Design and Application of a High Frequency Transformer

Sijo Augustine, Research Scientist

Dr. Olga Lavrova | Klipsch School of Electrical Engineering

NM STATE UNIVERSITY

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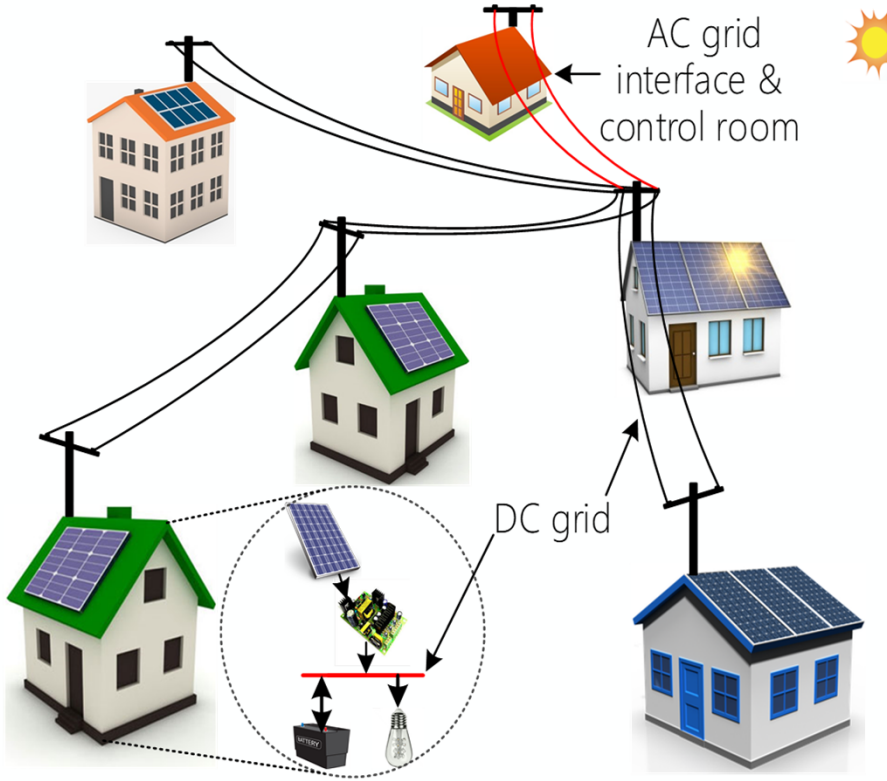
DC Microgrid- Overview

- Technologies, configurations
  - Single bus, multi-bus, radial, meshed, zonal etc.
- Energy efficiency
  - Reduced AC-DC conversion, generation sources closer to loads.
  - Economic benefits
- Simpler than AC
  - Reactive power, skin effect, etc. not an issue in DC power.



Motivation

- Why? -> Most modern electronic circuits require a DC power supply.
- Considering that both loads and sources could interface on a common DC bus, reducing the stages of AC-DC power conversion- more efficient !
- Hence, LV/ELV distribution systems from generation to consumption level are experiencing a shift towards DC.

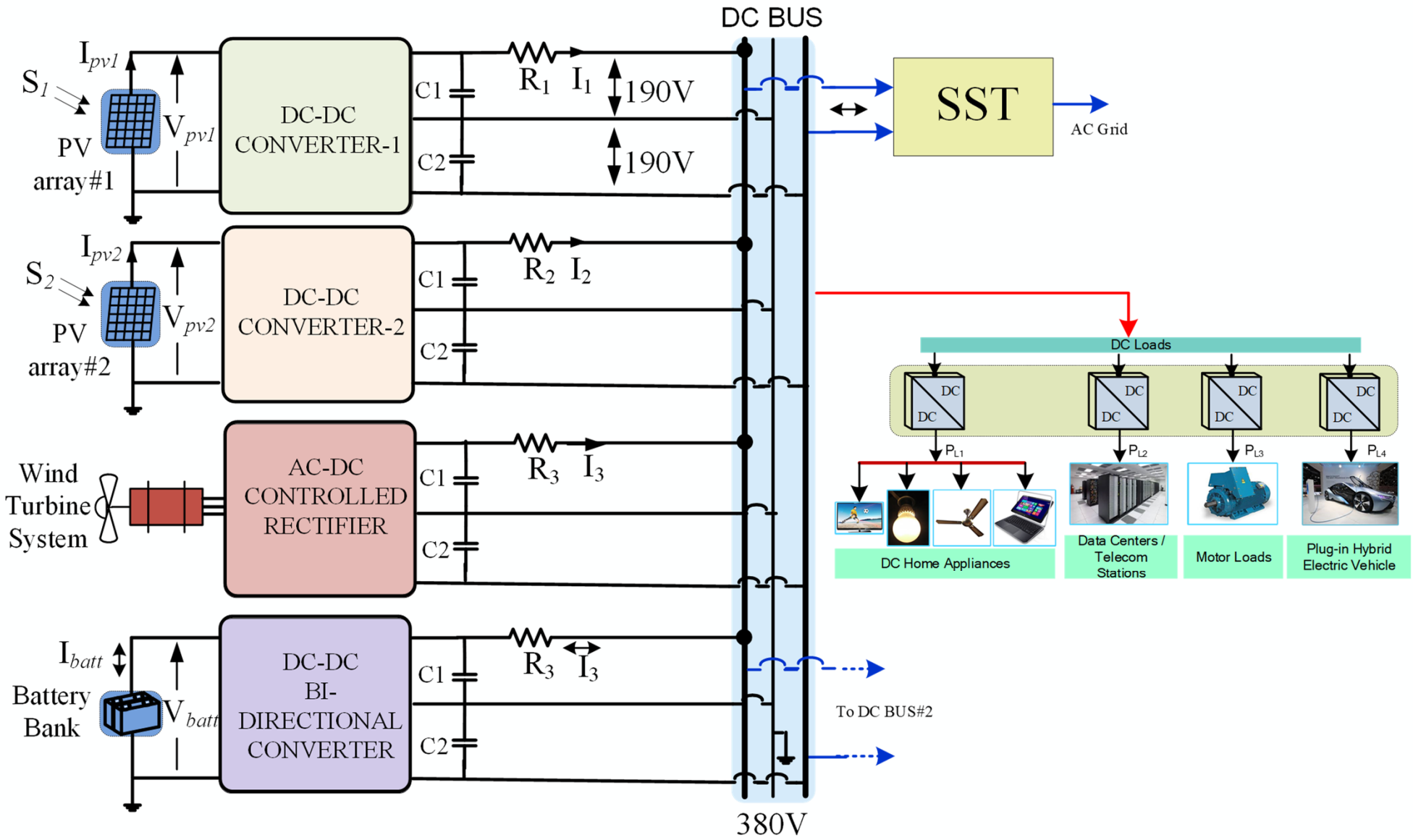
LVDC Microgrid - Present State-of-the-Art

- 24V to 1500V range (24V, 48V, 380V and 750V are more common).
- Residential homes, hospitals, businesses and factories synonymous with the emergence of DC loads.
- Shipboard power systems.
- Aircraft and automotive systems.
- “DC microgrid + DC SST” system can be a game changer to support EVs in the era of smart grids.
- Off-grid communities.

380V Bipolar DC Microgrid- Overview

- Bipolarity in the dc microgrid system is introduced to enhance the efficiency of the system.
- More supremacy in terms of reliability and flexibility such as load sharing, stability during disturbances/fault, better voltage regulation, etc.
- Continuity and reliability of power is not compromised in case of occurrence of fault in one of the dc buses.
- Therefore, bipolar voltage levels makes it more suitable for connecting with distributed energy resources(DERs) and dc loads.
- More beneficial and suitable for off-grid communities because of reliability.

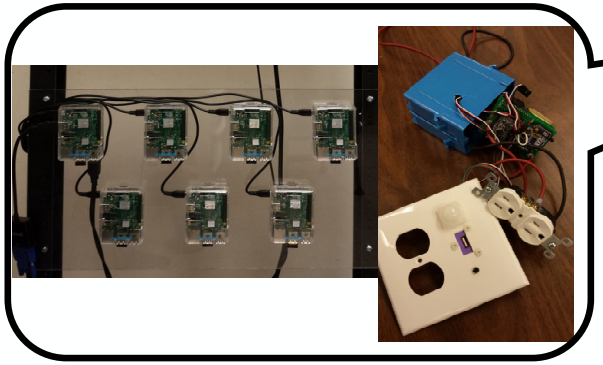
380V Bipolar Solar PV DC Microgrid- Design Concept



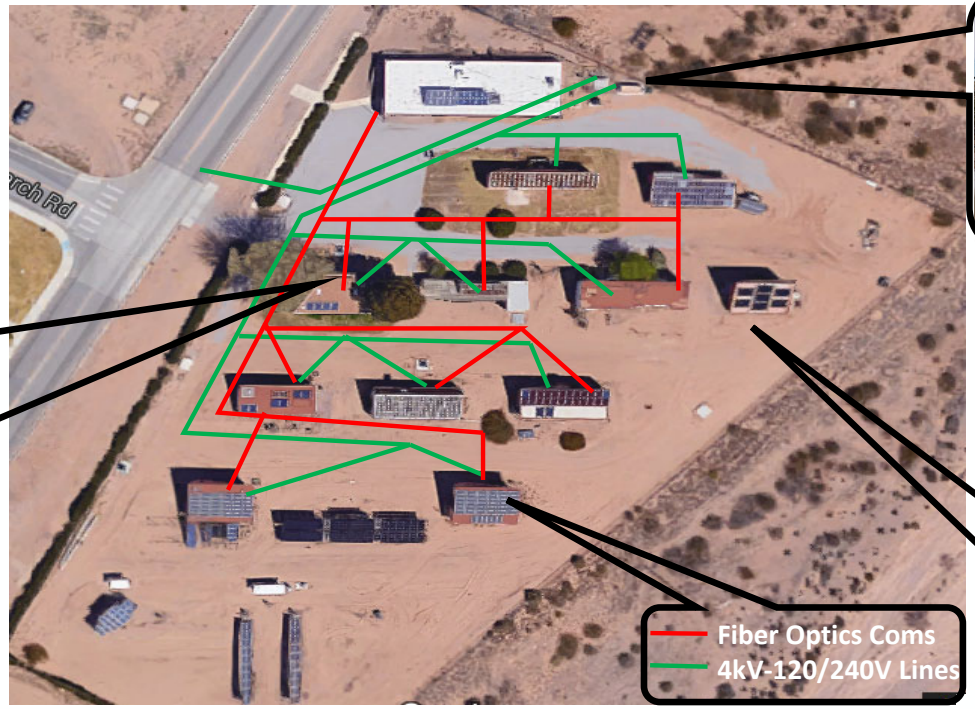
NMSU Microgrid Test Facility

The micro-grid at "IDEAL center" is a three phase, 4kV feeder interconnecting buildings containing PV interfaced with smart inverters, Controllable Loads, Electric Storage Systems. This provides the platform to evaluate centralized or distributed algorithms for energy delivery.

DC and AC microgrid capabilities allow for integral testing of both types of generation and load resources. Storage, storage simulators, Grid simulator is available.
DC microgrid is 380V Bipolar /30A capacity.



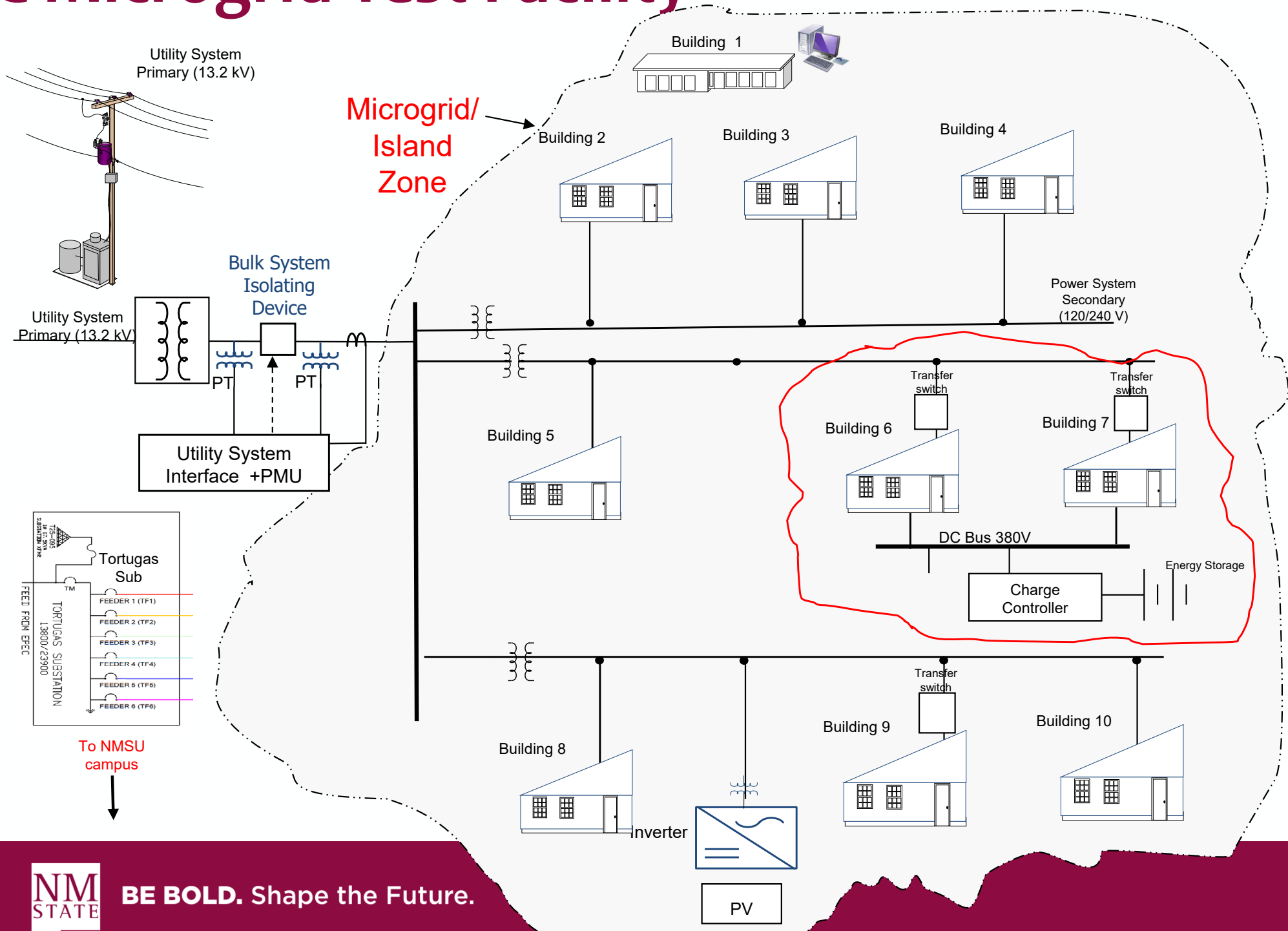
Raspberry Pis are being programed as agents to execute the centralized or distributed algorithms for Energy Delivery. Programmable loads and load banks can be controlled to emulate various operating conditions and loading scenarios.



IDEAL can be islanded from the utility by operating a set of three-phase reclosers (controlled by NMSU). System can operate as a microgrid. PMUs are co-located and monitored for emulitics and Machine Learning analysis

Both grid-forming and grid-following inverters manage power and energy balance.

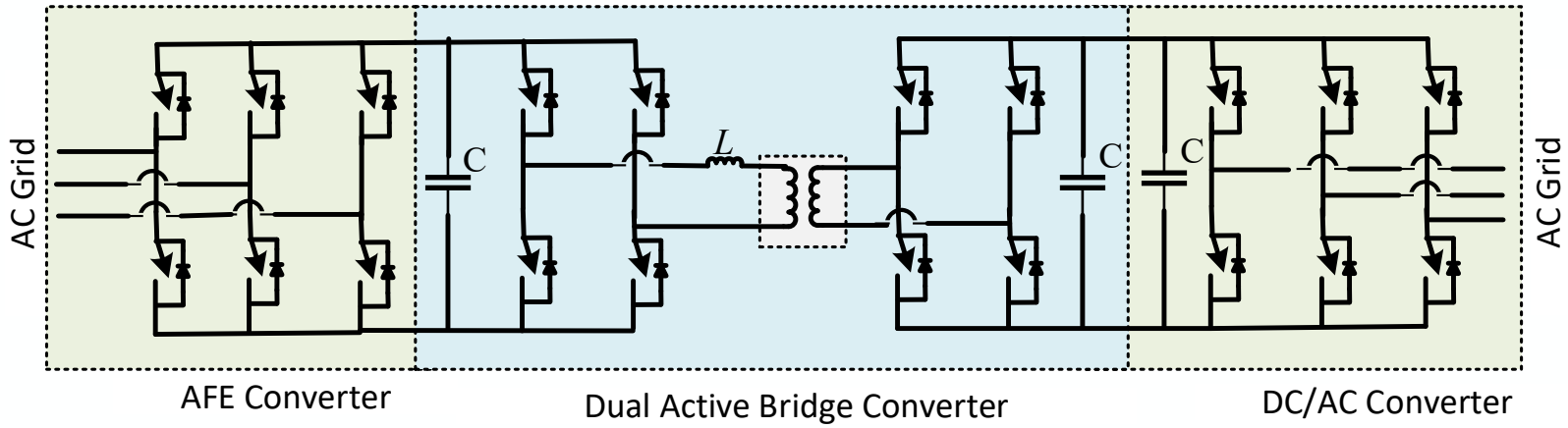
DC Microgrid Test Facility



Bipolar Boost Converter for DC Microgrid

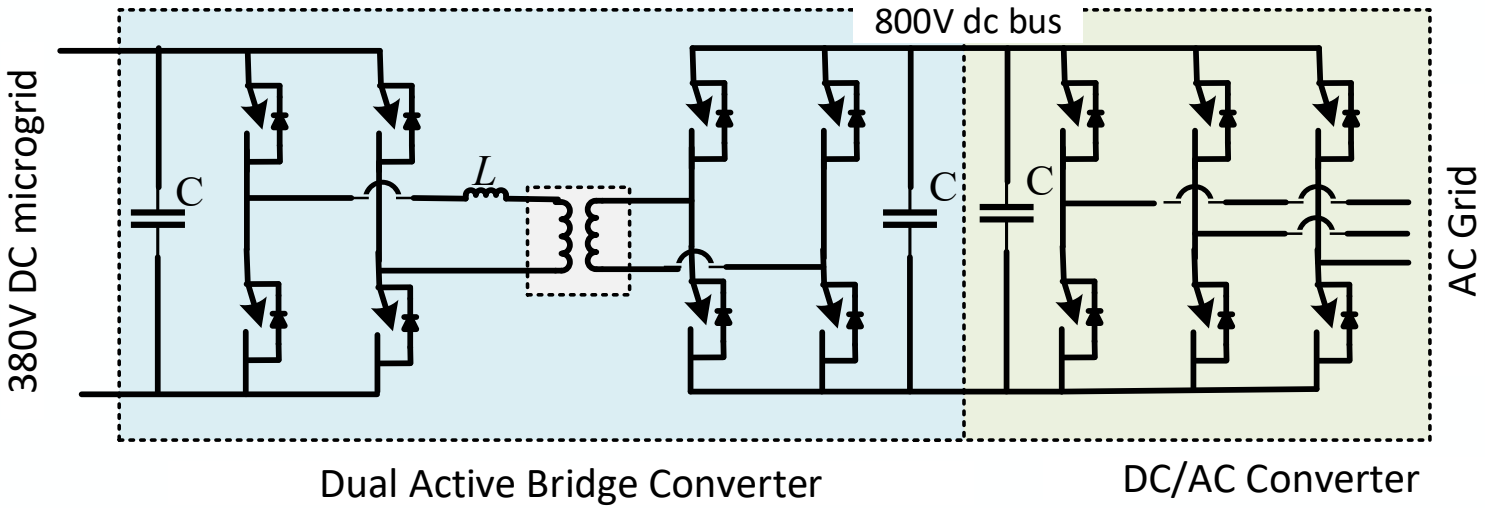
Solid State Transformer

- In the context of AC microgrids, the SST is as an alternative to passive transformer.
- SST basically comprises an AC-AC converter with three interfaces.



DC Solid State Transformer

- DC SST is a suitable solution to interface LVDC/MVDC systems with AC grid/DC grid (LVDC/MVDC).
- DC SST can be designed to perform unidirectional or bidirectional power flow.
- More options to integrate DC loads or storage within the MVDC/LVDC network.



DC Solid State Transformer

Parameter	Specifications
Input voltage	380V
Output voltage	800V
Power Rating	10kW
Output current	13A
Input current	26A
PWM switching frequency	50-100kHz

DC SST