

# Reliability Quantification and Visualization for Optimal Asset Dispatch in Electric Microgrids

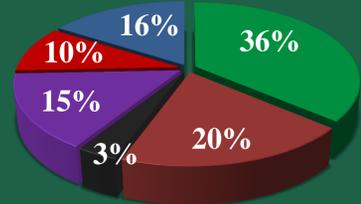
Mayank Panwar<sup>1</sup>, Siddharth Suryanarayanan<sup>1</sup>, Daniel Zimmerle<sup>2</sup>

<sup>1</sup>Advanced Power Engineering Laboratory, Department of Electrical and Computer Engineering, <sup>2</sup>Engines and Energy Conversion Laboratory, Department of Mechanical Engineering  
Colorado State University, Fort Collins, CO-80523, USA

## FortZED RDSI : A Microgrid in Action

- Renewable and Distributed Systems Integration - a microgrid demonstration project funded by US-DOE and participation from various other government and commercial entities.

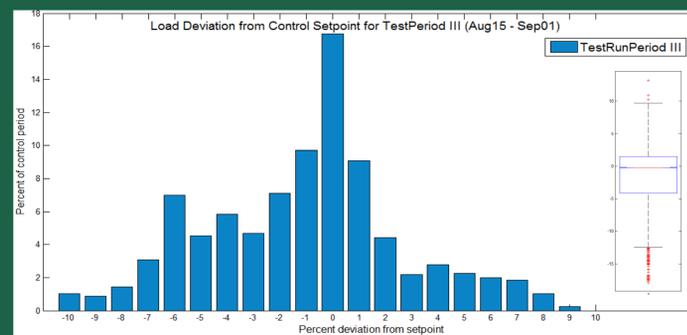
### RDSI Asset Distribution



- Conventional / Diesel
- Natural Gas / Biogas
- Thermal storage
- Load Shed
- Solar Photovoltaic
- CHP / Waste Heat

- Aim : Feeder peak load reduction by **20 %** of total feeder load
- Total demonstration period capacity : nearly **3 MW**
- Peak Load Reduction achieved in range of **6-18 %**
- Low control deviation was observed during runs

### System Control



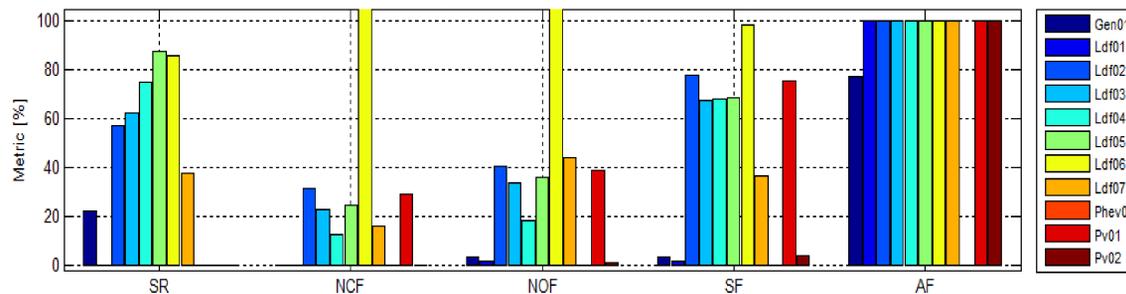
### Asset Dispatch

- RDSI asset dispatch was done through a centralized control system with a specific load scheduling algorithm in a round robin basis for maximum asset participation in test runs.

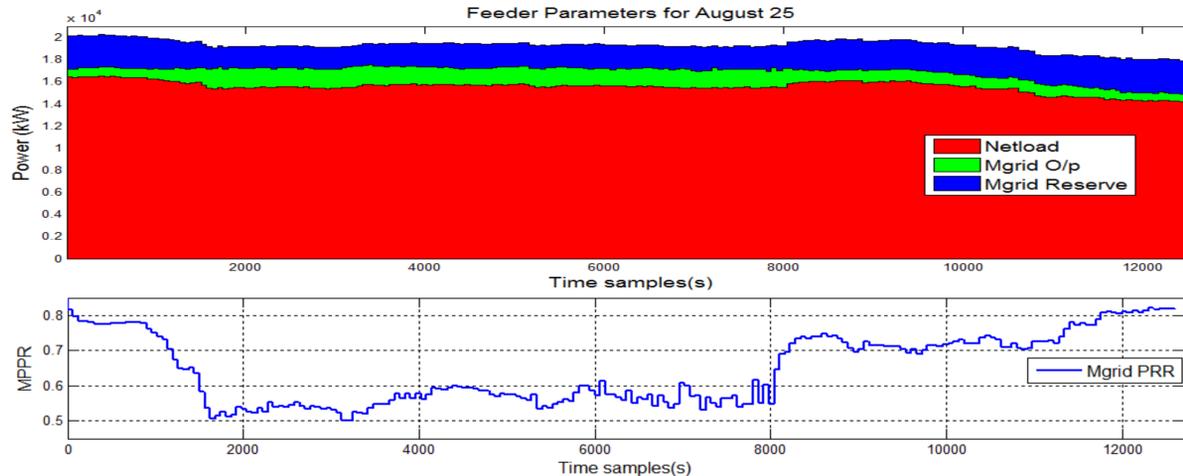
## Reliability Quantification

- Electric power reliability is defined by NERC metrics in North America
- Does not take into consideration the microgrid capacity to meet contingencies
- Metrics calculated as per NERC criterion: **Starting Reliability, Average Run Time, Availability Factor, Net Capacity Factor, Net Output Factor, Service Factor, Weighted Availability Factor and Weighted Service Factor.**

NERC reliability metrics for all assets at City of Fort Collins



Feeder Parameters for August 25



### Microgrid Peak Reserve Ratio

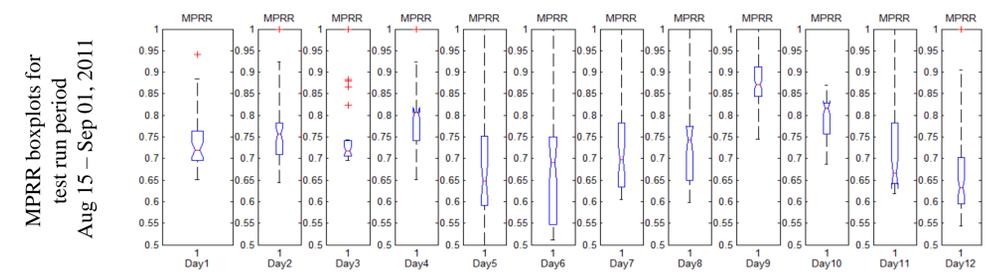
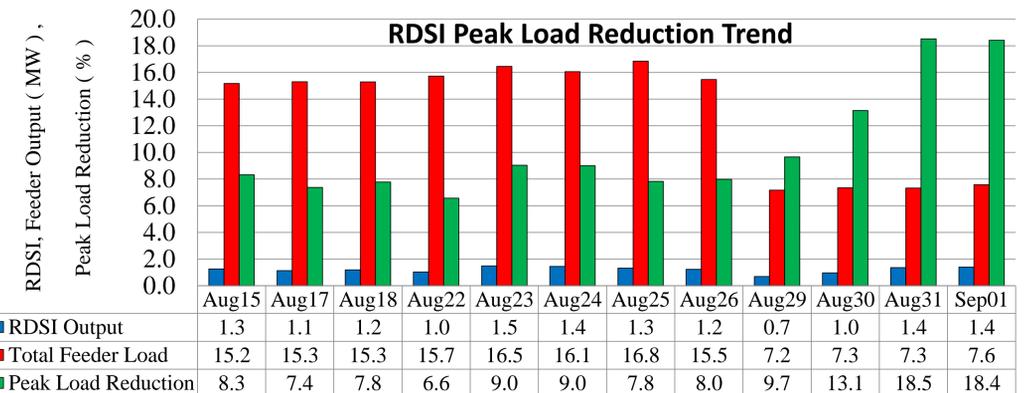
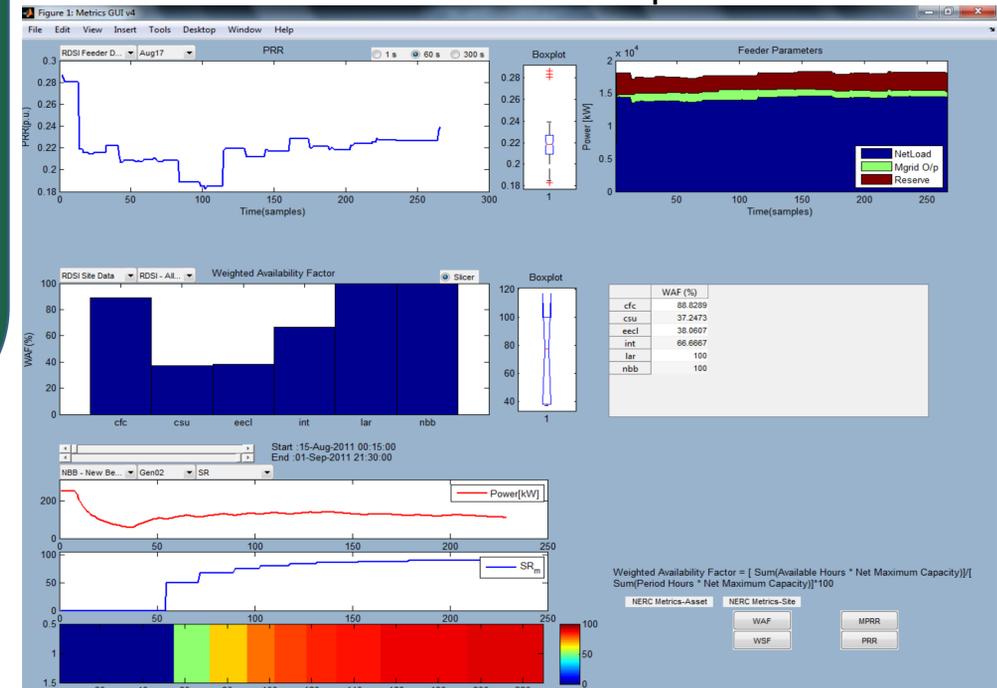
$$MPRR(t) = \frac{RDSI\ Capacity(t) - RDSI\ Output(t)}{RDSI\ Capacity(t)}$$

- MPRR gives the available reserve of the microgrid system
- Minimum MPRR gives the share of underutilized assets
- To avoid stranding of assets any value of MPRR beyond planned reserve may be dispatched either to serve base load or ancillary service based on nature of asset.
- Can be used as a design criterion for capacity assessment of future microgrids

## Visualization

- GUI developed in MATLAB for displaying asset and site level metrics
- Variation of metrics in time can be observed to study asset response during the test run period
- Comparison between two test run days or sites can be done easily
- Box plots provides scatter of metric data

### Visualization GUI screen snapshot



## Conclusion

- FortZED RDSI project is an insight into future aim of Fort Collins to be a Zero Energy District
- Peak reduction was achieved in the target range over a period of test runs

## Future Work

- To develop reliability metrics for microgrids that can model the aggregation of distributed sources in a microgrid
- Develop a reliability based methodology for optimal asset dispatch

## Acknowledgements

This material is based upon work supported by the US-Department of Energy (DOE) through FortZED RDSI and Power Systems Engineering Research Center (PSERC)