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Inverter-Based Generation Integration Protection Challenges: Real-life Experiences

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Outline

A. Introduction
B. Project Summary
C. Relay Impact Study
   a. Modeling
   b. Findings
   c. Relay Scope Identification
D. Implementation
   a. Solutions
   b. Testing
E. Conclusions

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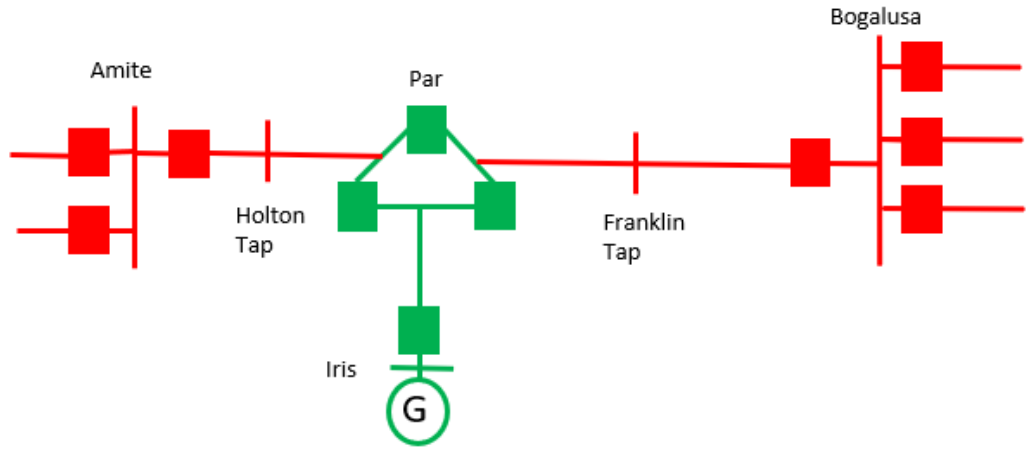
Introduction

- IBRs in Electric Grid
  - Impacts on Environment
  - Engineering Challenges
    - Non-rotating Irresponsive to Faults
    - Traditional Protection Schemes

Project Summary

- 50 MW at Iris
- Interconnect on Amite to Bogalusa Line
- 3 Breaker Ring Configuration of POI



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Relay Impact Study: Modeling

Solar Generator (Voltage Controlled Current Source)					
Enter kV	34.5				
Enter MVA	58.8				
Calculated Load Current (IL)	984.0345		IL = (S/(1.732*kV))*1000		
	I (pu)	V (pu)	I (A)	PF	
	1	1	984.0345	0	
	1.02	0.9	1003.715	-11.31	
	1.1	0.7	1082.438	-33.06	
	1.1	0.5	1082.438	-65.38	
	1.1	0.3	1082.438	-65.38	
	1.1	0.1	1082.438	-90	

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Relay Impact Study: Findings

- Short Transmission Line
  - Length: 1000 Ft
  - High SIR
  - Classical Protection Schemes Ineffective (Overreaching Risks of instantaneous step-distance element)

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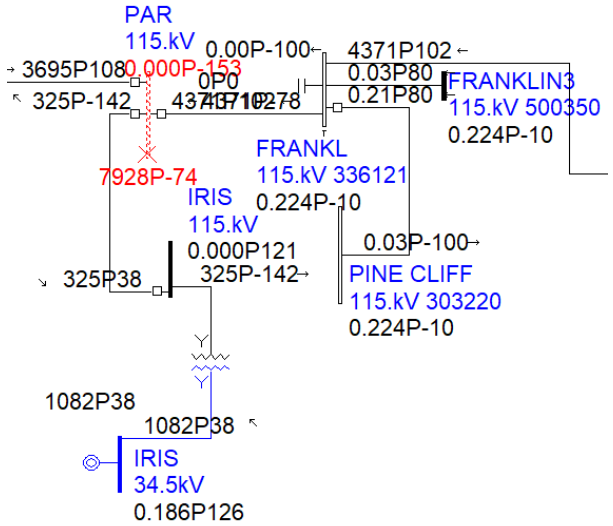
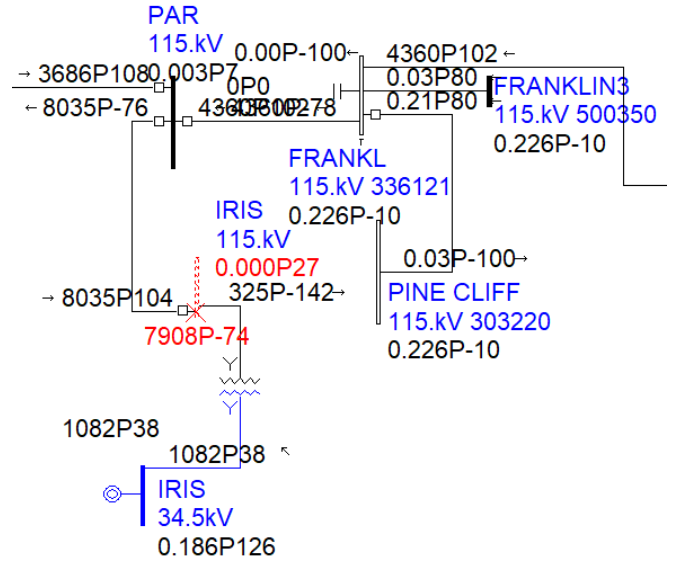
Relay Impact Study: Findings

- Weak Feed From Solar
  - Max Load 984 A
  - Low Fault Current Contribution
  - CT Selection Dilemma:
    - Low Relay Current for Transmission Side Faults (Required to tap the CT)
    - High Relay Current for IBR Side Faults (CT saturation risks for tapping CT)





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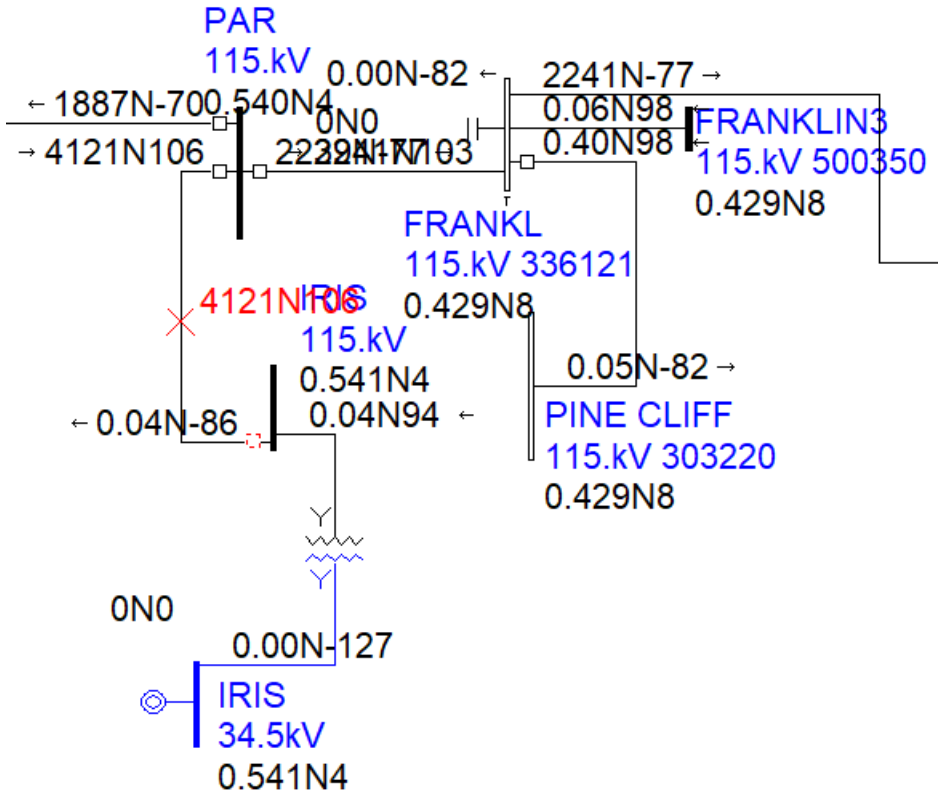
Relay Impact Study: Findings

- Lack of Negative Sequence Current
  - Traditional IBRs only produce positive sequence current
  - Distance Protection Directionality Challenges



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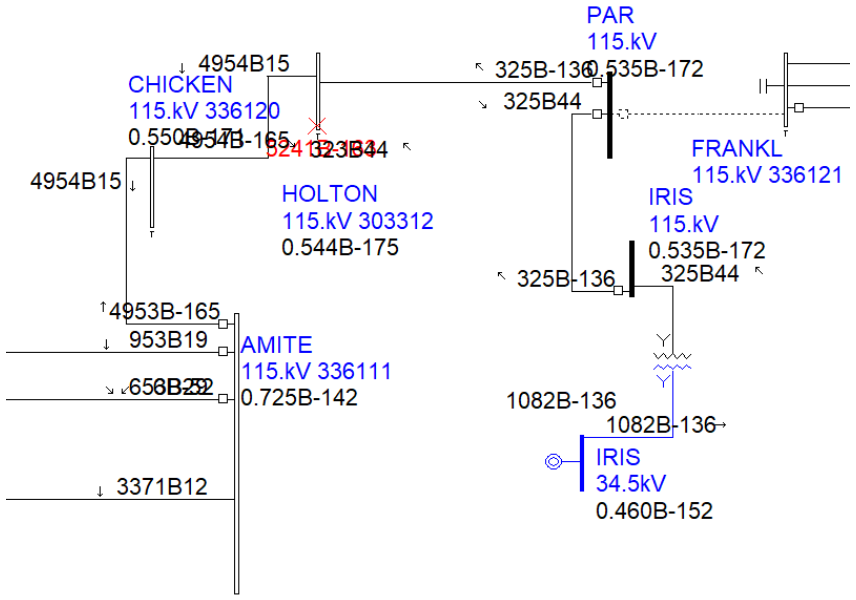
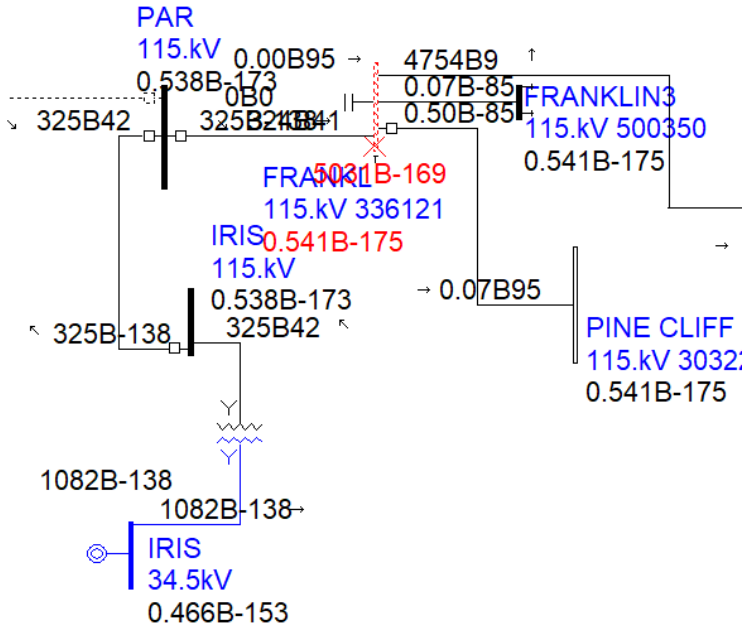
Relay Impact Study: Findings

- Network Sparsity Issues
  - Weak Infeed and Lack of Negative Sequence Issues Spread in the Existing Systems
  - Protection Upgrade for All Adjacent Radial Lines (n-1 contingency condition)





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Implementation: Solutions

- **Par to Iris Solar Line:**
  - Dual Line Differential with redundant channel
  - Time Delayed Step Distance From Par to Iris Solar (Backup) Direction
  - Polarizing Quantity: V
  - Customized Scheme to Enable Backup Step Distance
  - No Step Distance at Iris Solar
  - Iris Backup Protection: DTT from Par

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Implementation: Solutions

- **All Adjacent Lines in Contingency Condition (Par-Amite & Par-Bogalusa)**
  - Dual Line Differential with redundant channel
  - Time Delayed POTT
  - Time Delayed Step Distance (Backup)
  - Polarizing Quantity: V
  - Customized Scheme to Enable Backup Step Distance

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Implementation: Testing

- **Single-ended Element Test:**
  I. Calculated V/I simulated in Power System Simulator.
  II. Ensure individual protection function and alarm pickup.
- **End-to-End Test**
  I. V/I from fault analysis software simulated in Power System Simulator.
  II. Ensure comm. channel integrity.
  III. Ensure POTT coordination, and differential functionality.

Conclusions

- Opportunity to explore protection challenges.
- The implemented solution performed as intended during hurricane IDA and other events since 2020.
- Paving the way to future standards.

Questions???