

Control and Operation Considerations of Autonomous Microgrids

Abhimanyu Arora, Paula Geronimo, Marcos Ibanez, Damilola Owolabi,
Abel Martinez Ramirez, Ogbonnaya Bassey*, Karen L. Butler-Purpy**

Texas A&M University

* Team Leader, ** Faculty Mentor

ABSTRACT

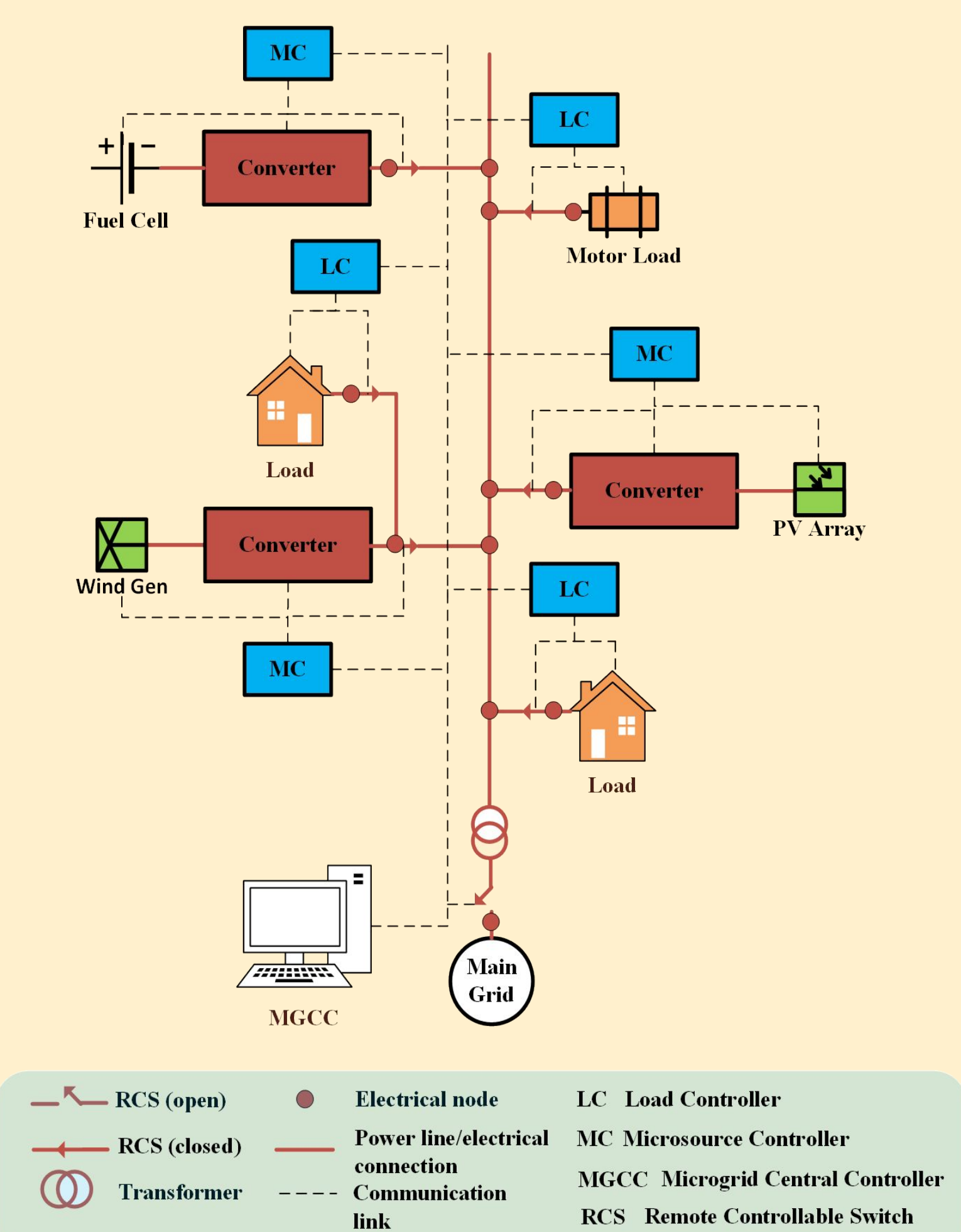
Power outages due to extreme weather conditions, cyber-attack, and occasional faults sometimes force sections of the electric power grid to operate in isolation to form autonomous microgrid. Advances in power electronics have enabled advanced control and integration of distributed generators to microgrids and distribution systems. The control and operation of the three-phase autonomous microgrid present variants of the challenges required for the operation of the main power grid. This project explores the state of art control and operation strategies of microgrids from literature, and identifies current challenges

MOTIVATION

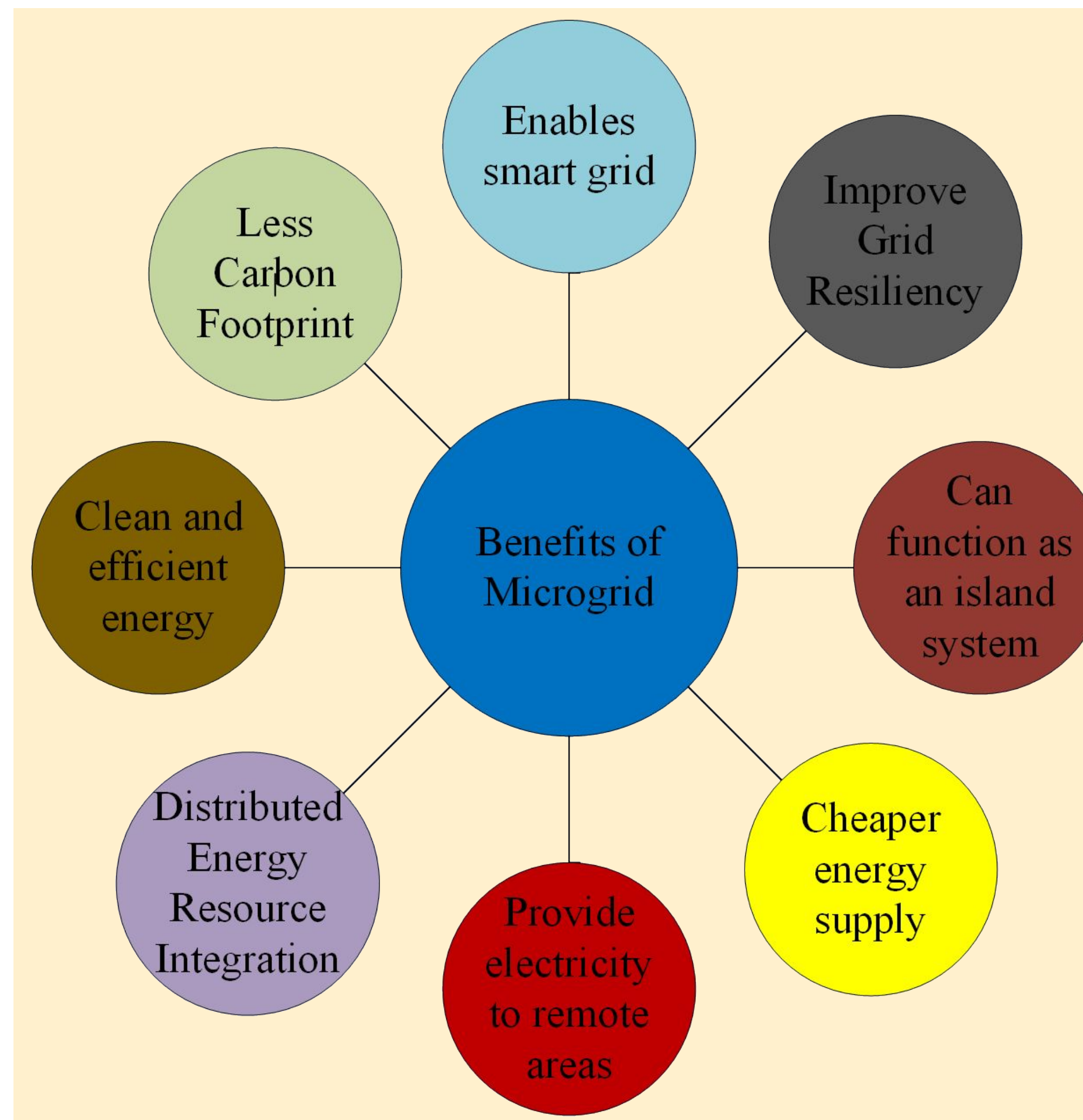
- In recent years the rising demand for cleaner energy, lower electricity costs, and higher energy efficiency has led to developments in distributed generation technologies
- The need for renewable energy sources has been steadily increasing, although using these sources leads to power balancing issues within the main grid
- In extreme weather areas the main grid may disconnect and lead to power outages, and cause the power grid to operate alone and form microgrids
- Microgrids are a great way to improve the efficiency coming from renewable energy sources to account for balancing issues, and control and operate these power grids. Their role of supplying power has usually been as a backup energy supply, but are on the rise to becoming a primary energy supply

THE MICROGRID CONCEPT

Microgrid is the interconnection of distributed energy resources and loads with central controller that intelligently coordinate its operation.



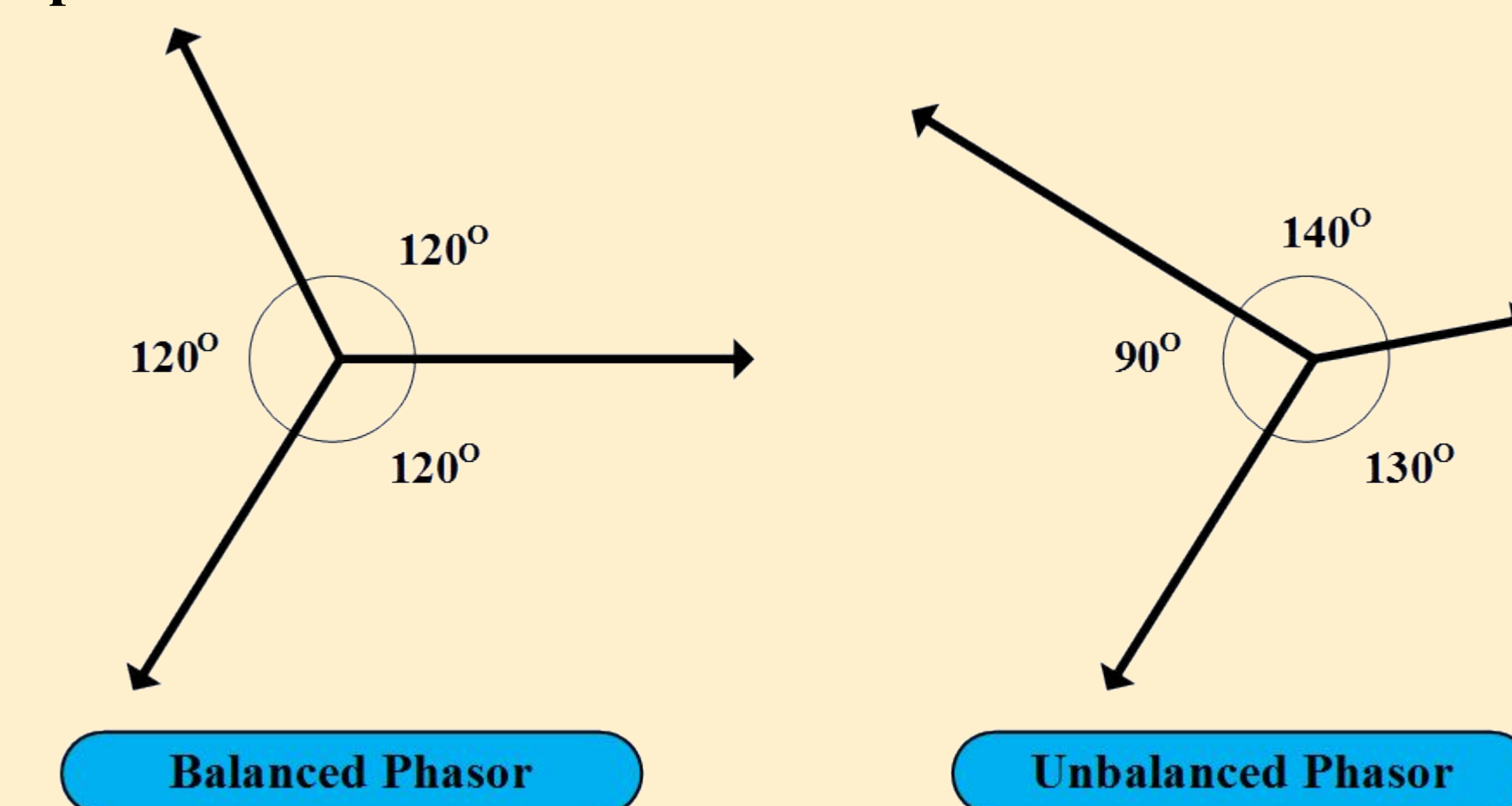
THE BENEFITS OF A MICROGRID



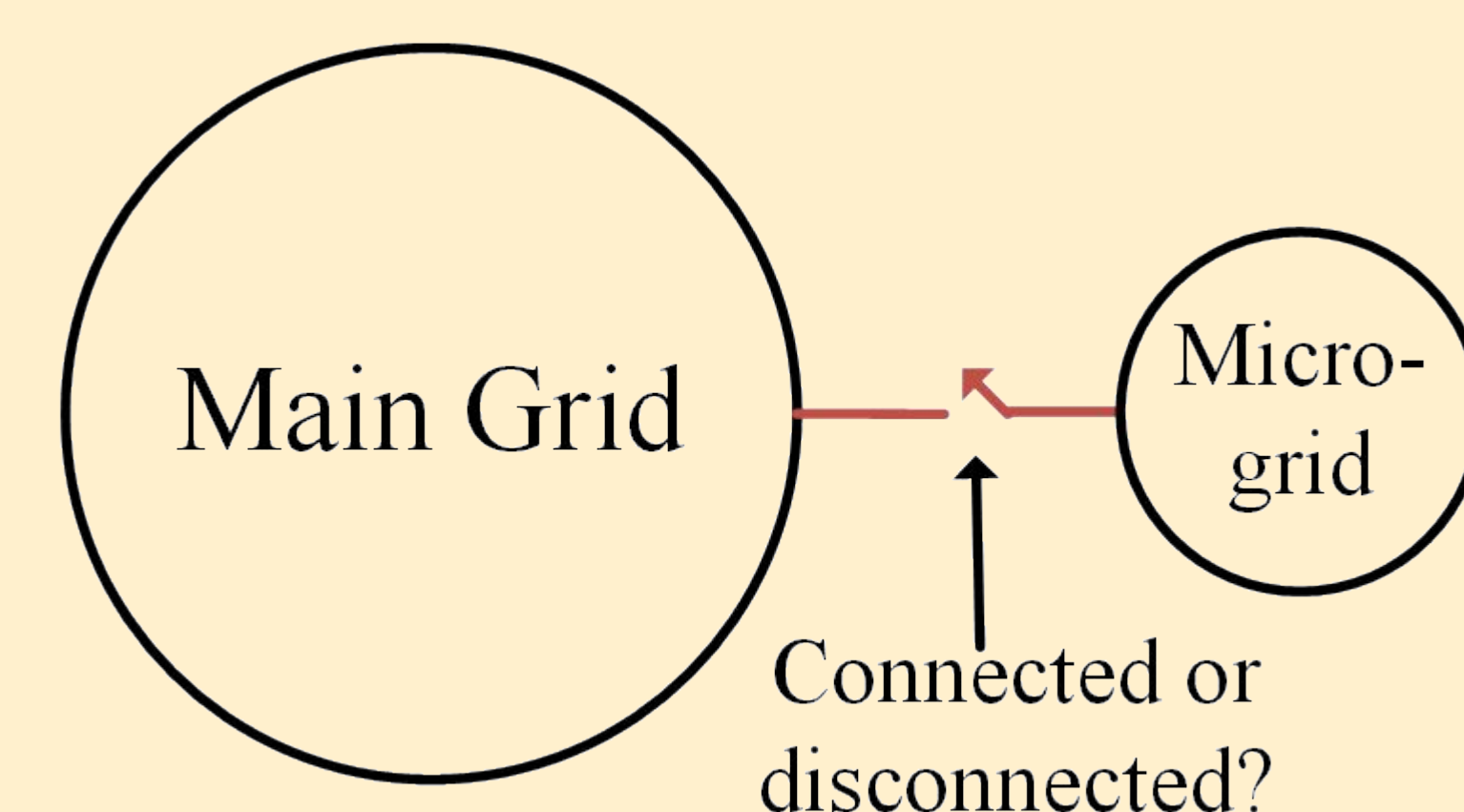
TECHNICAL CHALLENGES

Some of the technical challenges include

- Real-time load following and balancing
- High cost of storage systems
- System stability issues especially during island mode
- Microgrid protection is a lot more complicated than those of radial distribution system
- Maintaining load and voltage balance across the three phases

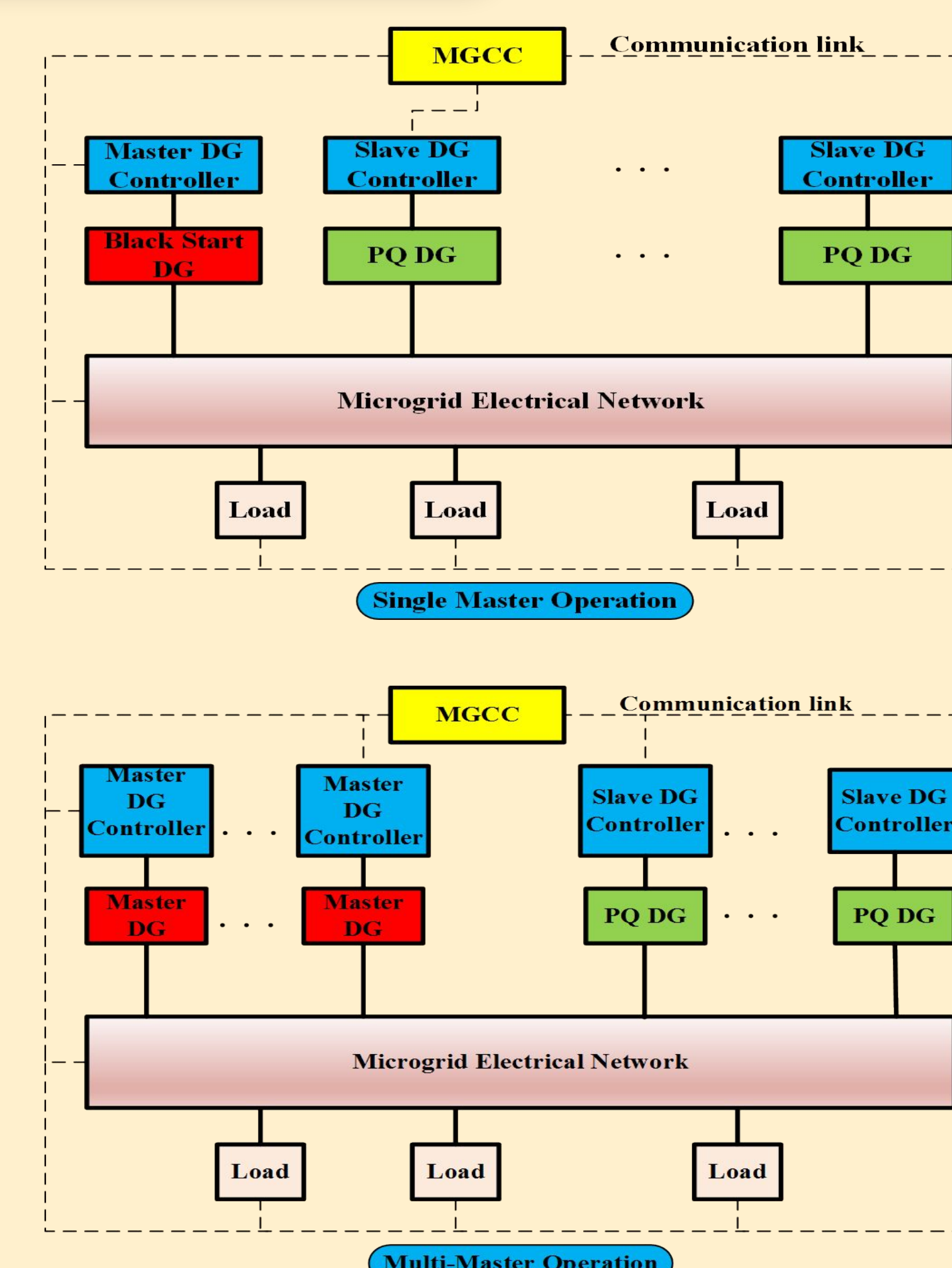


- Dual-Mode Operation



MICROGRID CONTROL PHILOSOPHY

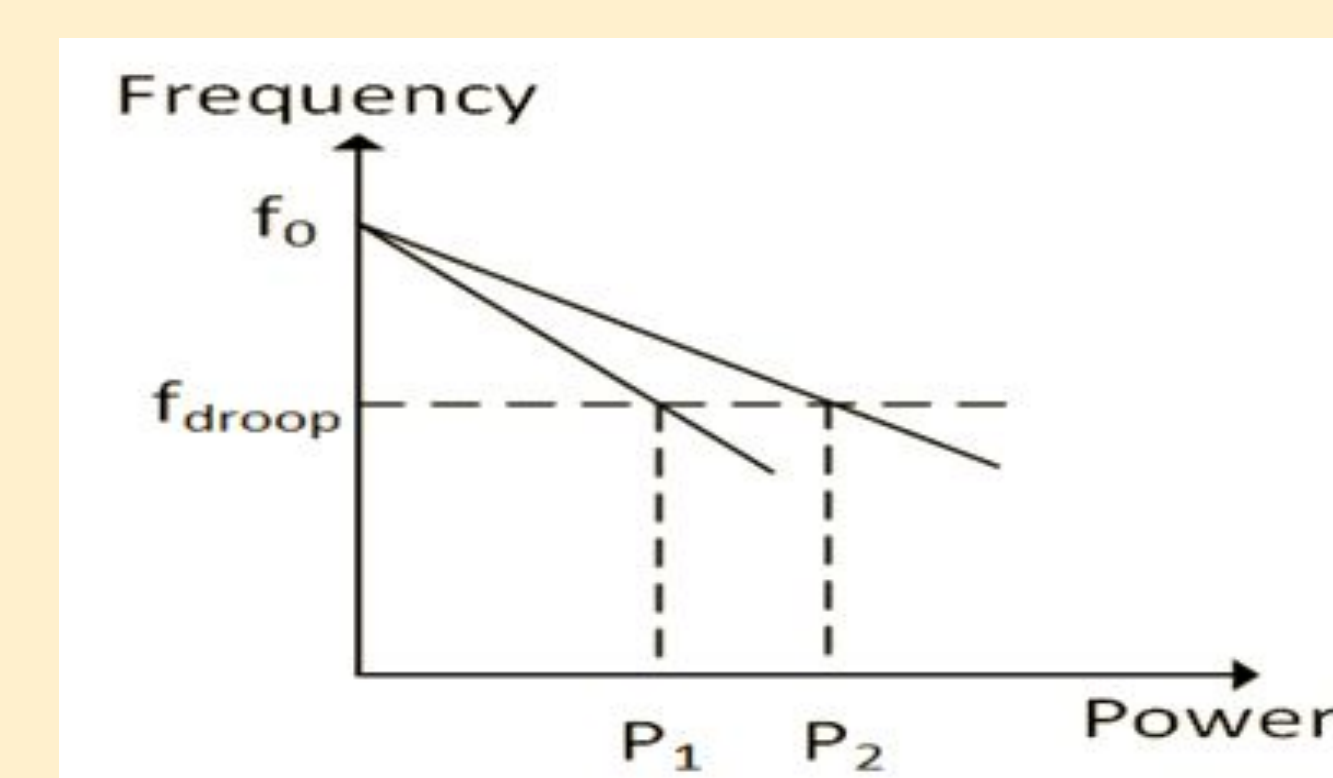
Control Strategy



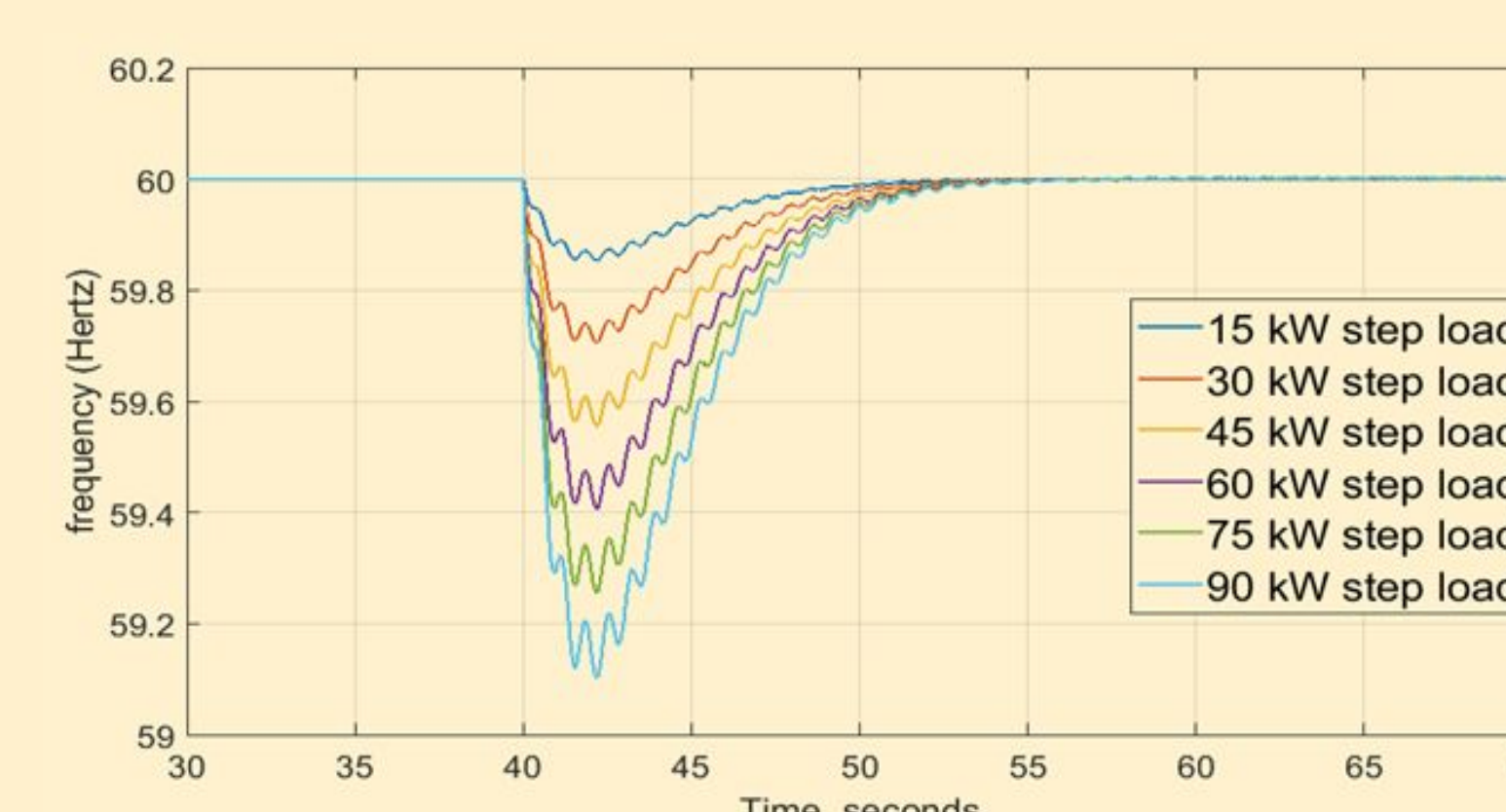
Frequency Control Method

Frequency control choice is important to ensure that the frequency does not deviate significantly from nominal value during each restoration sequence.

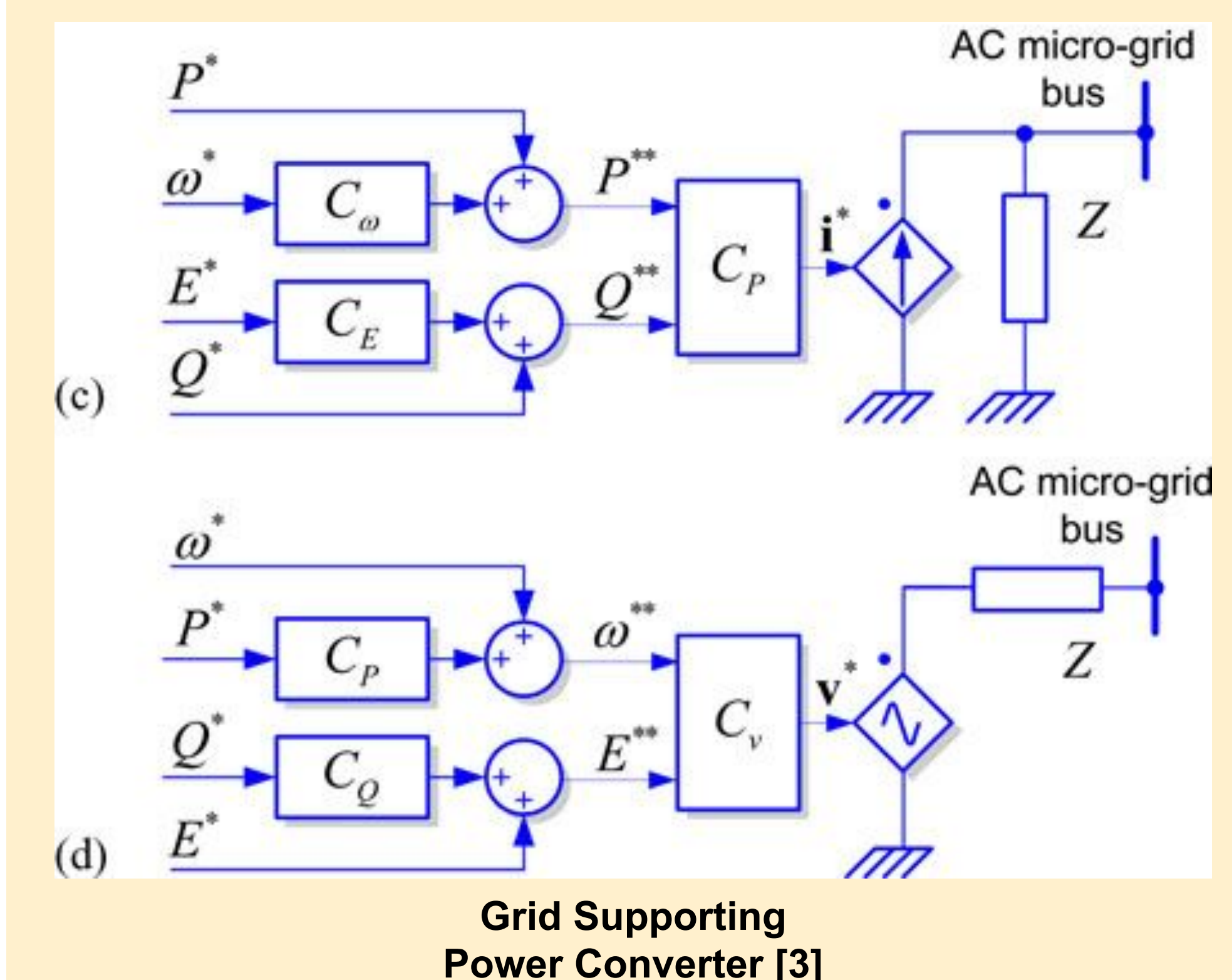
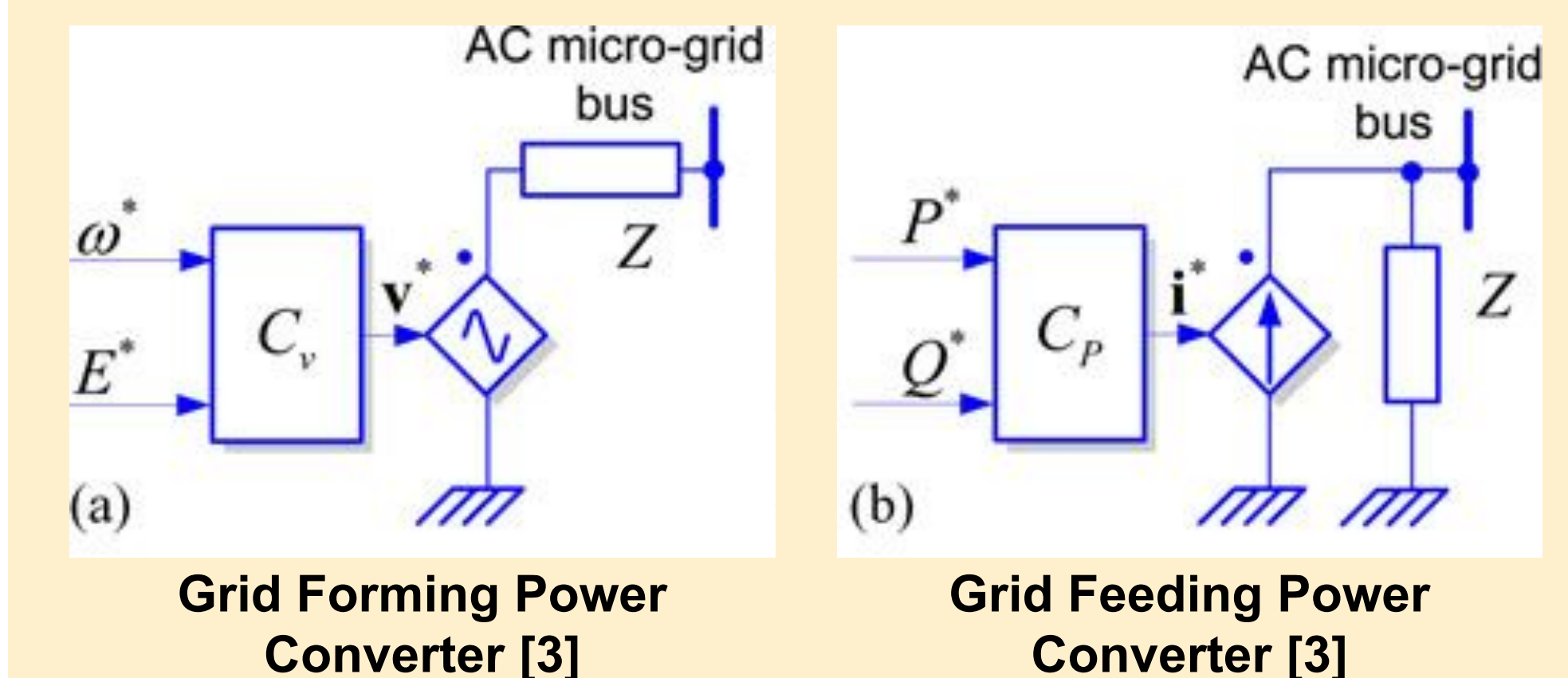
- Droop control method (multi-master approach)
 - Robust load sharing between master DGs
 - Frequency restoration to nominal dependent on additional control



- Isochronous method (single master approach)
 - One DG working in isochronous or grid forming mode integrates the frequency error to zero
 - May not be very reliable since failure of the grid forming DG means failure of system



INVERTER CONTROL MODES IN AC MICROGRIDS



CONCLUSIONS

We covered:

- The efficiency of renewable resources is increasing and microgrids are a great way to take advantage of it
- Although microgrids still have a few technical issues with switching modes, their roles are changing to becoming primary sources of energy
- The benefits provided by microgrids outweigh their cost to implement

KEY REFERENCES

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- [2] J. A. P. Lopes, C. L. Moreira and A. G. Madureira, "Defining control strategies for MicroGrids islanded operation," in *IEEE Transactions on Power Systems*, vol. 21, no. 2, pp. 916-924, May 2006. doi: 10.1109/TPWRS.2006.873018
- [3] J. Rocabert, A. Luna, F. Blaabjerg and P. Rodríguez, "Control of Power Converters in AC Microgrids," in *IEEE Transactions on Power Electronics*, vol. 27, no. 11, pp. 4734-4749, Nov. 2012.d oi: 10.1109/TPEL.2012.2199334