

# Using Time Series Analysis to Integrate DA FLISR and CVR Systems

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Cigre - Grid of The Future

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# Systems Integration into the Distribution Network

## Various Distribution Automation Schemes

- Fault, Location, Isolation, and Restoration (FLISR)
- Conservation Voltage Reduction (CVR)
- Integrated Volt Var Control (IVVC)

## Distributed Energy Resources

- Solar
- Batteries
- Energy Efficiency
- Microgrids

# System Types

## Active Systems

- Receives feedback from current system conditions to make future decisions

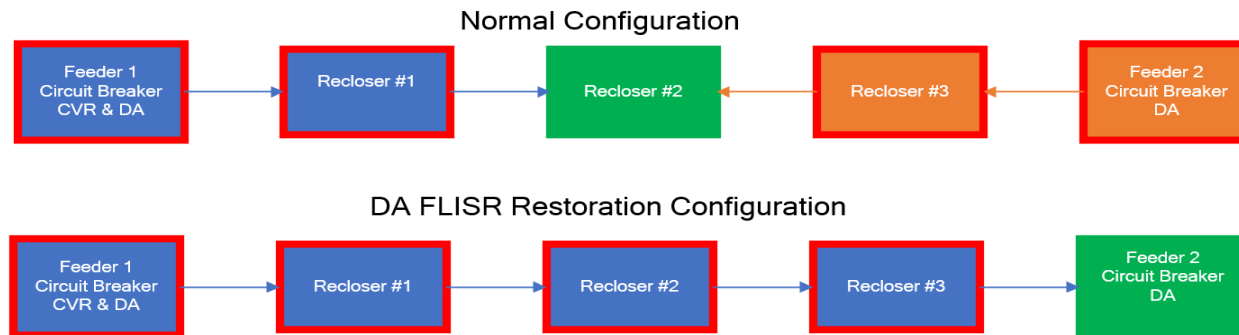
## Passives Systems

- Studied and configured for certain system condition(s) does not make decisions about abnormal non studied system configuration(s)

Integration of Active and Passive Systems can present issues when active systems changes system configuration

# DA FLISR and CVR Systems

DA FLISR – Active system receives feedback to reconfigure the distribution system to restore customers



CVR – Passive system studied to reduce system voltage on distribution system to conserve energy by operating closer to designed utilization of end user equipment



# Integration Studies of DA FLISR & CVR

## Traditional Study

- Static Study
- Worst Case(s)
- Non-Holistic

## Time Series Analysis

- Dynamic Study
- Adjustable Cases (Different Time Resolutions)
- Provides a Greater Holistic View

# Time Series Analysis Setup

## Traditional Regulation Settings vs CVR Settings

- Voltages under 116V was consider a violation

## Utilize Plant Information (PI) Data:

- Average Hourly Loading
- Circuit Breaker Loadings
- Recloser Loadings

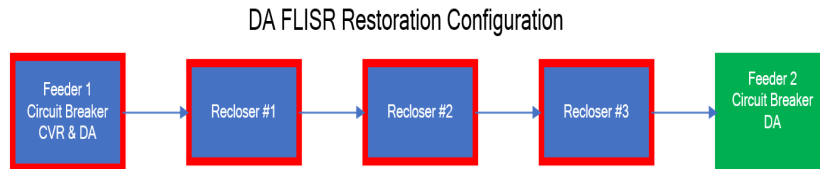
## Abnormal Circuit Configuration

### DA FLISR Restoration Configuration



# Proof of Concepts Explored

## Allocation from the Normal Open Point vs Feeder Circuit Breaker



Allocation Comparison between Feeder Head and Normal Open						
	Average	Max	Average Loading of Node Amps	Peak Loading of Node Amps	Average Deviation Amps	Max Deviation Amps at Peak
<b>Node #1</b>	-6.17%	-8.78%	55	105	-3.4	-9.2
<b>Node #2</b>	-4.84%	-6.53%	39	53	-1.9	-3.5
<b>Node #3</b>	-4.01%	-5.59%	55	60	-2.2	-3.4
<b>Node #4</b>	-3.90%	-5.51%	45	67	-1.8	-3.7
<b>Overall Average</b>	-4.73%	-4.25%			-2.3	-4.9

\*Hourly average values over peak month

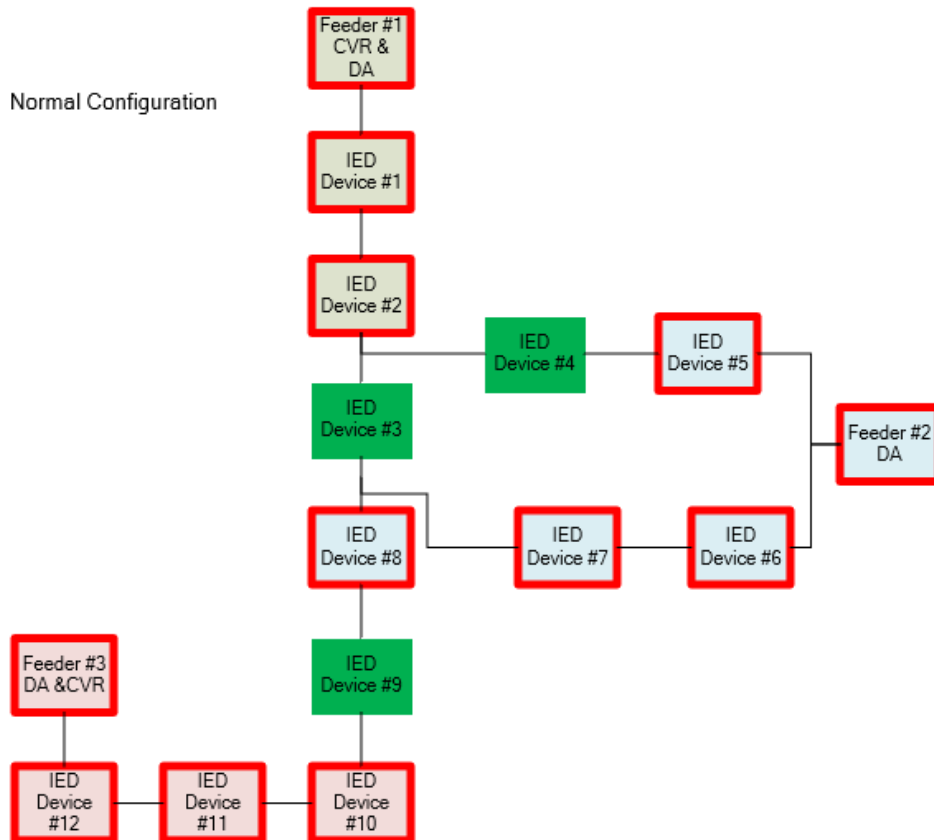
# Proof of Concepts Explored

Utilizing the known loading values of IED Recloser Devices on the DA Feeder to improve model accuracy

Benefits Achieved from Utilizing Historical Data				
IED Device	Data Allocation	Average	Min	Max
Device 1	Including Historical Data	0.21%	0.01%	0.61%
	Excluding Historical Data	1.13%	0.01%	6.54%
Device 2	Including Historical Data	0.31%	0.00%	0.56%
	Excluding Historical Data	9.51%	1.36%	1.36%
Device 3	Including Historical Data	0.07%	0.00%	0.38%
	Excluding Historical Data	20.31%	0.01%	63.03%

\*Hourly average values over Peak Month

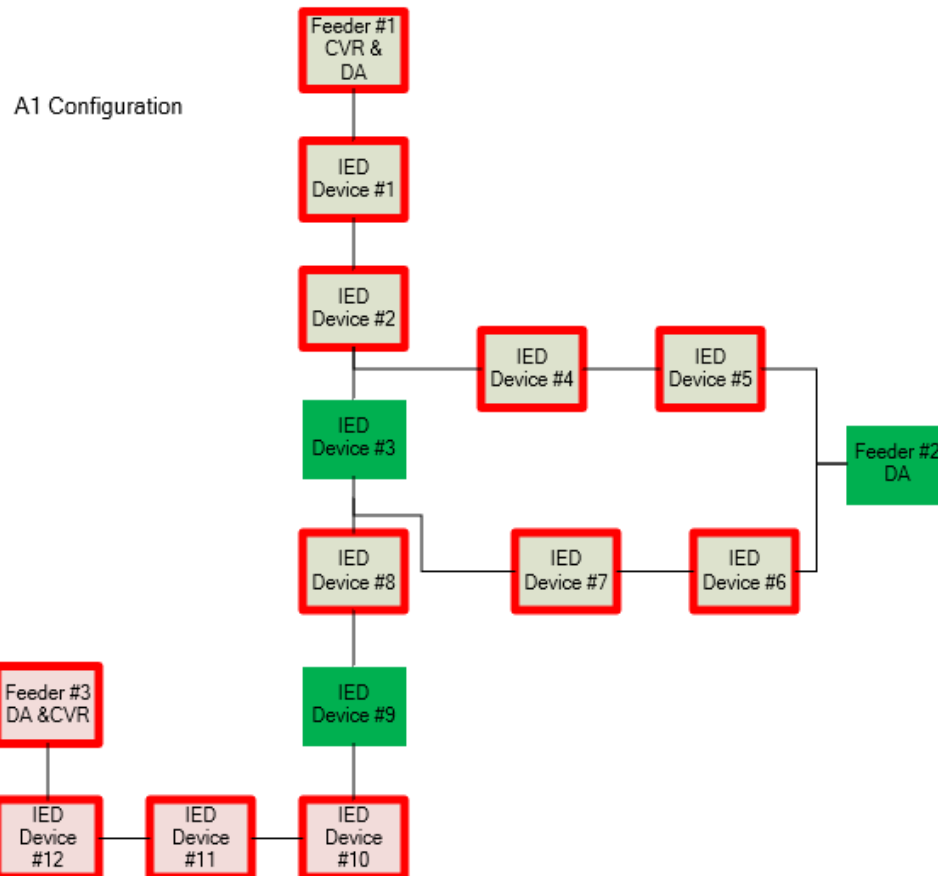
# Normal Configuration of CVR/DA Deployments



All three feeders have a deployed DA FLISR system and are on different substations

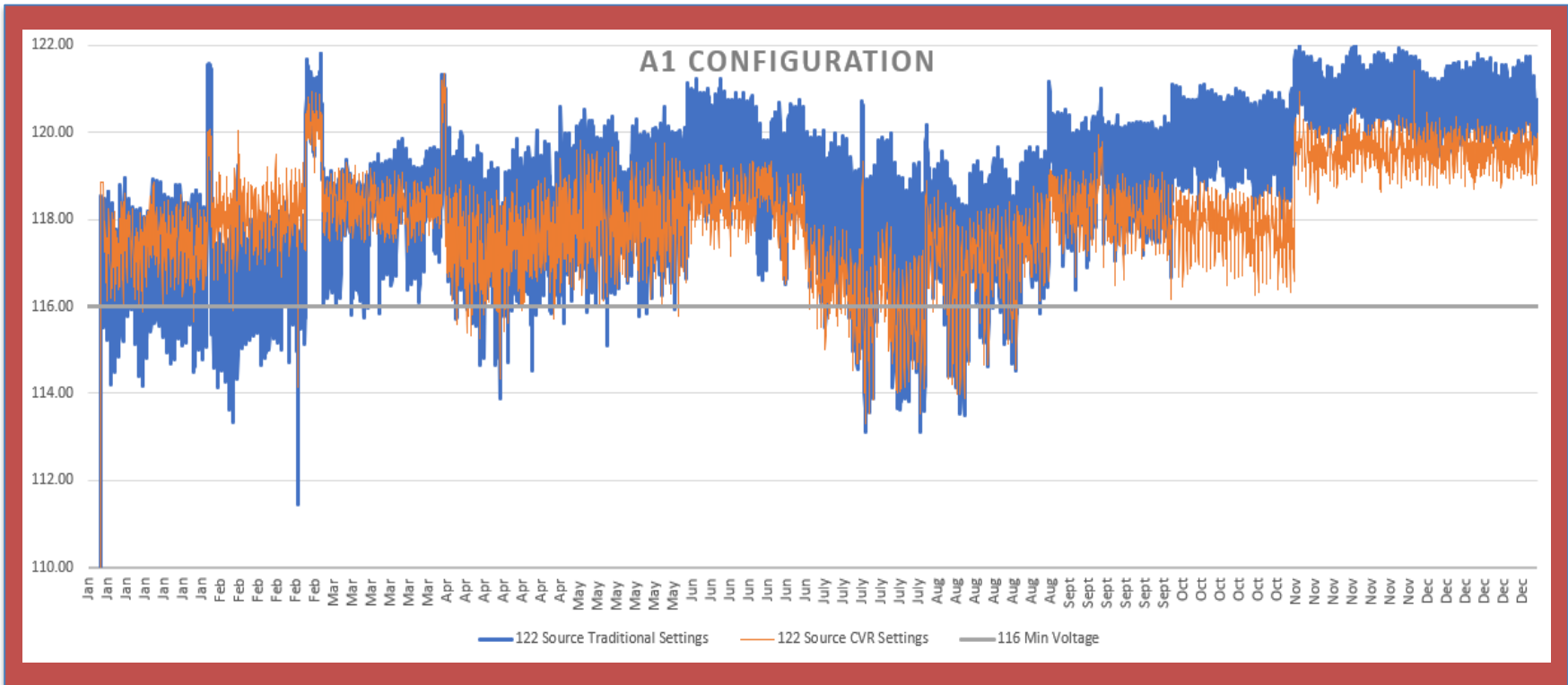
Feeder #1 & Feeder #3 substations are targeted for this study and to have CVR implemented

# Study Case – A1



Feeder #1 is used to restore Feeder #2 through IED Device #4

# Results A1



\*Lowest Voltage on restored feeder

Number of Hourly Violations			
Case	Traditional Violations	CVR Violations	CVR > Traditional within Violation
A1	590	396	129

# Results / Conclusions

Time Series Analysis provided a holistic view of the response of the integration of DA FLISR and CVR Settings

2 of the 3 cases studied CVR settings performed better with less violations than the normal traditional settings

Possible Solutions:

- Configure load limits on DA system to prevent restoration for loading cases that trigger violations
- Develop CVR settings for abnormal system configuration (Cost of Energy Savings)
- Create Multiple Settings and add SCADA Control to LTC
- ADMS Deployment
- Line Regulators Deployments and Custom Settings

# Questions?

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