



# SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE-35

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**DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING**

UNIT 4

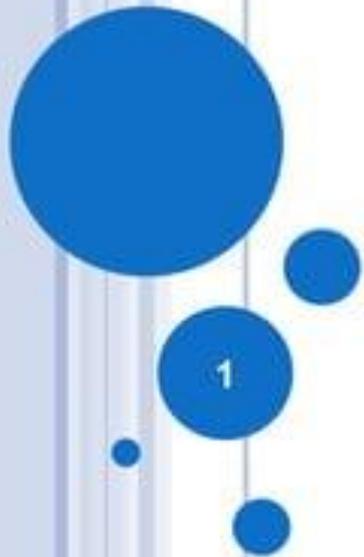
## SMART GRID TECHNOLOGIES – Power Quality Conditioners for SG

19EEE308 – SMART GRIDS  
III year / VI Semester



01/08

# POWER QUALITY CONDITIONERS FOR SMART GRID



## POWER QUALITY

- The quality of electrical power supply is a set of parameters which describe the process of electric power delivery to the user under normal operating conditions, determine the continuity of supply (short and long supply interruptions) and characterize the supply voltage (magnitude, asymmetry, frequency, and waveform shape).
- Power quality phenomena can be divided into two types :-
  - A characteristic of voltage or current (e.g., frequency or power factor) is never exactly equal to its nominal and desired value. The small deviations are called voltage variations or current variations.
  - When the voltage or current deviates significantly from its normal or ideal wave shape. These sudden deviations are called events. Power quality events are the phenomena which can lead to tripping of equipment, to interruption of the production or of plant operation, or endanger power system operation. This includes interruptions, under voltages, overvoltage, phase angle jumps and three phase unbalance.

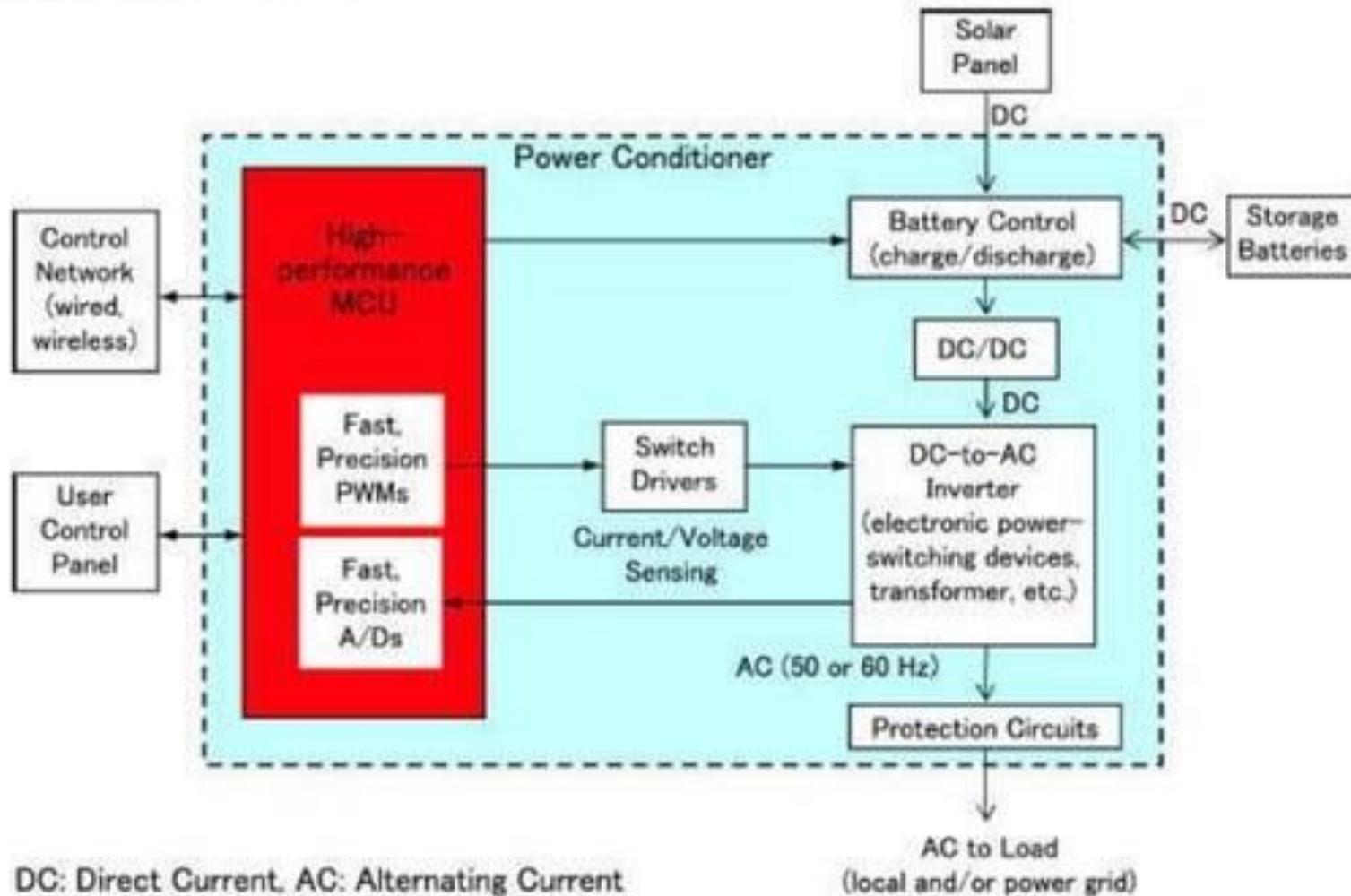
## POWER QUALITY CONDITIONERS

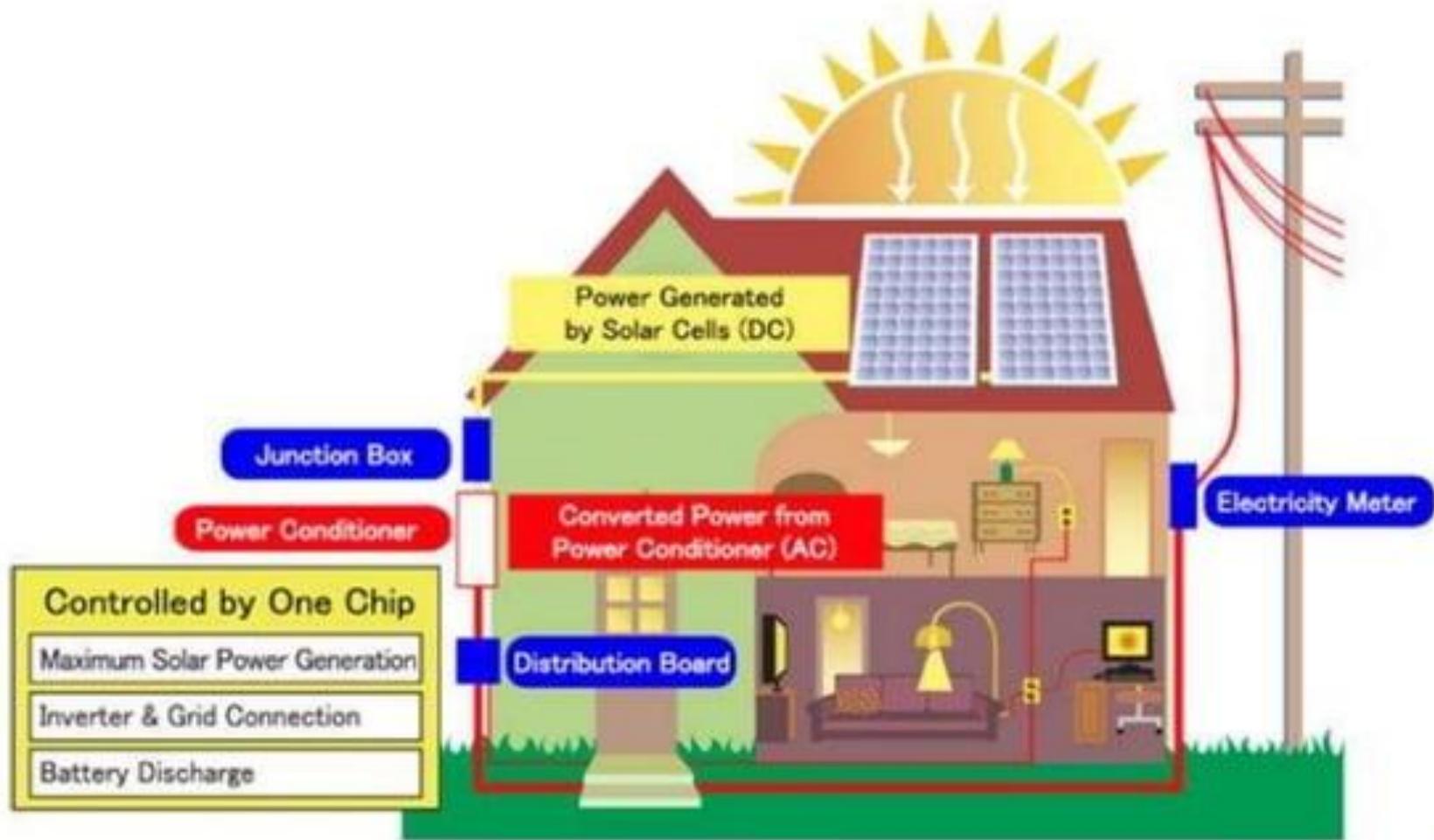
A power conditioner (also known as a line conditioner or power line conditioner) is a device intended to improve the quality of power that is delivered to electrical load equipment.

In a smart grid the role of a power quality conditioner is to:-

- Deliver voltage & current of the proper level and characteristics to enable load equipment to function properly.
- Ensure efficient power transfer between utility grid & micro grid.
- Isolate each micro grid and the utility grid from there respective noises and disturbances.
- Energy creation i.e. to convert DC power generated by Solar panels to AC.
- Integration with energy storage system.

# BLOCK DIAGRAM





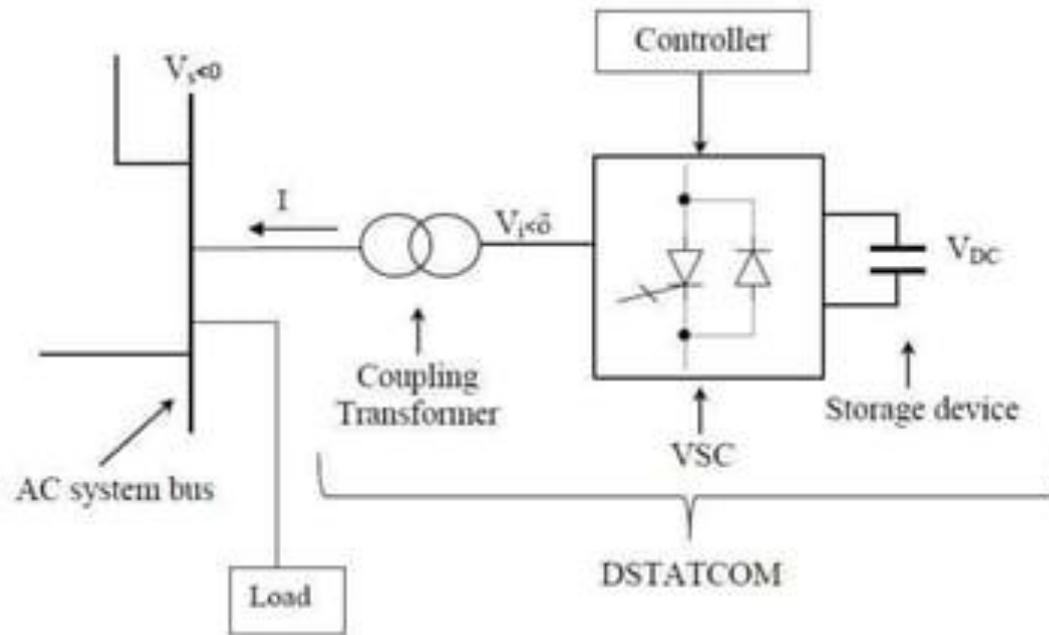
## TYPES OF POWER QUALITY CONDITIONERS

- Distribution Static Compensator (DSTATCOM)
- Active power filters
  - Shunt active power filters
  - Series active power filters
  - Hybrid Active Power Filters
- Unified Power Quality conditioner (UPQC)

## DISTRIBUTION STATIC COMPENSATOR (DSTATCOM)

- The DSTATCOM is a custom power device based on a voltage Source Converter (VSC) shunt connected to the distribution networks.
- A DSTATCOM is normally used to precisely regulate system voltage, improve voltage profile, reduce voltage harmonics and for load compensation.
- D-STATCOM can also mitigate voltage dips and can compensate both magnitude and phase angle by injecting reactive or reactive power to the point of connection with the grid.
- The VSC connected in shunt with the ac system provides a multifunctional topology which can be used for up to three quite distinct purposes: voltage regulation and compensation of reactive power, correction of power factor, and elimination of current harmonics.

## BLOCK DIAGRAM

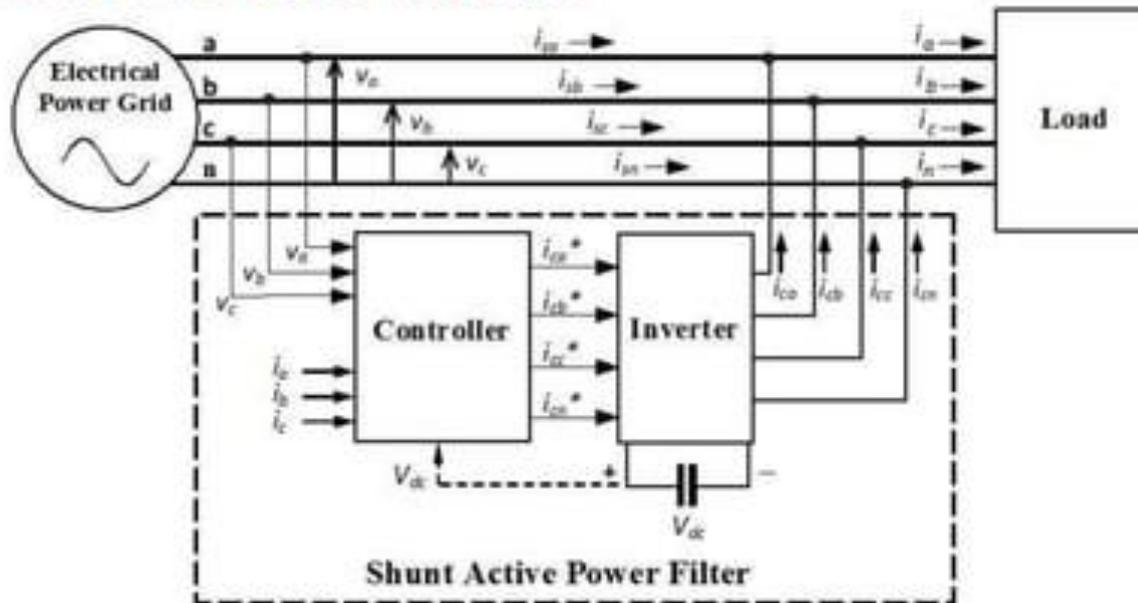


The VSC converts the dc voltage across the storage device into a set of three-phase ac output voltages. These voltages are in phase and coupled with the ac system through the coupling transformer. Such configuration allows the device to absorb or generate controllable active and reactive power.

## ACTIVE POWER FILTERS

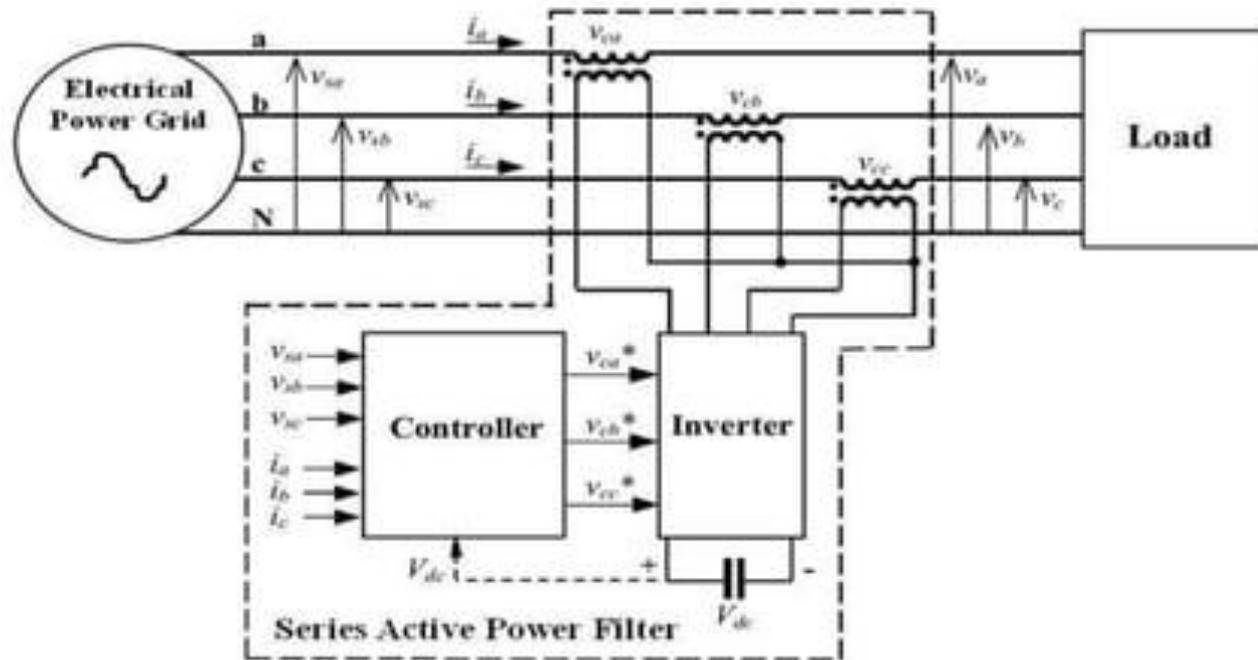
- Active power filter technology has evolved in the past quarter century with varying configurations and control topologies as a full fledged technique for providing compensation for reactive power, harmonics and neutral current in ac networks. Active filters are also used to terminate the voltage harmonics, to regulate terminal voltage, to inhibit voltage flicker and to advance voltage balance in 3- phase systems.
- Generally there are three configurations in which they are connected in power system :-
  - ✓ Shunt active power filters
  - ✓ Series active power filters
  - ✓ Hybrid Active Power Filters

# SHUNT ACTIVE POWER FILTERS



- ✓ It compensate current harmonics by injecting equal-but-opposite harmonic compensating current.
- ✓ It operates as a current source injecting the harmonic components generated by the load but phase shifted by 180deg.
- ✓ They are usually connected across the load to compensate for all current related problem such as reactive power compensation, power factor correction, current harmonics and load unbalance compensation.

## SERIES ACTIVE POWER FILTERS



- It compensates current system distortion caused by non-linear loads.
- The high impedance imposed by the series APF is created by generating a voltage of the same frequency as that of the harmonic component that needs to be eliminated.
- It acts as a controlled voltage source and can compensate all voltage-related problems such as voltage harmonics, voltage sags & swells, voltage flicker, etc.

# HYBRID ACTIVE POWER FILTERS

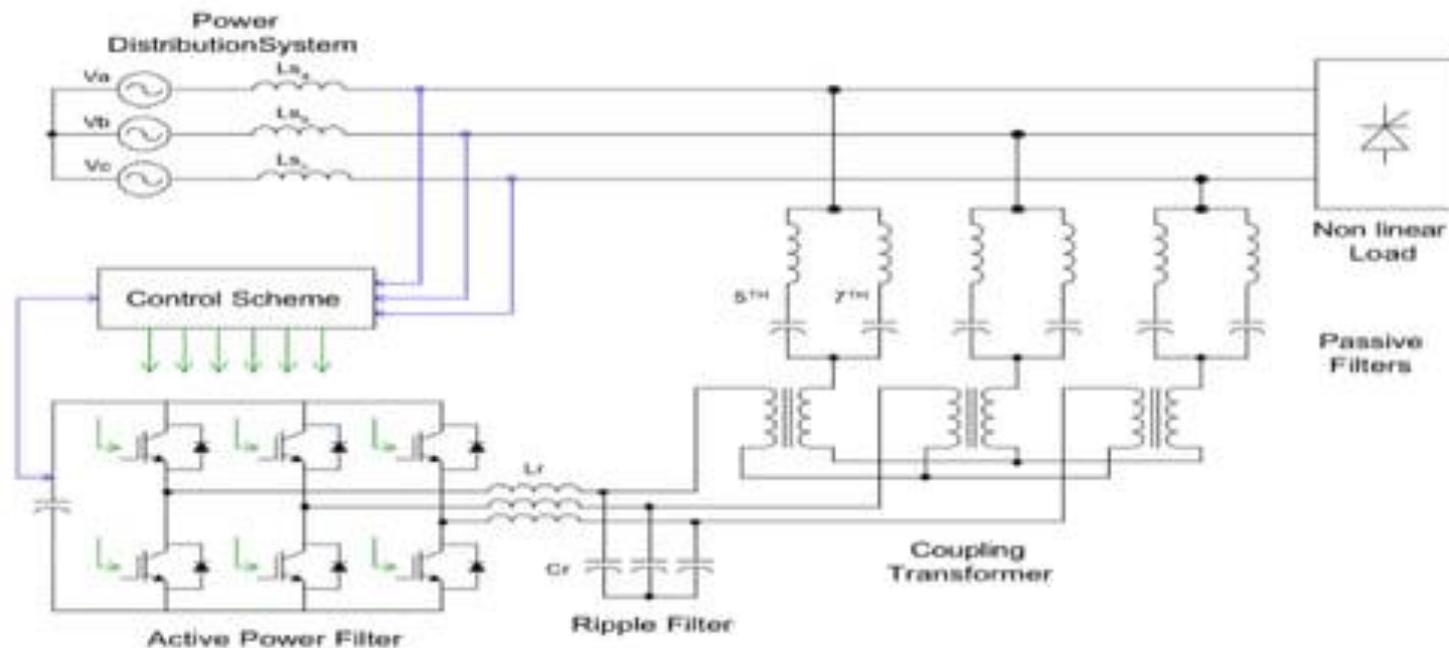
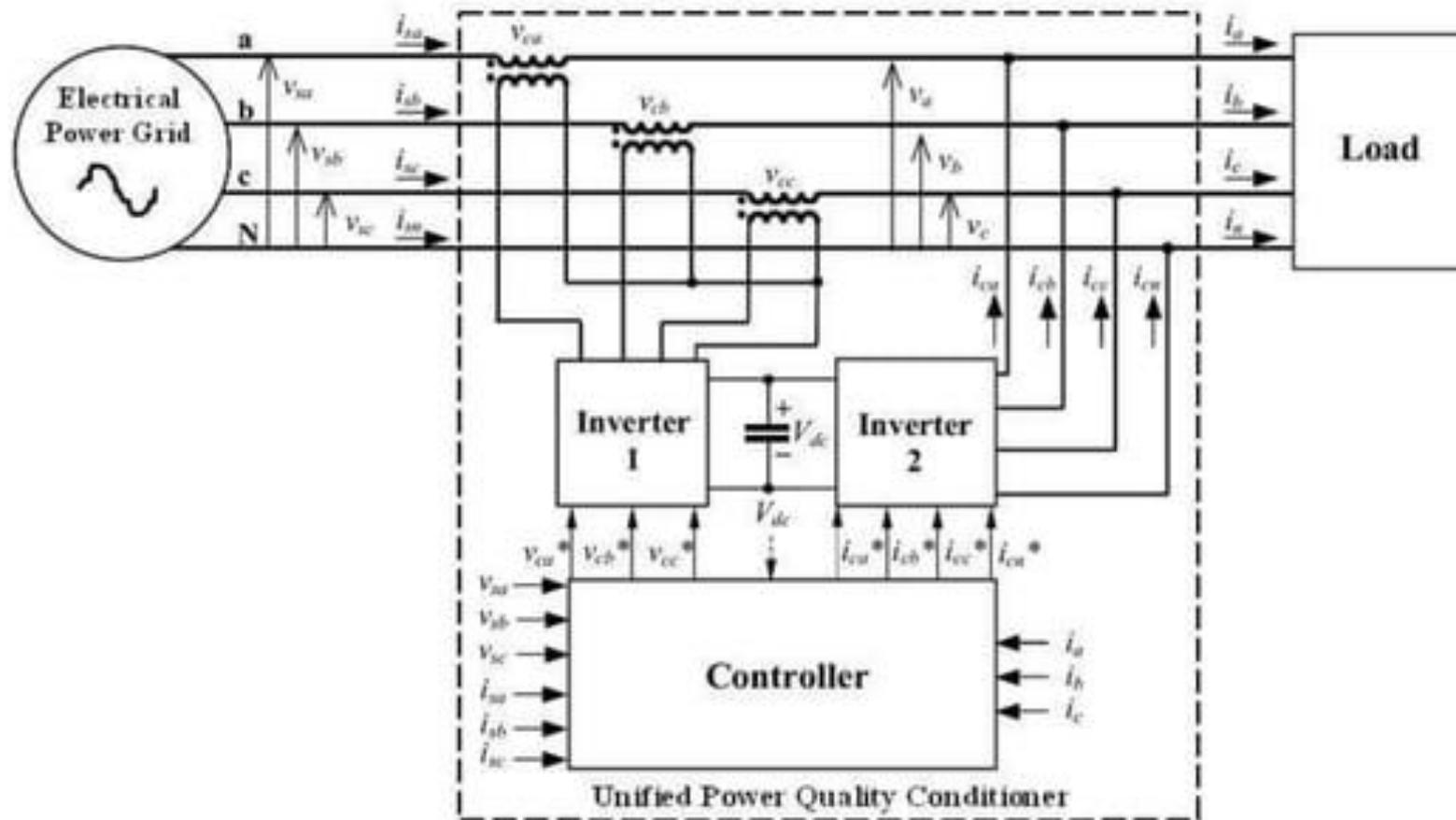


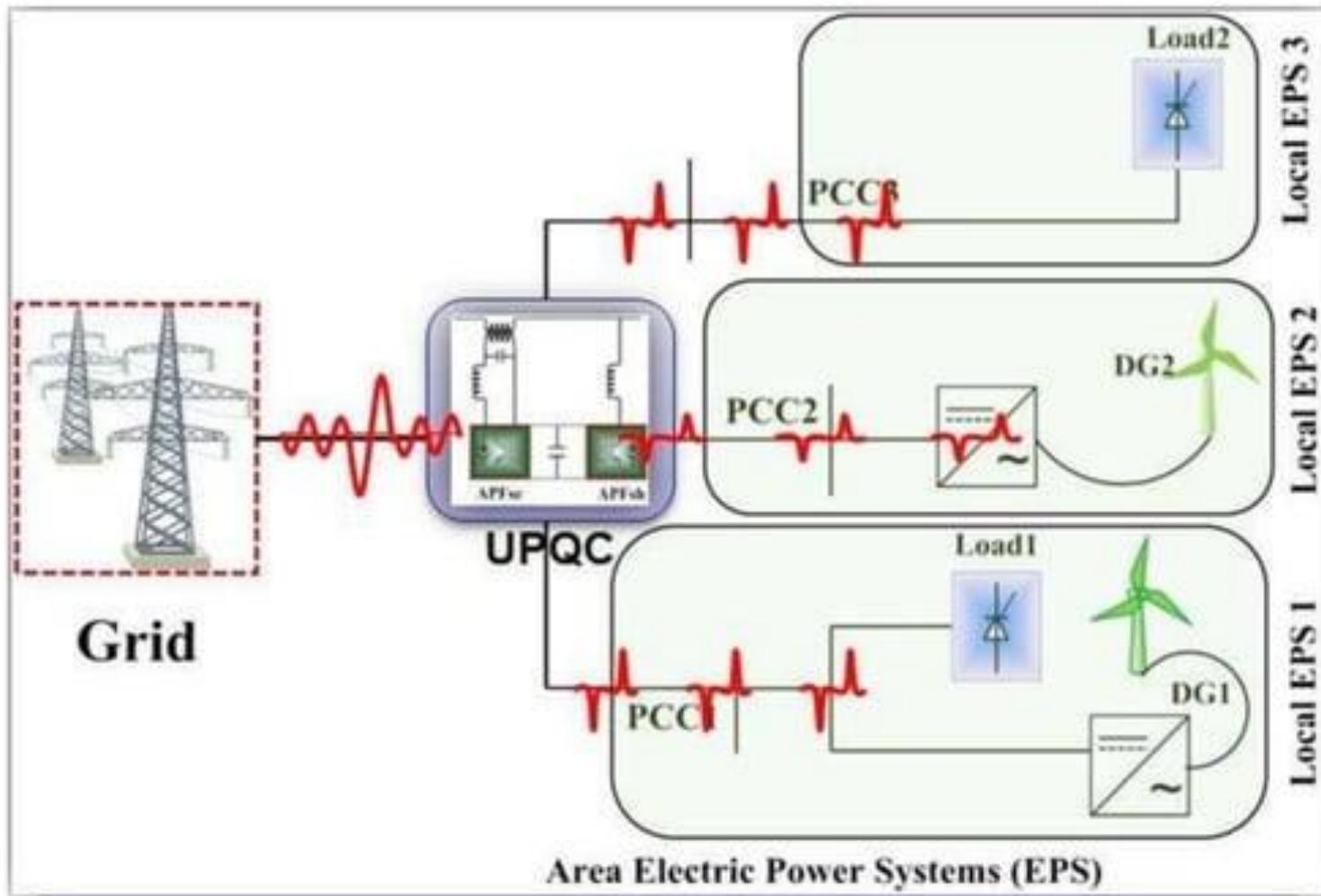
Fig. Hybrid Active power filter

- By controlling the amplitude of the voltage fundamental component across the coupling transformer, the PF of the power distribution system can be adjusted.
- The control of the load power factor imposed a higher voltage across the filter capacitor.
- This type of configuration is very convenient for compensation of high power medium voltage non linear loads

# UNIFIED POWER QUALITY CONDITIONER (UPQC)



- The Unified Power Quality Conditioner (UPQC) combines the Shunt Active Power Filter with the Series Active Power Filter, sharing the same DC Link, in order to compensate both voltages and currents, so that the load voltages become sinusoidal and at nominal value, and the source currents become sinusoidal and in phase with the source voltages.
- UPQC can compensate both voltage related problems such as voltage harmonics, voltage sags/swells, voltage flicker as well as current related problems like reactive power compensation, power factor correction, current harmonics and load unbalance compensation.
- There is a significant increase in interest for using UPQC in distributed generation associated with smart grids because of availability of high frequency switching devices and advanced fast computing devices (microcontrollers, DSP, FPGA) at lower cost.



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**THANK YOU**