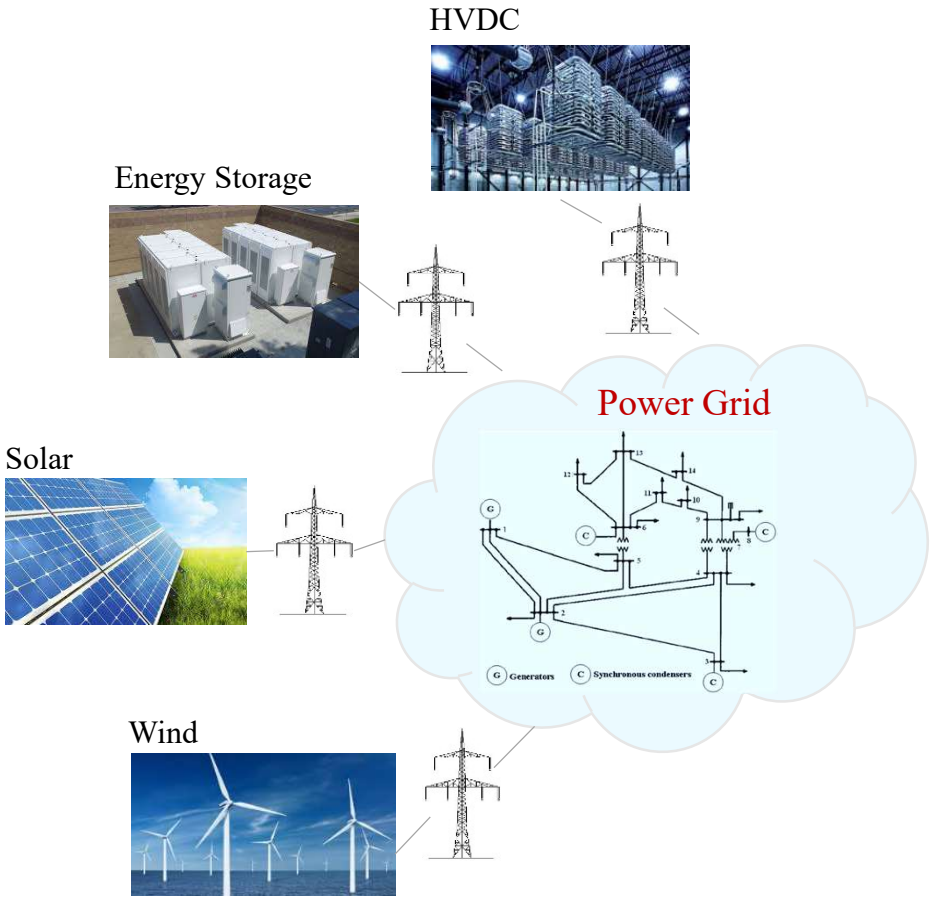
Saeed Lotfifard

Associate Professor,
School of Electrical Engineering and Computer Science, Washington State University
tel: (509) 335-0903
e-mail: s.lotfifard@wsu.edu
web: http://eecs.wsu.edu/~lotfi

Research Interests: **Operational Security of Inverter-dominated power grids** to address **Protection, Control** and **Stability** challenges of grid integration of inverter-based resources (IBRs)

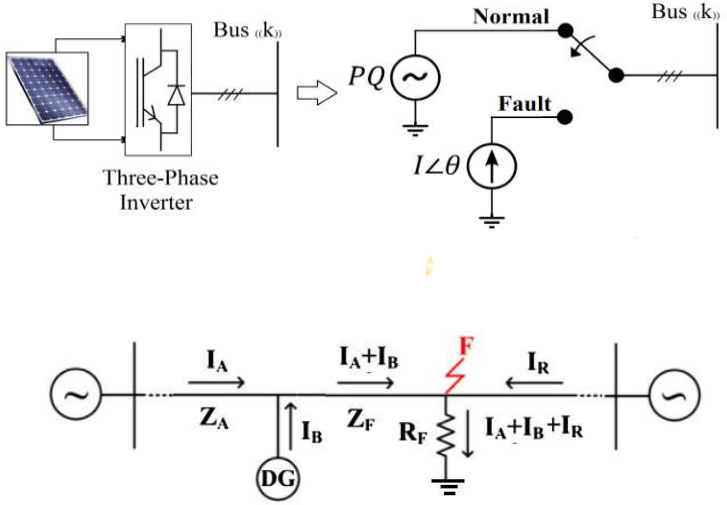
Challenges: **New dynamics** and **new fault characteristics** of inverter-based resource (IBRs) dominated systems pose challenges to operational security of power systems defined by NERC as the ability of the system to tolerate large disturbances such as faults.

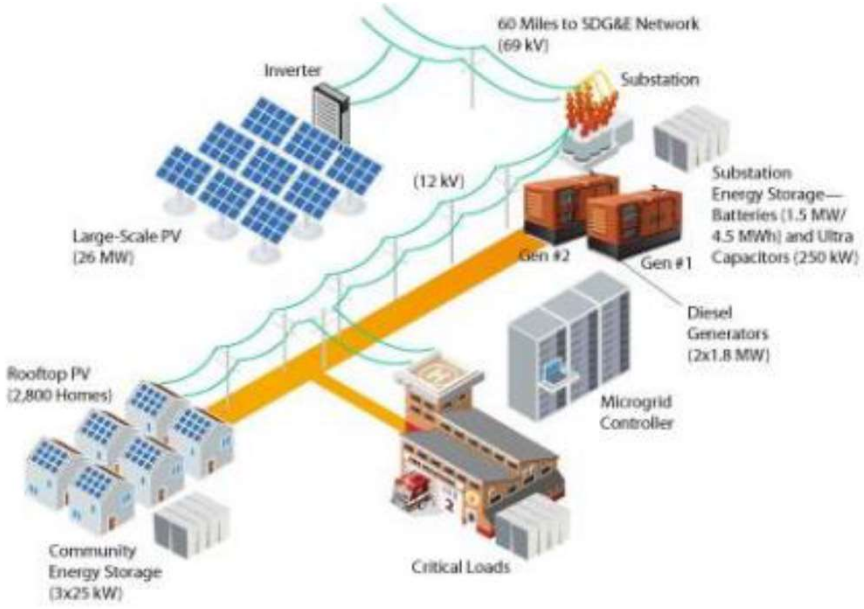


RENEWABLE
FAULT
STABILITY
SYSTEM
FAILURE
CONTROL
OPTIMIZATION
CRITICAL
Synchro-phasor
RELIABILITY
EMEGENCY CONTROL
TOLERANCE
AC-DC power systems
AVAILABILITY
PROTECTIVE RELAY
PROTECTION
Real-time Operational Security

Protection of Active Distribution Systems

- **Funded by DOE, 2020-2023**
- **WSU-PI: Saeed Lotfifard (Subcontract from Georgia Tech)**
- **This project will develop protection, fault location identification and system restoration methods for active distribution systems with large integration of inverter-based sources**

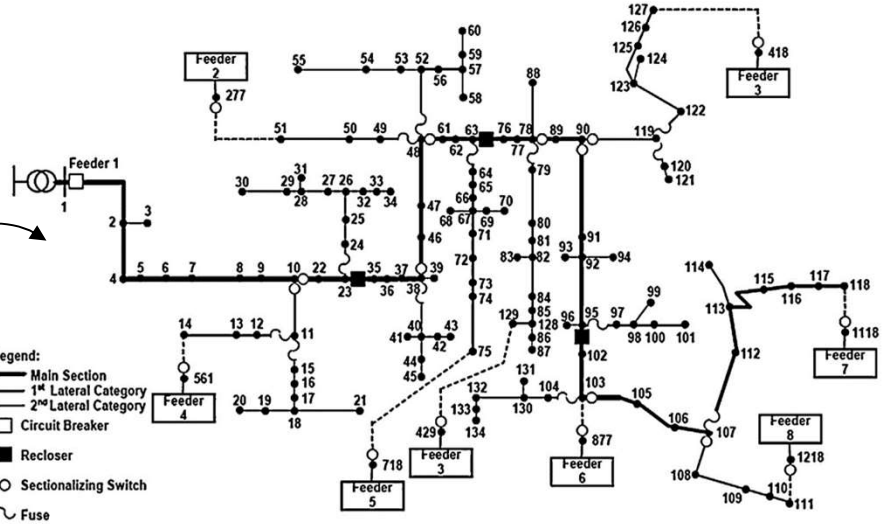




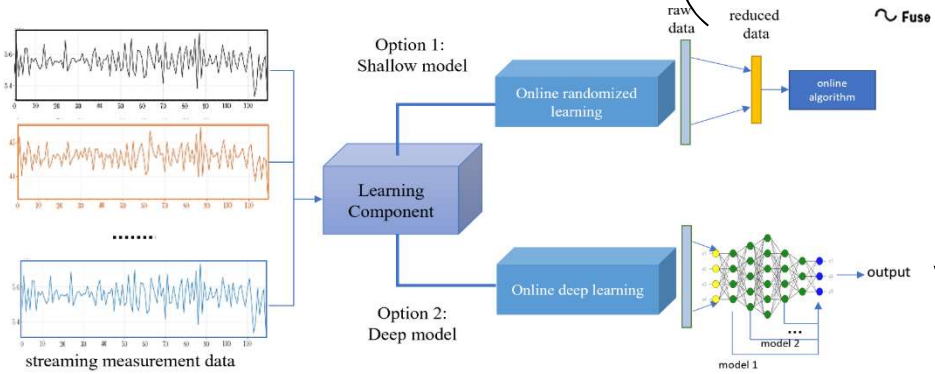
Autonomous, Adaptive, and Secure Distribution Protection (a2SDP)

Virtual Meter for Active Distribution Systems

- Funded by NSF, 2019-2022
- WSU-PI: Saeed Lotfifard
- This project will develop a virtual meter to address the problem of lack of observability in active distribution systems using a co-modeling of data driven models and physics-based models



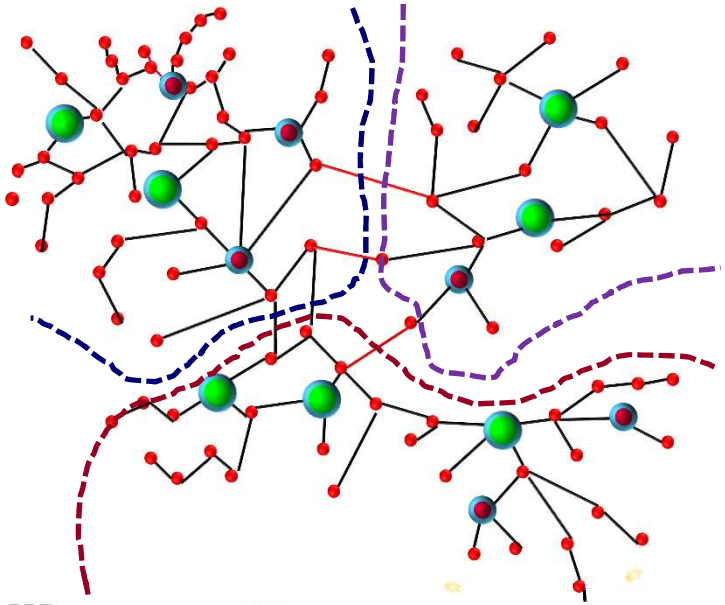
physics-based model

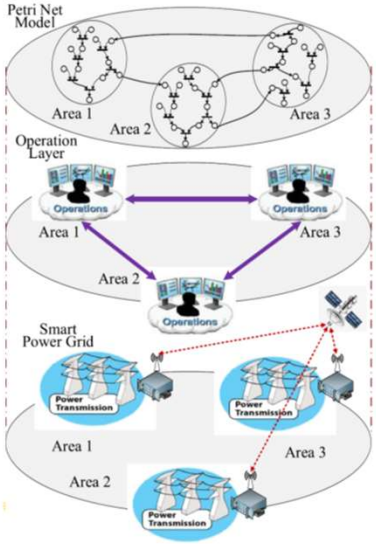


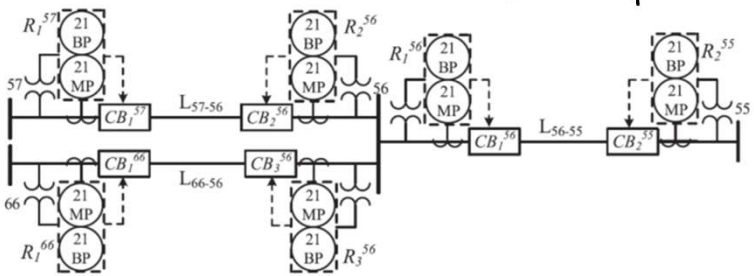
data-driven model

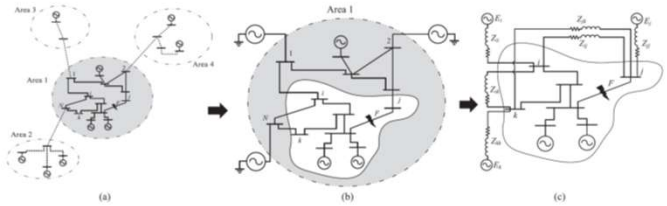
Situational awareness: Root cause analysis

- Funded by NSF, 2019-2024
- Co-PI: Saeed Lotfifard
- This project will develop a method for robust identification of root cause in presence of protection failures and data loss



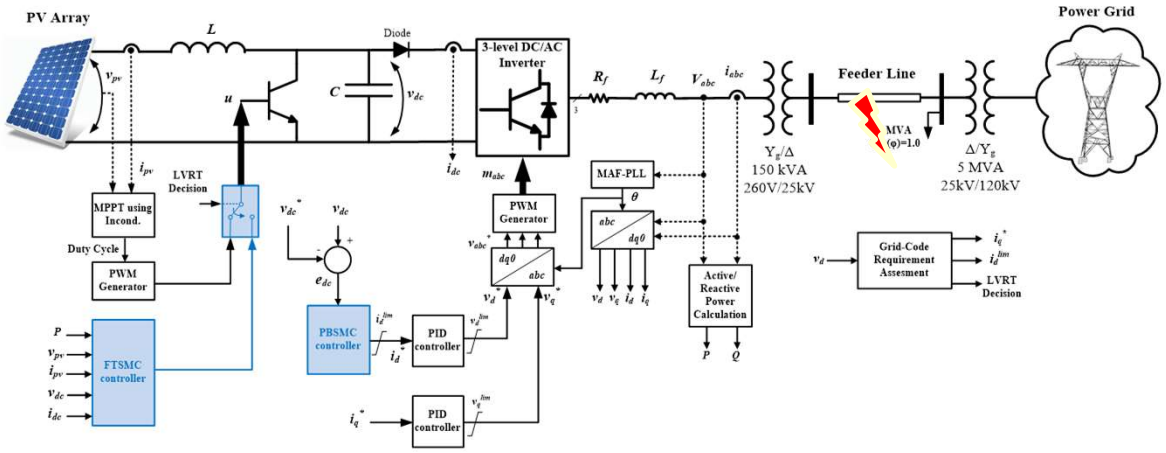


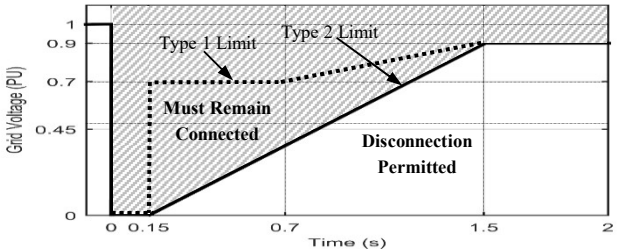


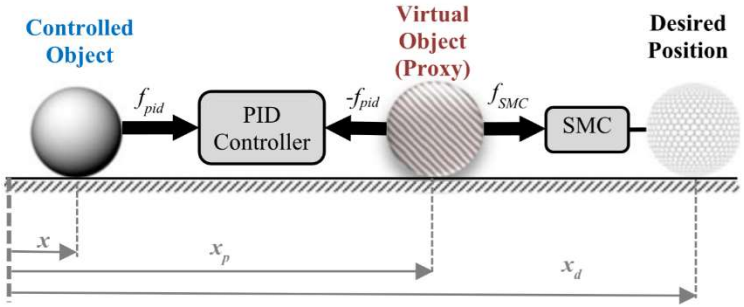


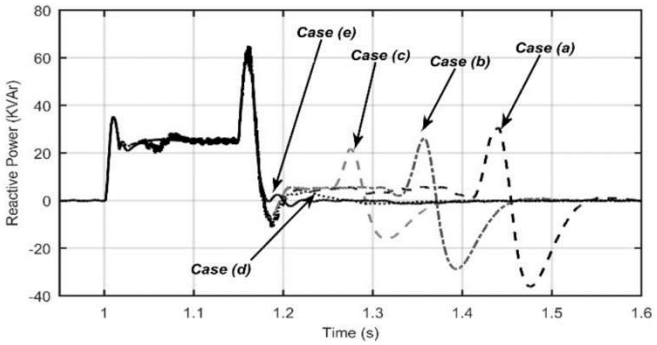
Fault Resilient Inverters

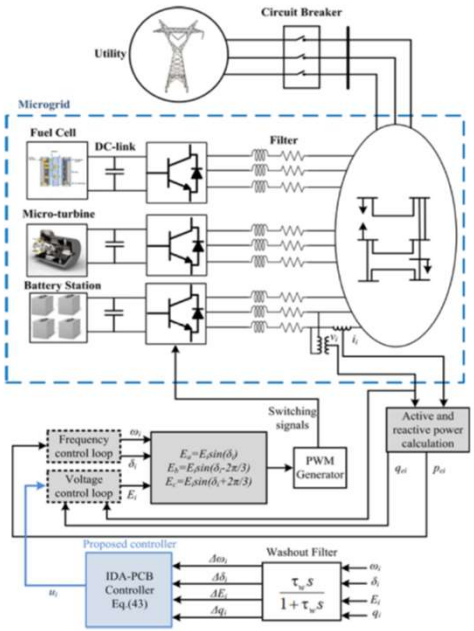
- Funded by PSERC, 2020-2022
- WSU-PI: Saeed Lotfifard
- This project will develop methods for enhancing fault ride through (FRT) capability of inverter-interfaced resources

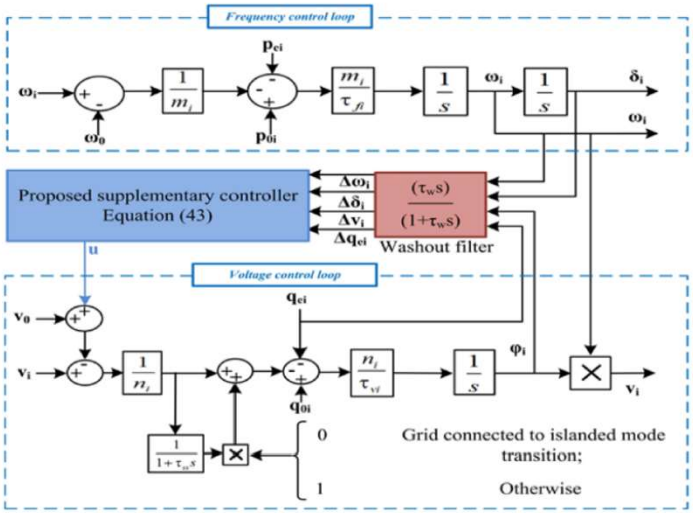


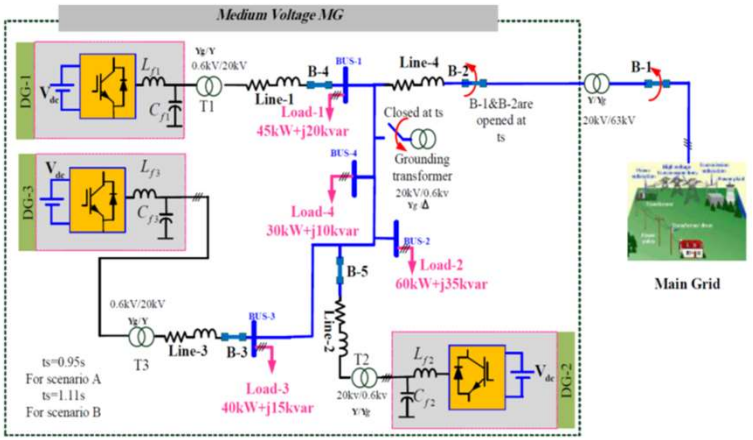


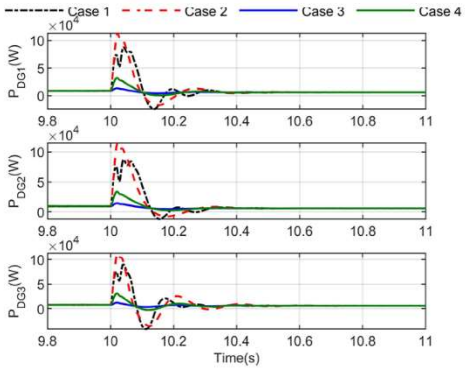


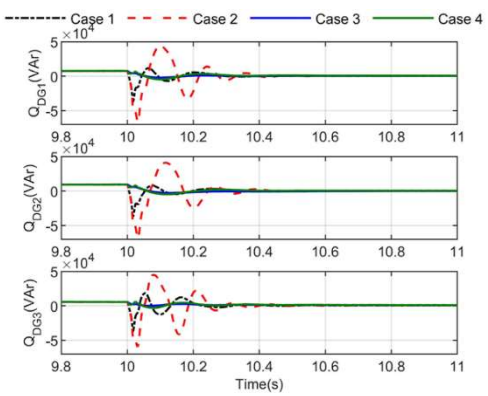


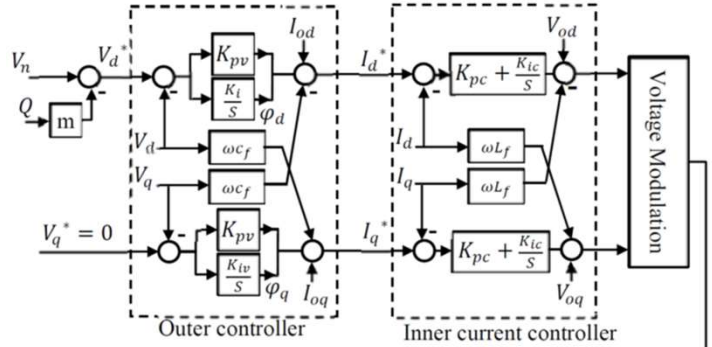

Circuit Breaker
Utility
Microgrid
Fuel Cell
DC-link
Filter
Micro-turbine
Battery Station
Switching signals
Active and reactive power calculation
Frequency control loop
Voltage control loop
PWM Generator
Proposed controller
IDA-PCB Controller Eq.(43)
Washout Filter

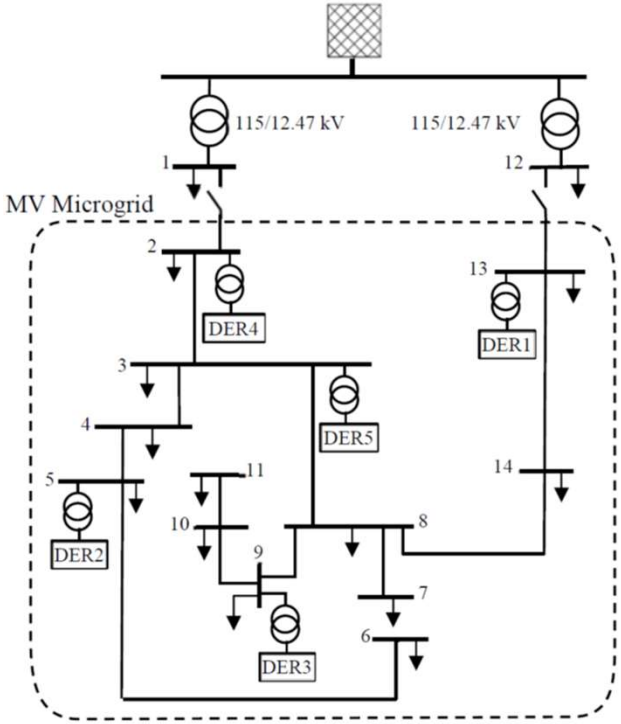

Frequency control loop
Proposed supplementary controller Equation (43)
Washout filter
Voltage control loop
Grid connected to islanded mode transition;
Otherwise

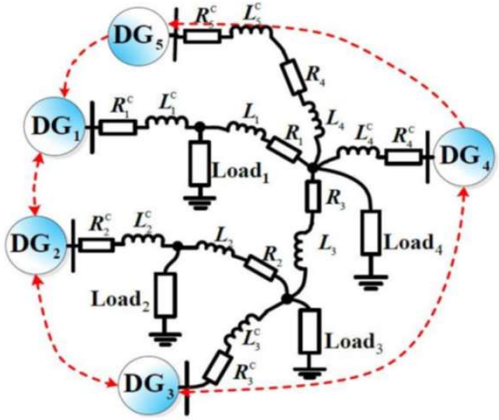

Medium Voltage MG
DG-1
DG-3
DG-2
T1
T2
T3
Line-1
Line-2
Line-3
Line-4
Load-1
45kW+j20kvar
Load-2
60kW+j35kvar
Load-3
40kW+j15kvar
Load-4
30kW+j10kvar
Closed at ts
Grounding transformer
B-1&B-2are opened at ts
Main Grid
ts=0.95s
For scenario A
ts=1.11s
For scenario B


Case 1
Case 2
Case 3
Case 4
Time(s)

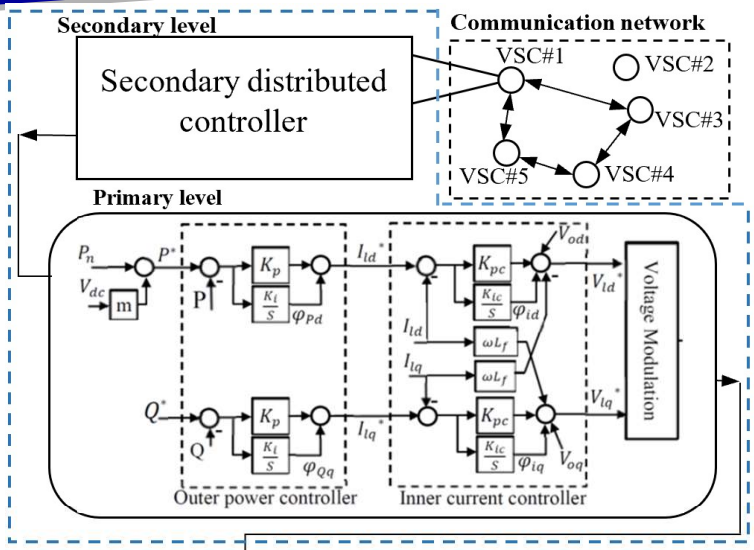

Case 1
Case 2
Case 3
Case 4
Time(s)

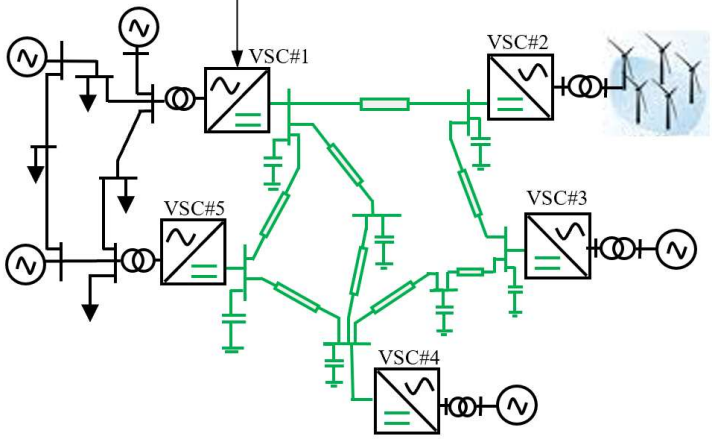


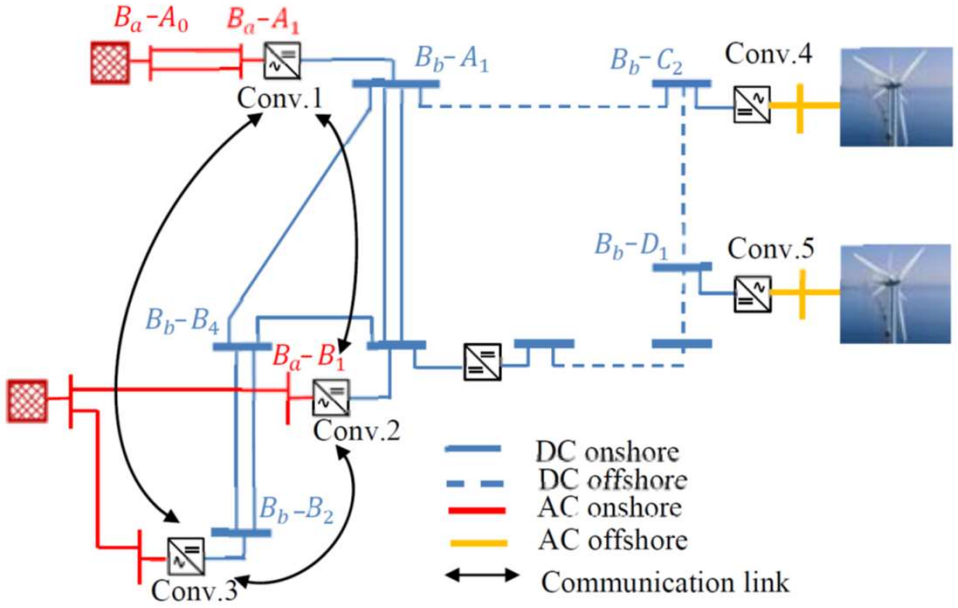




D. Nojavanzadeh, S. Lotfifard, Z. Liu, A. Saberi, A. A. Stoorvogel "Scale-free Distributed Cooperative Voltage Control of Inverter-based Microgrids with General Time-varying Communication Graphs" IEEE Transactions on Power Systems, Accepted



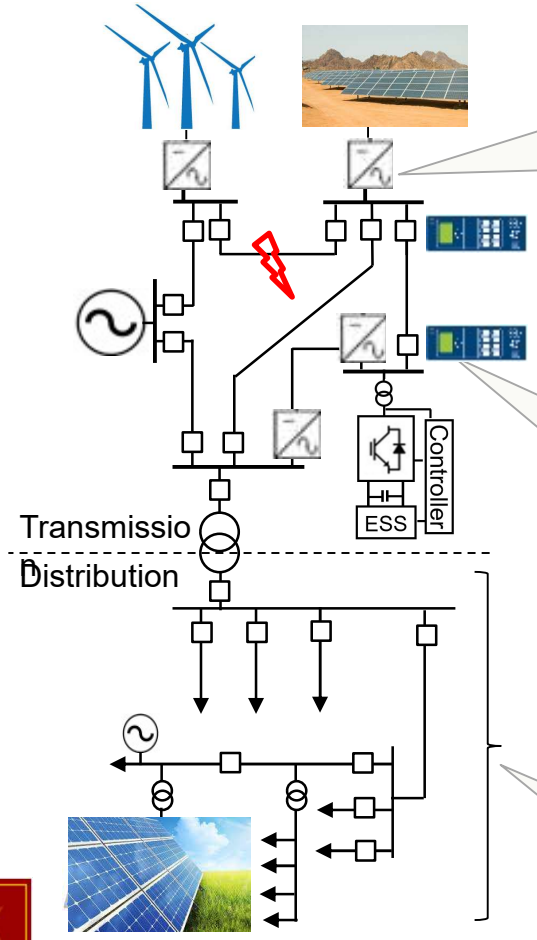




S. Lotfifard, D. Nojavanzadeh, Z. Liu, A. Saberi, and A. A. Stoorvogel, "Distributed Cooperative Voltage Control of Multiterminal High Voltage DC Systems" IEEE Systems Journal, Accepted.

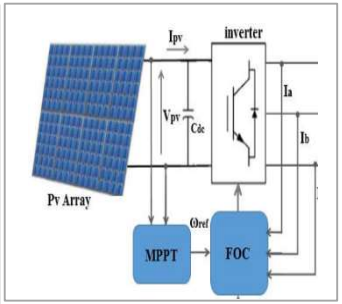
Identification and Mitigation of operational security vulnerabilities of inverter dominated power grids

- **Funded by PSERC, 2021-2023**



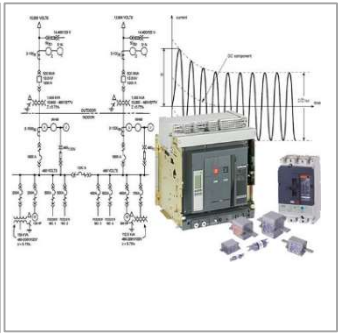
Grid Synchronization Stability of IBRs

- Identify scenarios leading to grid synchronization instability of IBRs
- Develop holistic tuning processes for controllers
- Design supplementary controls for IBRs for stabilization during external transients



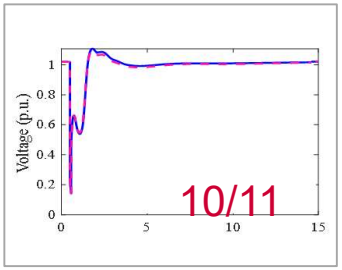
Protection Systems Vulnerability Identification and Mitigation

- Identify vulnerabilities of protective relaying functions.
- Design IBR controllers to (a) shape fault characteristics, (b) harden the response to external faults.
- Design protection functions immune to IBRs characteristics and influences



Load and IBR Dynamic Response Analysis

- Develop reduced distribution system dynamic models
- Identifying critical settings of IBRs in distribution systems for dynamic support to transmission lines



Thanks!

Saeed Lotfifard
e-mail: s.lotfifard@wsu.edu
web: http://eecs.wsu.edu/~lotfi