A Survey of Techniques Used to Control Microgrid Generation and Storage during Island Operation

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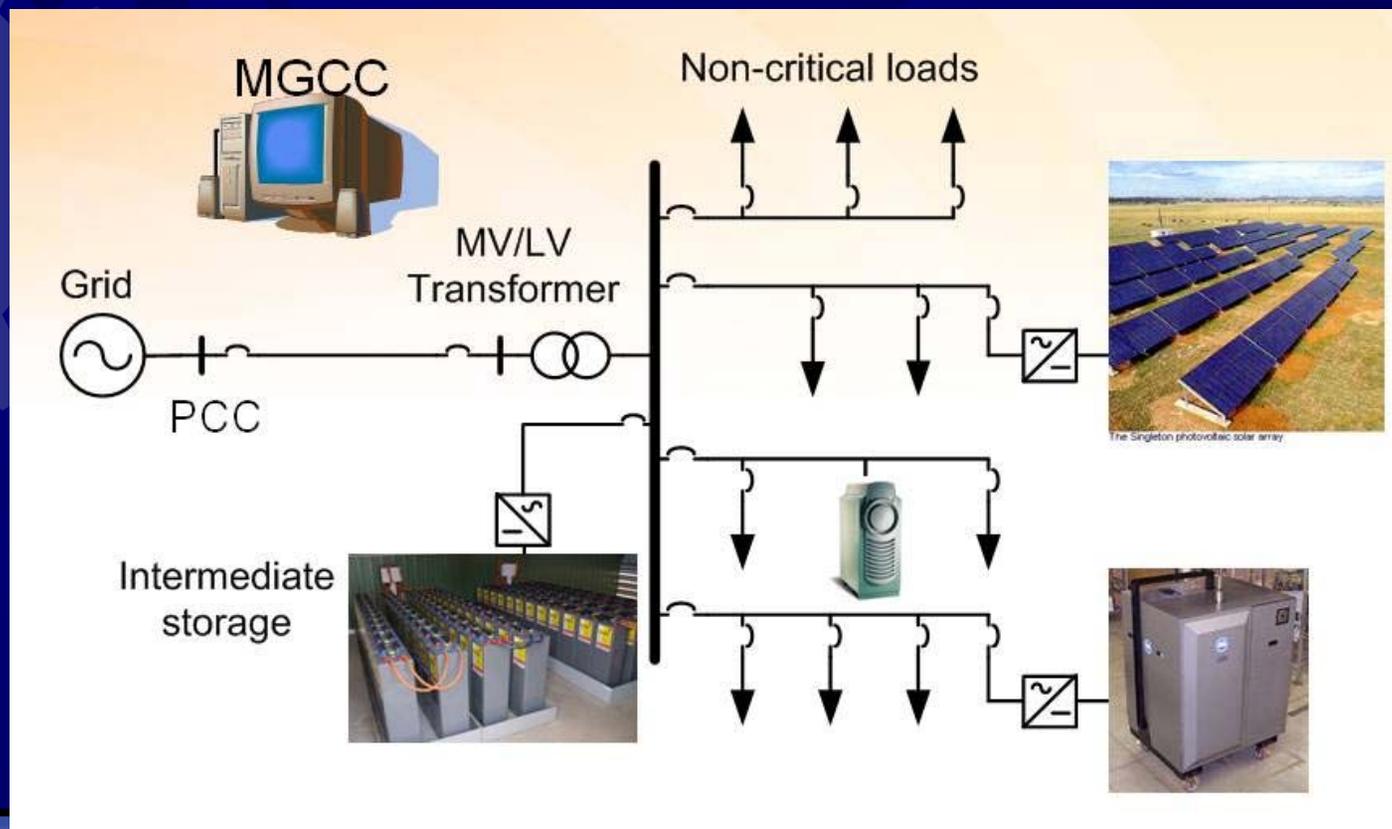Presented by: Saad Sayeef

AUPEC 2006

1

Presentation Outline

- Introduction

- Island operation of microgrids

- Co-operation strategies of generators and storage devices
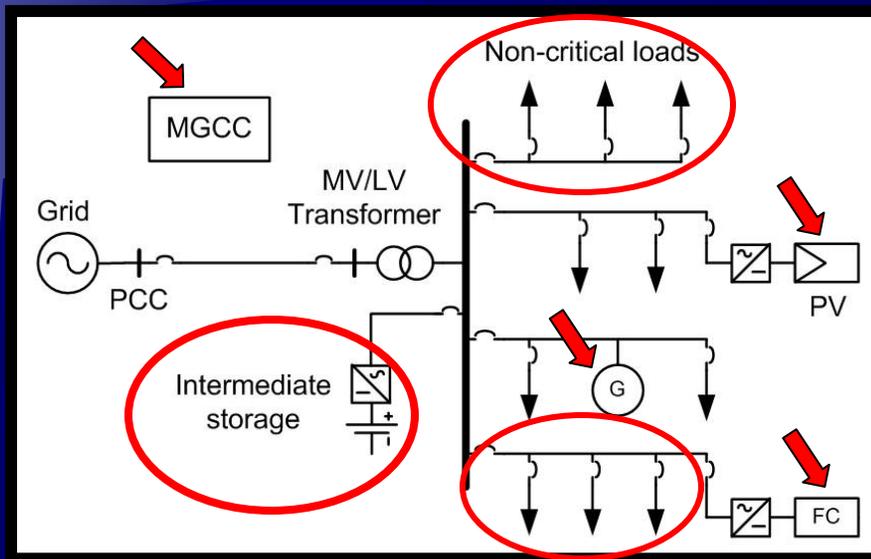
- Comparison of co-operation strategies

- Conclusion

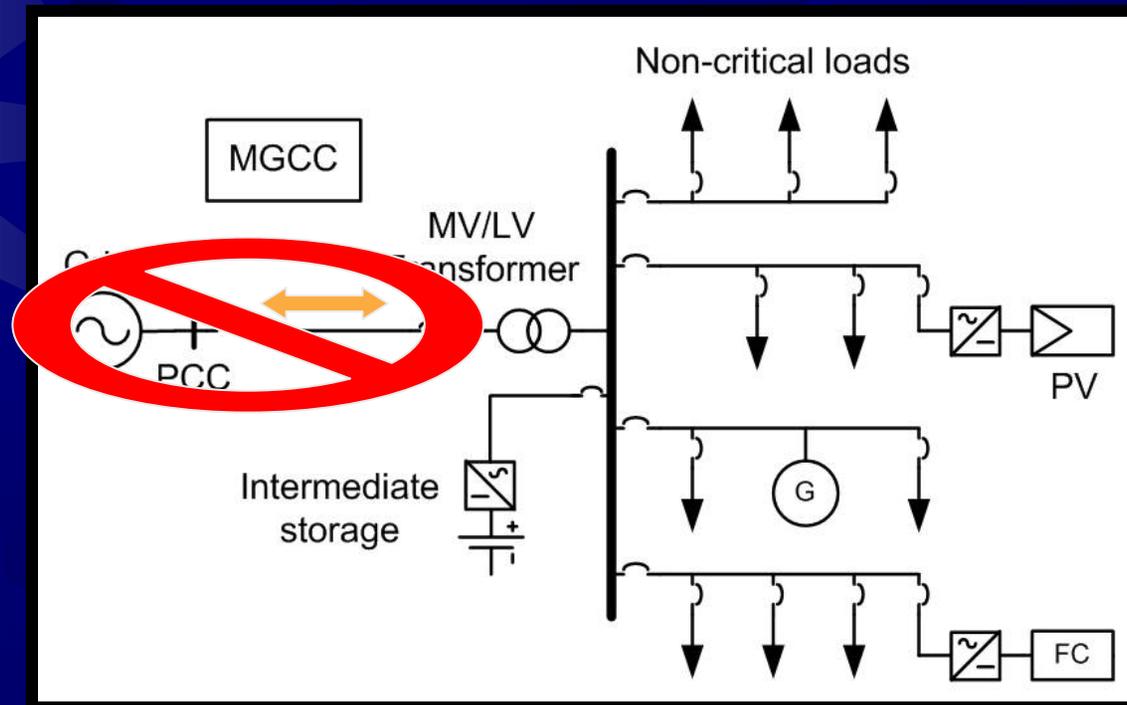# Introduction

★ What is a microgrid?

Microgrid Components

- Distributed generation (microsources)
- Loads

- Intermediate storage
- Controller (MGCC)
- Point of common coupling

Microgrid Operation

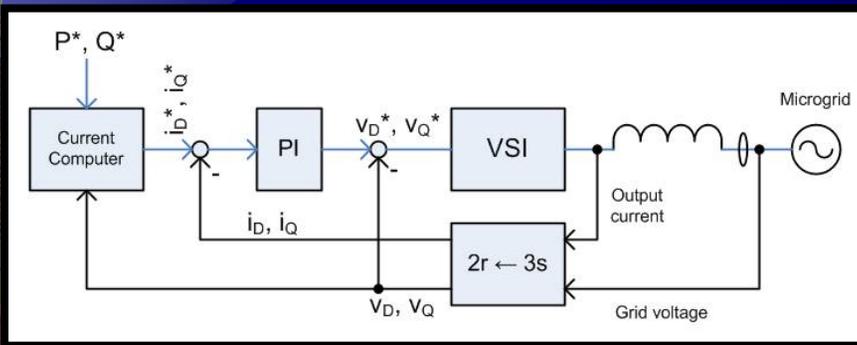- **Grid Connected**
- **Island Mode**

Island Operation of Microgrids

* Voltage and frequency management
* Balance between supply and demand
* Power quality
* Microsource issues
* Communication among microgrid components

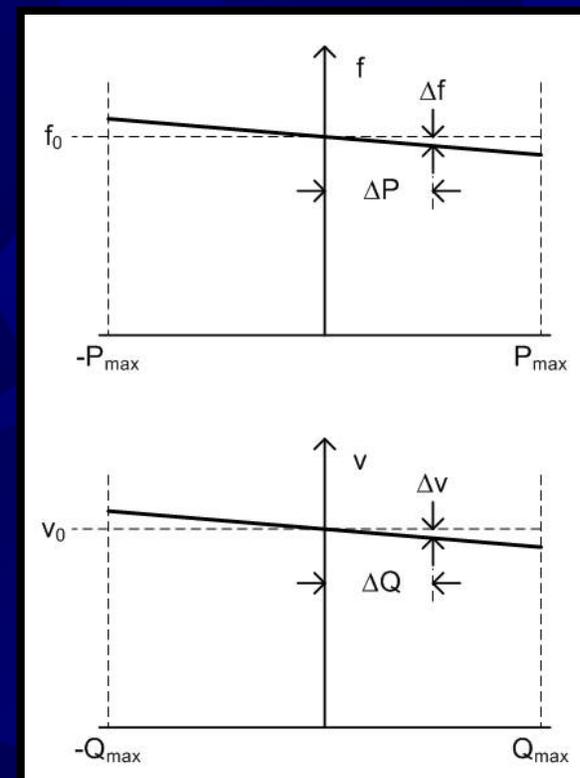School of Electrical Engineering and Telecommunications

Co-operation Strategies

- Pure droop control

- Inverter modes control

- Primary energy source control

- Reverse droop control

- Autonomous control

- Agent-based PQ control

Output Power Control of Microsources

☀ PQ Control

☀ Droop Control

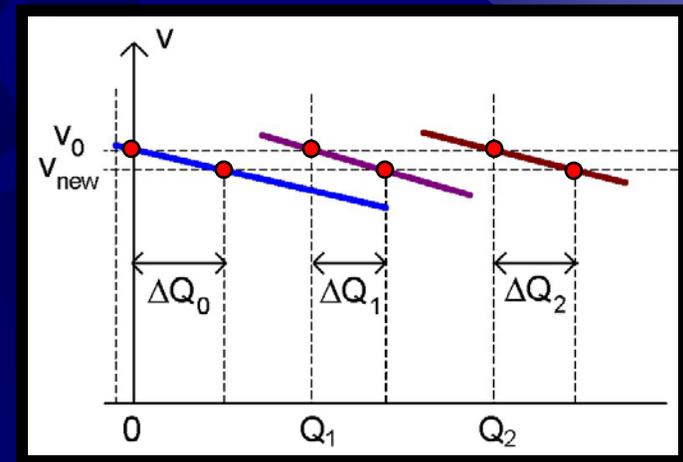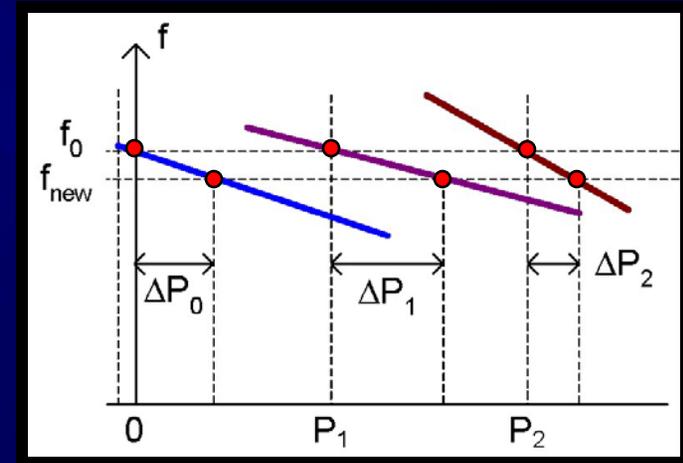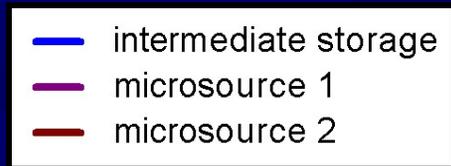# Pure Droop Control

- ☀ **Grid-connected**
  - ✸ v_0 and p_0
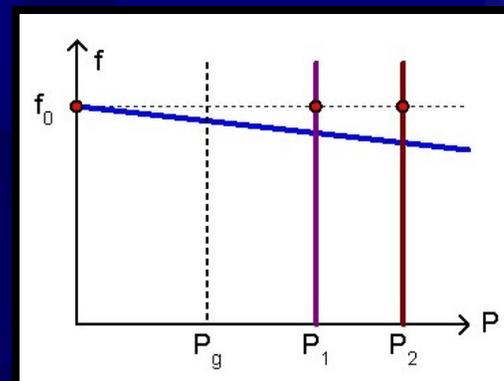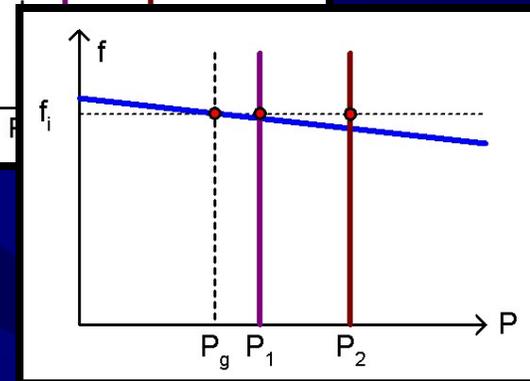 - ✸ Importing P_g and Q_g
- ☀ **Island operation**
  - ✸ v_{new} and p_{new}
  - ✸ $P_g = \Delta P_0 + \Delta P_1 + \Delta P_2$
  - ✸ $Q_g = \Delta Q_0 + \Delta Q_1 + \Delta Q_2$

— intermediate storage
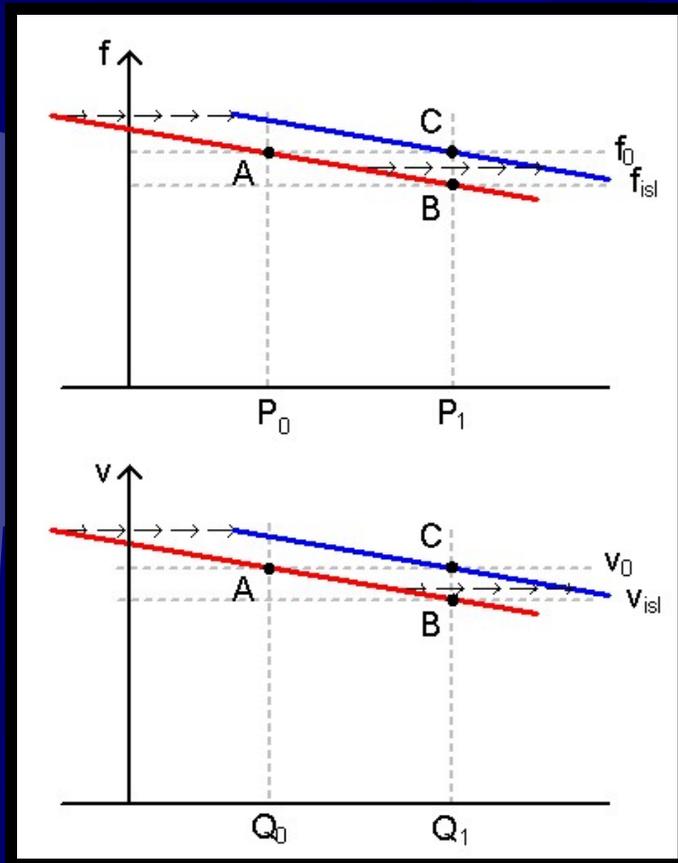— microsource 1
— microsource 2

Inverter Modes Control

★ **Master microsource**

  ● Shifts to droop control

  ● Sets microgrid frequency and voltage

★ **Slave microsource**

  ● Remains in PQ control

★ **Single master operation**
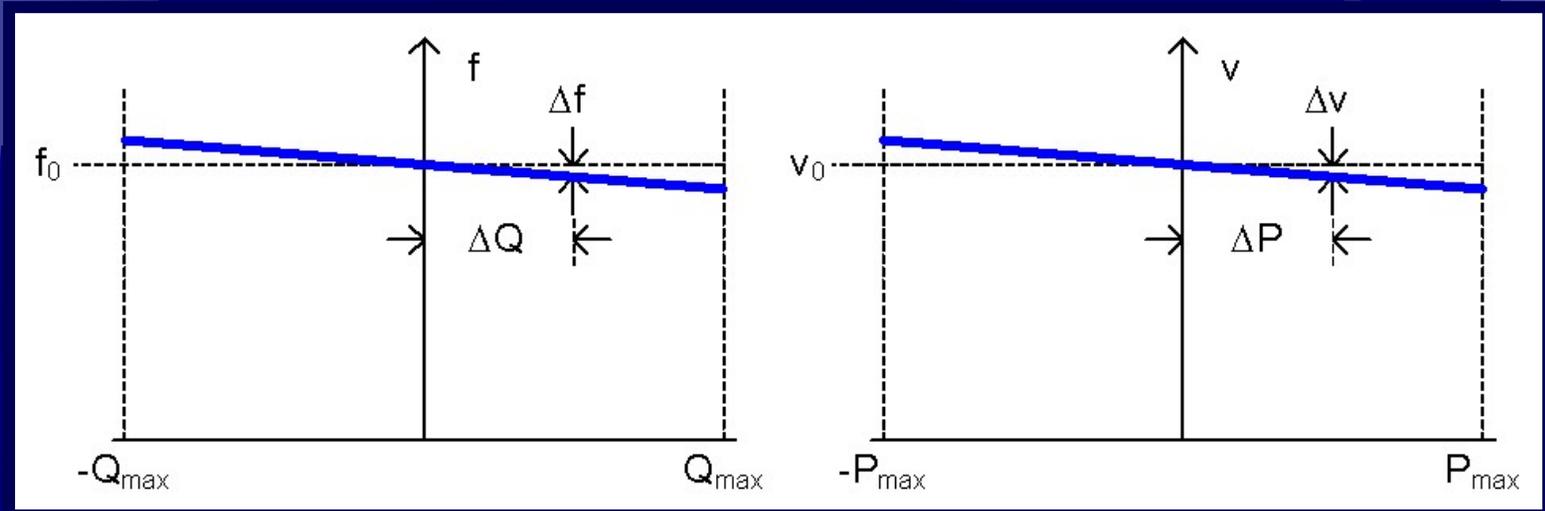
★ **Multi-master operation**
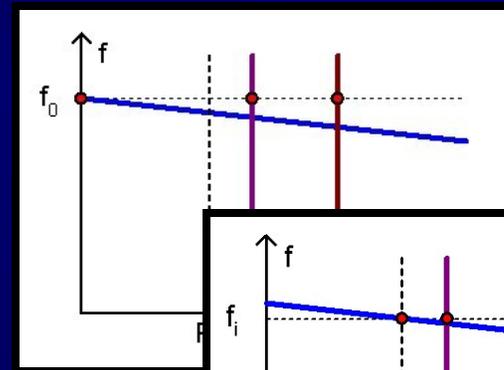
Primary Energy Source Control

- ☀ All microsources and storage are in droop control

- ☀ The droop characteristics of the microsources shift to restore frequency and voltage to pre-island values

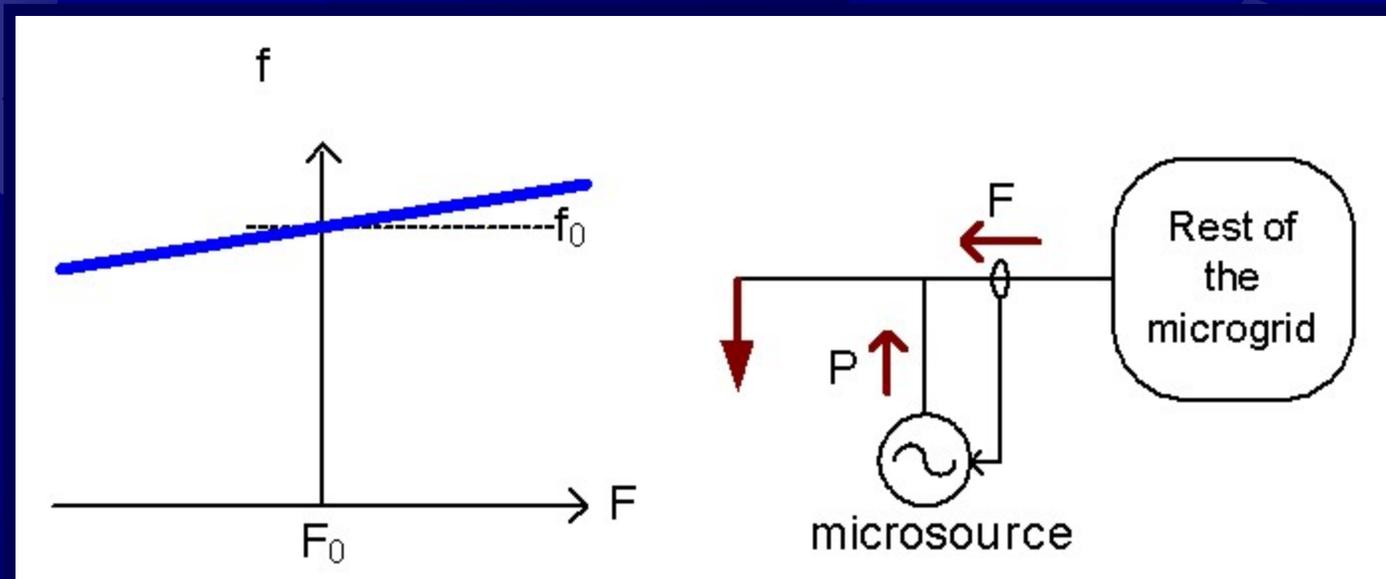# Reverse Droop Control

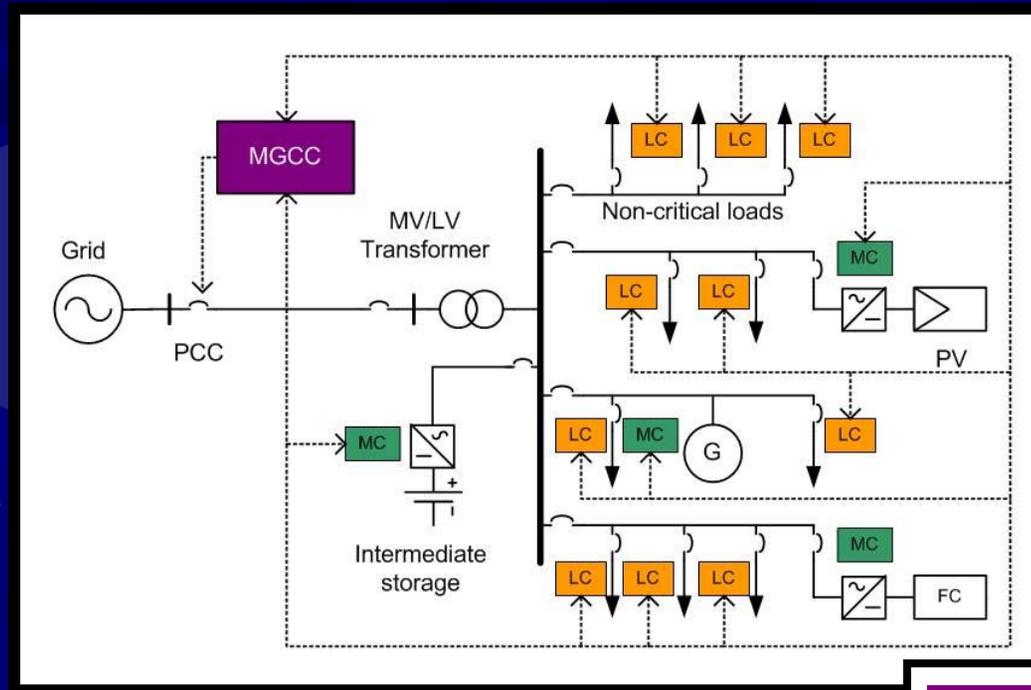* Bus voltage is controlled by the real power flow while the frequency is controlled by the reactive power

Autonomous Control

- Unit power flow configuration
  - Similar to pure droop control
- Feeder flow configuration

Agent-Based PQ Control

MGCC	Microgrid controller agent
LC	Load agent
MC	Microsource/storage agent

Comparison of Co-operation Strategies

- ☀ **Voltage and frequency variation**
  - ✸ High for pure droop, reverse droop and autonomous control
  - ✸ Low for inverters mode, primary energy source and agent-based control

- ☀ **Intermediate storage capacity**
  - ✸ Small for inverter modes and agent-based control
  - ✸ Large for pure droop, reverse droop and primary energy source control

Comparison of Co-operation Strategies

- **Communication infrastructure**
  - Not required except for agent-based control

- **Intermittent sources**
  - Inverter modes and agent-based control if installed storage capacity is small

- Pure droop and reverse droop control if installed storage capacity is large
- Used feeder flow configuration is autonomous control is used

Comparison of Co-operation Strategies

- Ownership of microgrid generators and storage
  - All approaches if uGrid is normally importing power
  - Agent-based and autonomous control of uGrid is normally exporting power

Conclusion

* Six co-operation approaches are presented
* Compared with respect to
  * Power quality and stability
  * Required storage capacity
  * Required communication infrastructure
  * Performance with intermittent sources
  * Microgrid ownership

End

Thank you.