An Overview of Microgrids

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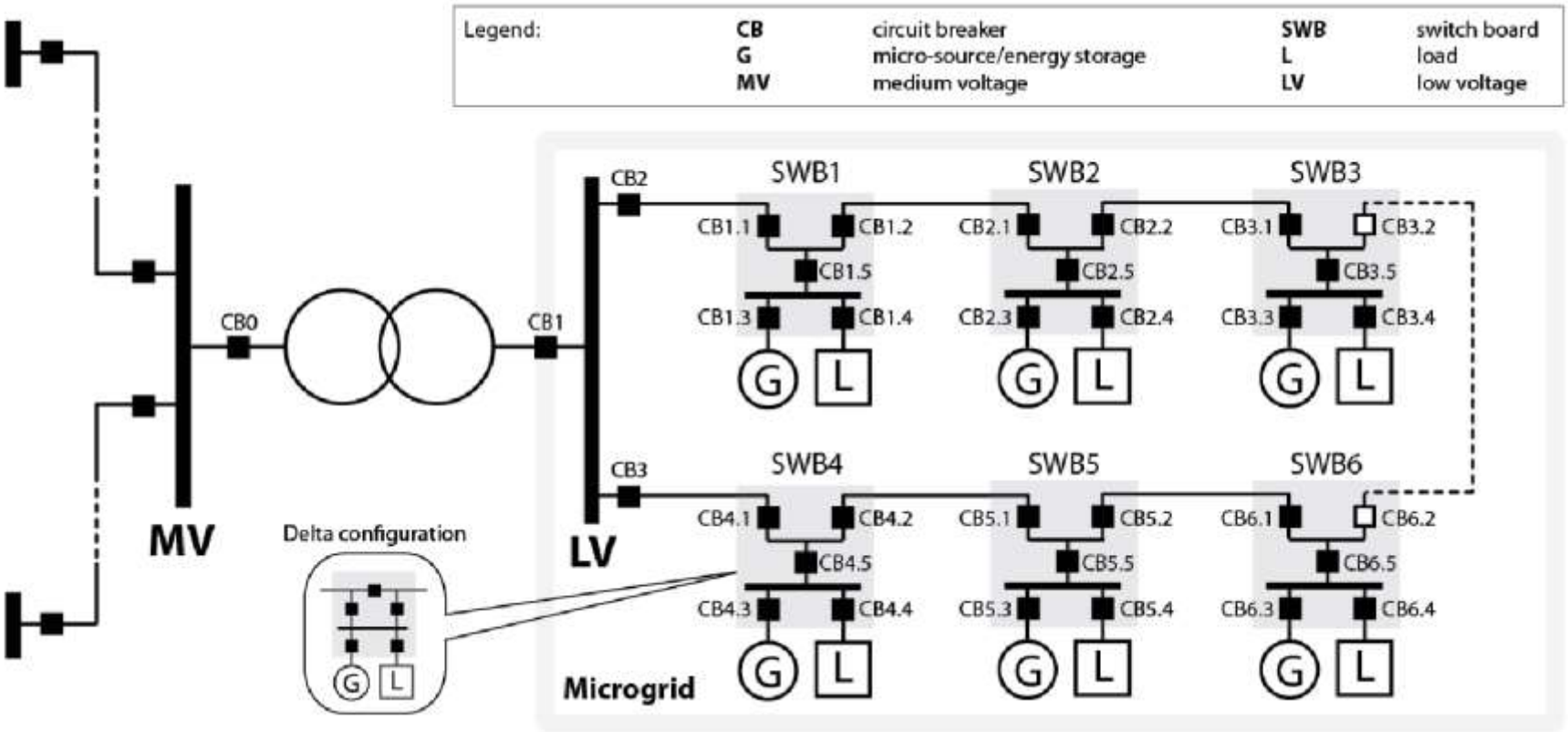
Characteristics of a microgrid

- A small, low-voltage (typically less than 15kV) grid that can operate autonomously (isolated).
  - Or connected to the utility grid through a limited interconnection.

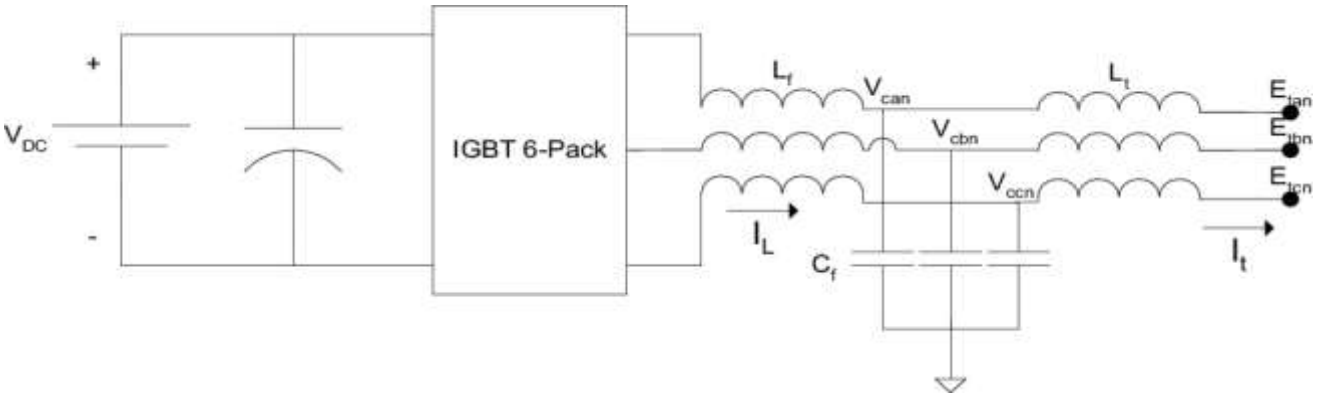


From: Novel Protection Systems for Microgrids

Microgrid characteristics (2)

- Incorporate multiple sources that must be coordinated (voltage and frequency regulation).
  - Newer sources (e.g. storage, solar PV) interface to the microgrid via an inverter (power electronics).
- Can connect/disconnect (synchronize) seamlessly with the utility grid.
- Designs must adequately size generation to cover critical loads.

DC/AC Inverter



Uninterruptable power supplies (UPSs)

- Emergency back-up supply for critical infrastructure.
- UPS installations have been around forever.
- Single source, often a synchronous generator driven by a diesel/natural gas powered engine.
- No synchronization with the utility grid.
- Much simpler to control.
- Simple to size the generator to match critical loads.

Microgrid control

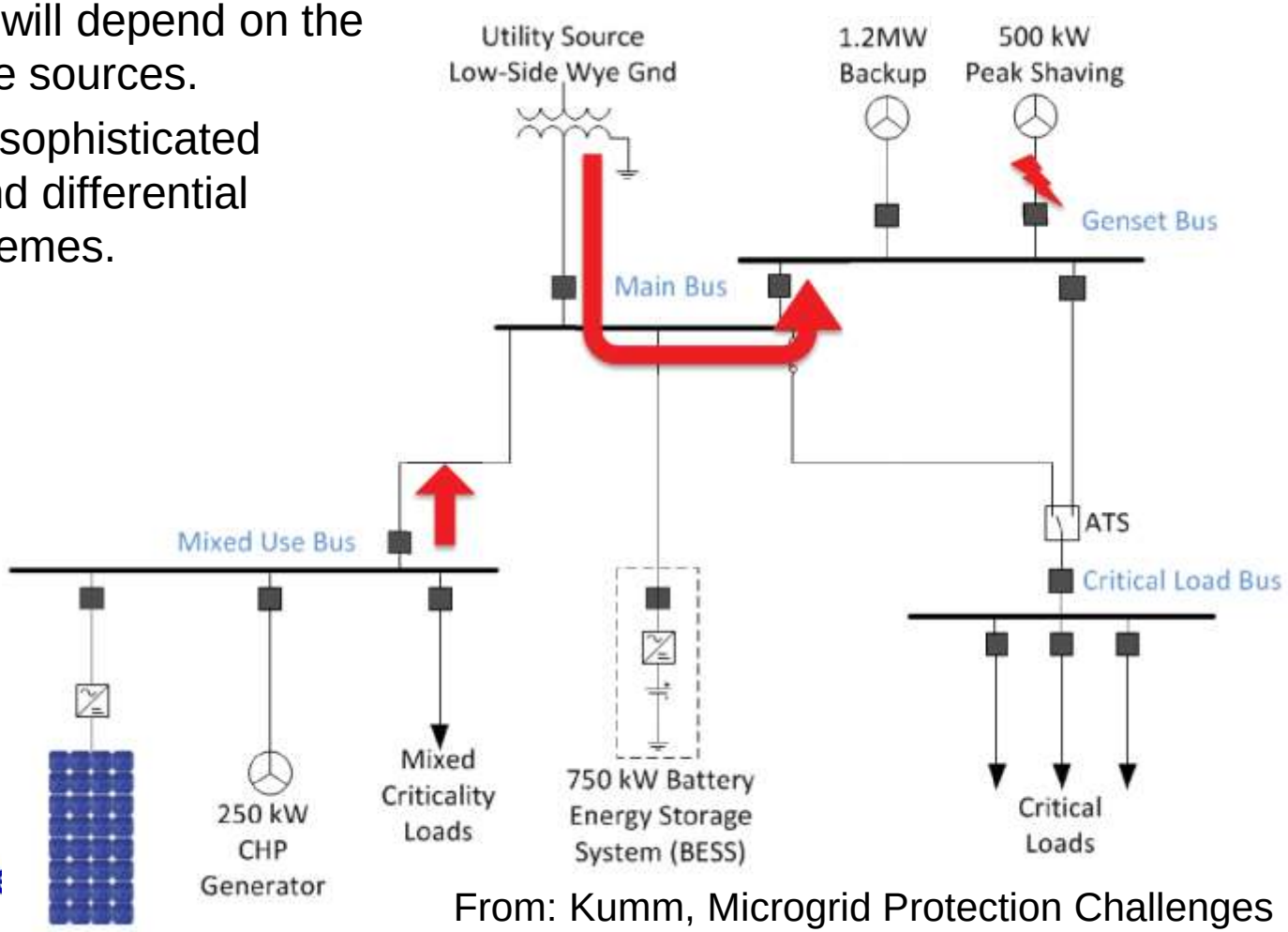
- Sophisticated decentralized controls are required as no central controller.
- Isolated operation requires “grid-forming” inverters.
- Synchronization – all sources must operate at the same frequency.
- Load sharing – load changes must be distributed equitably across multiple sources.
  - Load control/shedding schemes may also be required.
- Voltage control – set-points must be coordinated to prevent circulating current.

Solar PV for resilient microgrids

- About 2.5 acres of solar panels are required to produce 1MW (maximum) power output.
  - Power output is normally less than the maximum.
- Solar panels may not do well through hurricane-strength winds.
  - Nor be particularly useful during post-hurricane rain.
- Sizing batteries for days of storage is extremely expensive.

Protection

- Fault protection is easy when there is a single source.
  - Fuses are often sufficient to protect against high currents induced by faults.
- Multiple sources in microgrids complicate protection.
  - Fault currents will depend on the locations of the sources.
  - Require more sophisticated overcurrent and differential protection schemes.



From: Kumm, Microgrid Protection Challenges

Conclusions

- Microgrids offer enhanced capabilities beyond those provided by UPS backup.
- Microgrids require more sophisticated control and protection than UPS.
  - Control and protection schemes are available.
- Cost/benefit analysis is (as always) vital!