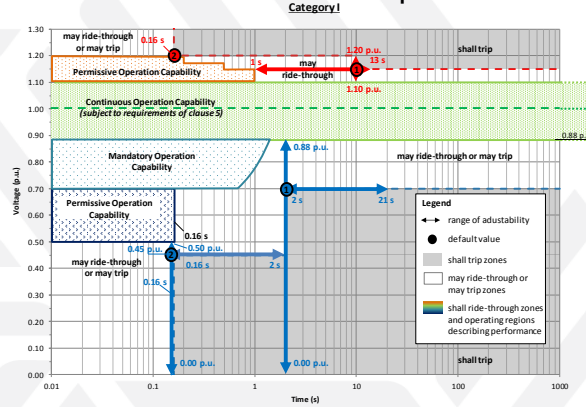
From: B. Mather, F. Ding, "Distribution-connected PV's Response to Voltage Sags at Transmission-Scale," IEEE PVSC, Portland, OR, Jun., 2016.

Current Project Investigating Tradeoffs of IEEE 1547:2018 Voltage Settings

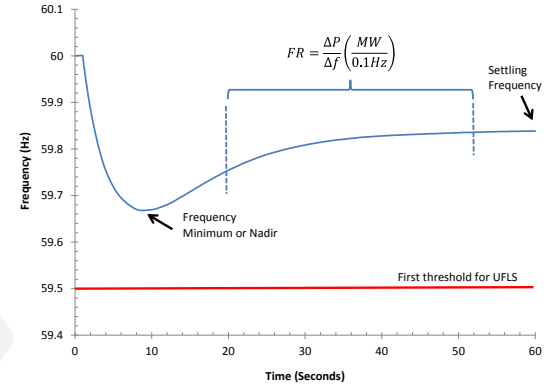
Transmission Model Determines Area of Impact



DER and Distribution Models Determine DER Response



Overall Co-Simulation Gives Generation Lost Due to Event



- We are combining the worlds of transmission and distribution system modeling to determine the reliability impacts and tradeoffs for regional voltage issues in areas with high amount of DER (PV)

Thank you

Questions?