TEXAS STATE
INGRAM SCHOOL OF ENGINEERING

E2.02 - L³ Energy

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System Impact Study of a 5 MW Photovoltaic Generator into 24 kV Distribution System

TRC | L³ ENERGY

Meet the Team



Luke Scarpato | Lisette Lugo | Lilly Martinez

Project Overview

Goal

- Conduct a System Impact Study for integrating a 5 MW solar PV generator into a 24 kV distribution network.

Objective

- To study the impacts of interconnecting a 5 MW solar generator to a 24 kV distribution system, focusing on stability, safety, and compliance.

Tools Used

- Simulations are performed using Milsoft WindMil to evaluate load flow, short circuit, and flicker levels both before and after PV integration.

Project Requirements

PV Generator

- Evaluate impact from PV generation fluctuations to meet flicker standards.

Interconnection

- Conduct short circuit analysis.

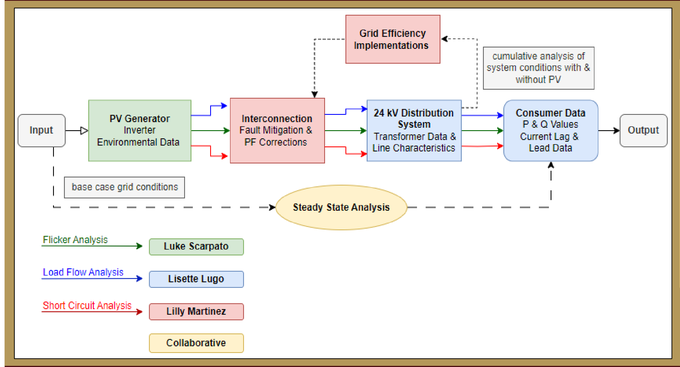
24 kV Distribution System

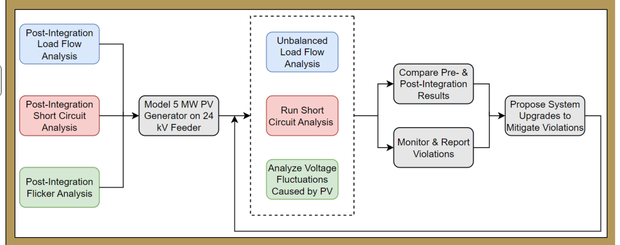
- Perform load flow and post-integration load flow to detect voltage violations.

Project Objectives

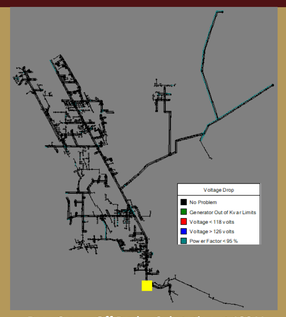
- Analyze the PV generator's effect on the distribution network.
- Maintain voltage stability and avoid overloads or unacceptable flicker levels in the system.
- Ensure the PV generator's integration enhances grid resilience and supports reliable power delivery during varying demand conditions.
- Identify necessary upgrades or mitigations to meet safety and regulatory standards.

Overall Block Diagrams

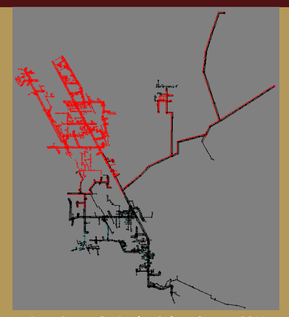




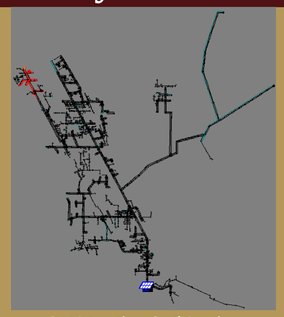
Load Flow Analysis



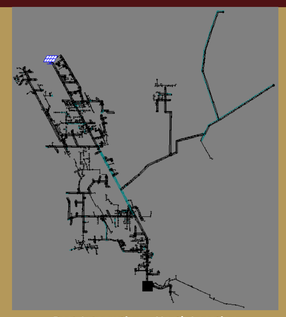
Base Case – Off Peak – Substation at 120 V



Base Case – On Peak – Substation at 120 V



Post-Integration – South Location

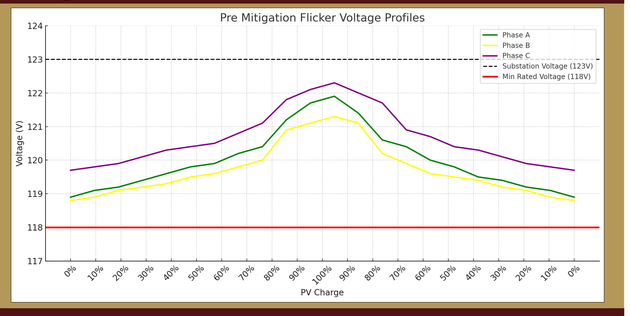


Post-Integration – North Location

Flicker Analysis

Flicker Voltage System Wide Pre-Mitigation

PV Location	Transient Response From 0% - 100% PV Output		Transient Response 100% - 0% PV Output	
Central	0% Output	100% Output	100% Output	0% Output
Sub Station (V)	Min-Max Volt LL	Min-Max Volt LL	Min-Max Volt LL	Min-Max Volt LL
120	115.0 - 119.9	114.3 - 119.9	114.4 - 119.9	112.9 - 119.9
125	120.2 - 124.9	119.6 - 124.9	119.6 - 124.8	118.3 - 124.8
126	121.2 - 124.9	121.5 - 125.9	120.7 - 125.9	119.5 - 125.9

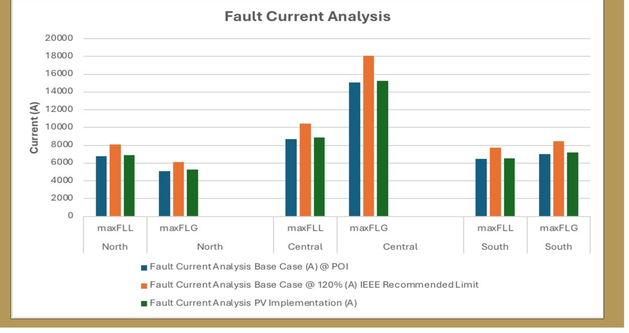


Short Circuit Analysis

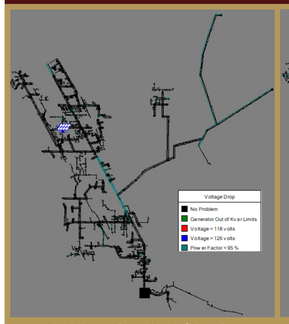
Fault Current Analysis

Location @ Fault	Fault Type	Base Case (A)	Base Case @ 120% (A)	PV Implementation (A)
North	maxFLL	6767.3	8120.8	6877.1
North	maxFLG	5104.3	6125.2	5263.5
Central	maxFLL	8710.9	10453.1	8854.0
Central	maxFLG	15088.6	18106.3	15269.0
South	maxFLL	6443.6	7732.3	6561.9
South	maxFLG	7031.1	8437.3	7169.5

- All protective devices should be upgraded to ensure proper coordination and safe operation, with breakers sized according to IEEE C37.010 and IEEE C37.13, fuses and reclosers rated per IEEE C37.46 and IEEE C37.60, and interconnection requirements guided by IEEE 1547.

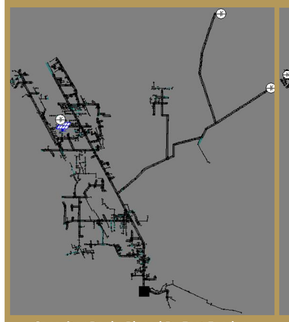


Post Mitigation

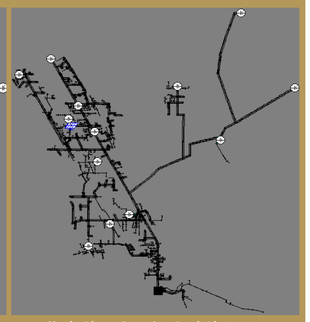


Post-Integration – Central Location

Capacitor Bank Placed By Generator



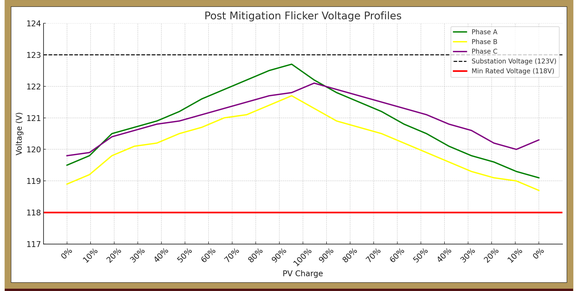
Capacitor Banks Placed By East Feeders



Single-Phase Capacitor Bank Placement

Flicker Voltage System Wide Post-Mitigation

PV Location	Transient Response 0% - 100% PV Output		Transient Response 100% - 0% PV Output	
Central	PV @ 0% Output	PV @ 100% Output	PV @ 100% Output	PV @ 0% Output
Sub Station (V)	Min-max Volt LL	Min-max Volt LL	Min-max Volt LL	Min-max Volt LL
120	116.5 - 119.9	117.2 - 119.9	117.8 - 119.9	114.8 - 119.9
123	119.75 - 122.9	119.5 - 124.2	120.3 - 122.9	118.3 - 122.9
126	122.8 - 125.9	123.1 - 127.2	122.6 - 125.9	121.1 - 125.9



Conclusion

The System Impact Study found the central location to be the most optimal for 5 MW PV integration. It showed minimal impact on voltage, flicker, and fault current levels, making it the most compatible with existing municipal infrastructure.

Acknowledgements

- Faculty Advisor: Dr. Billy Diong
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