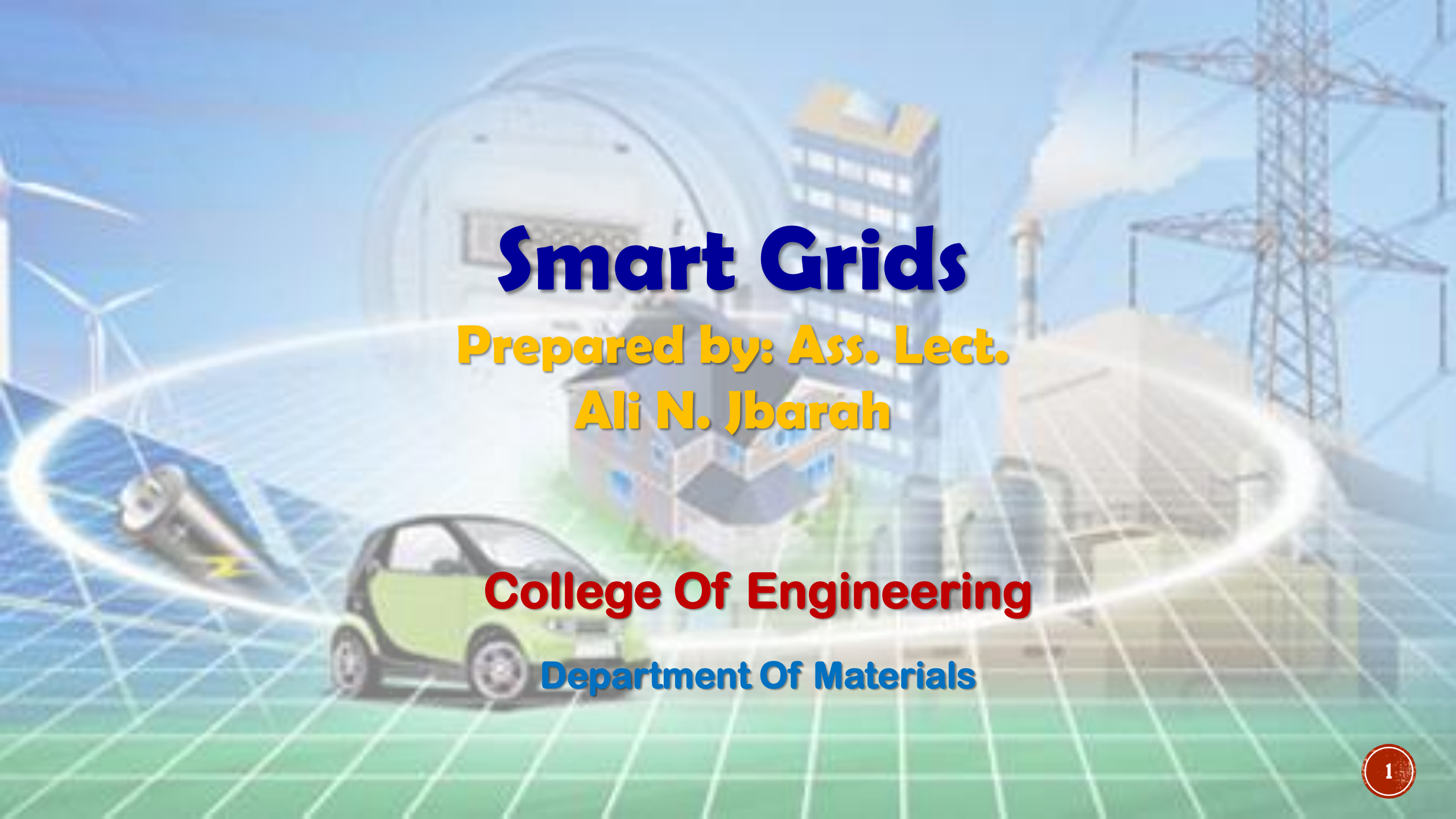


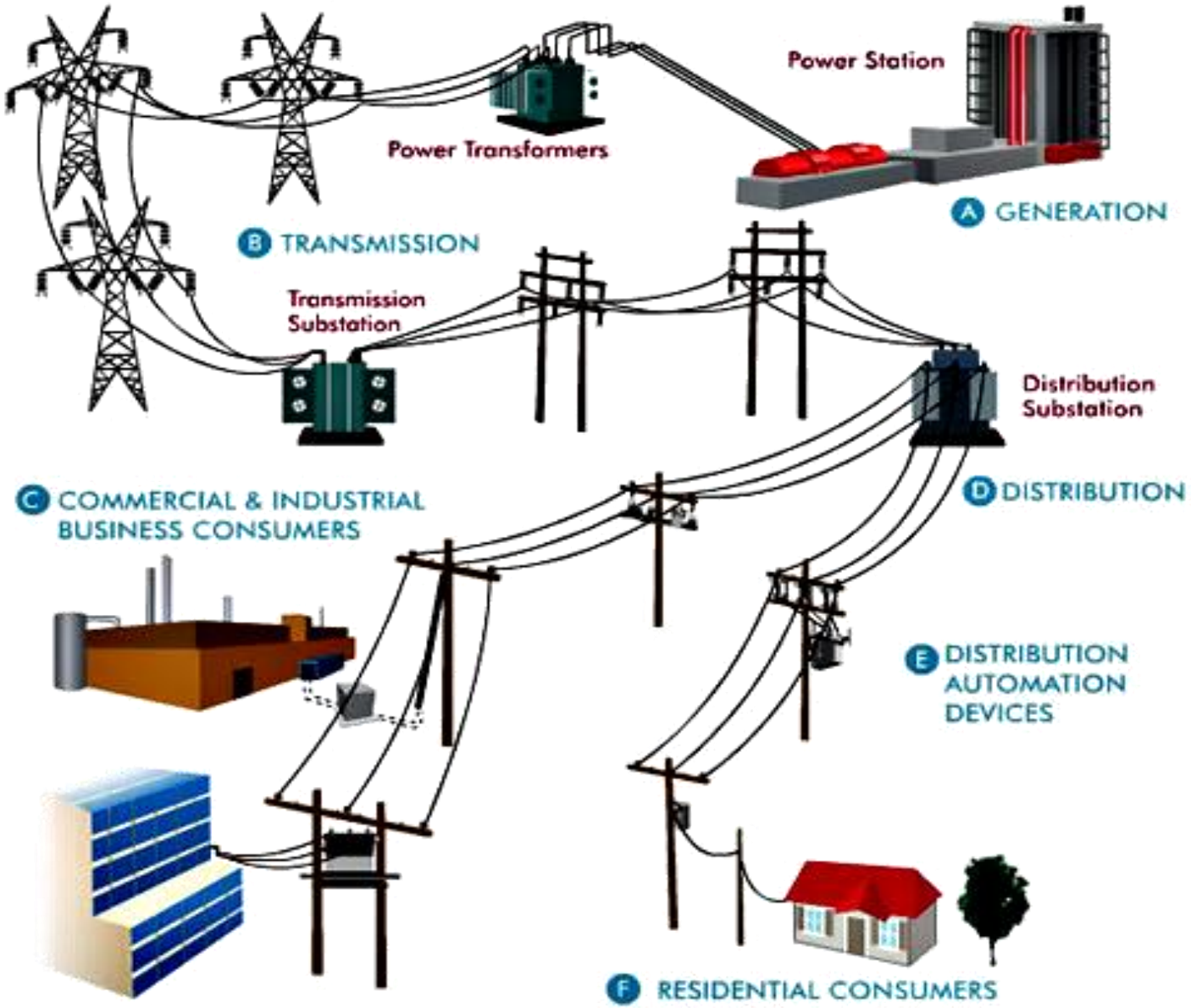
Smart Grids

Prepared by: Ass. Lect.
Ali N. Jbarah

College Of Engineering

Department Of Materials

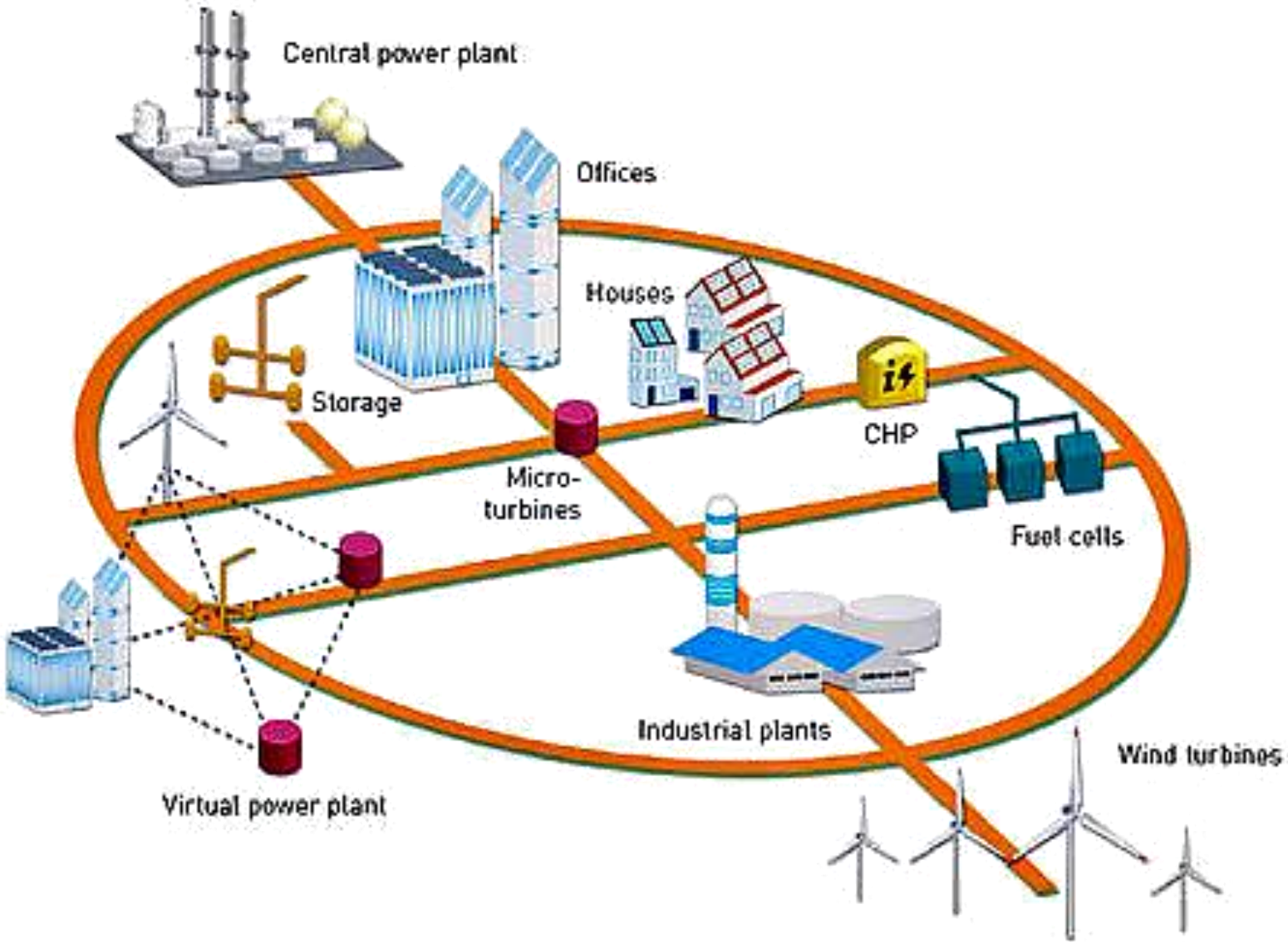
Electrical Grid



Electrical Grid

- Dependency on a high capacity fossil-fuel generators
- Increasing carbon emissions
- Getting a large amount of power in one place
- Using a long transmission lines to deliver power
- Not economic
- Has low reliability against sudden faults

Microgrid


Central power plant
Offices
Houses
Storage
CHP
Micro-
turbines
Fuel cells
Industrial plants
Wind turbines
Virtual power plant

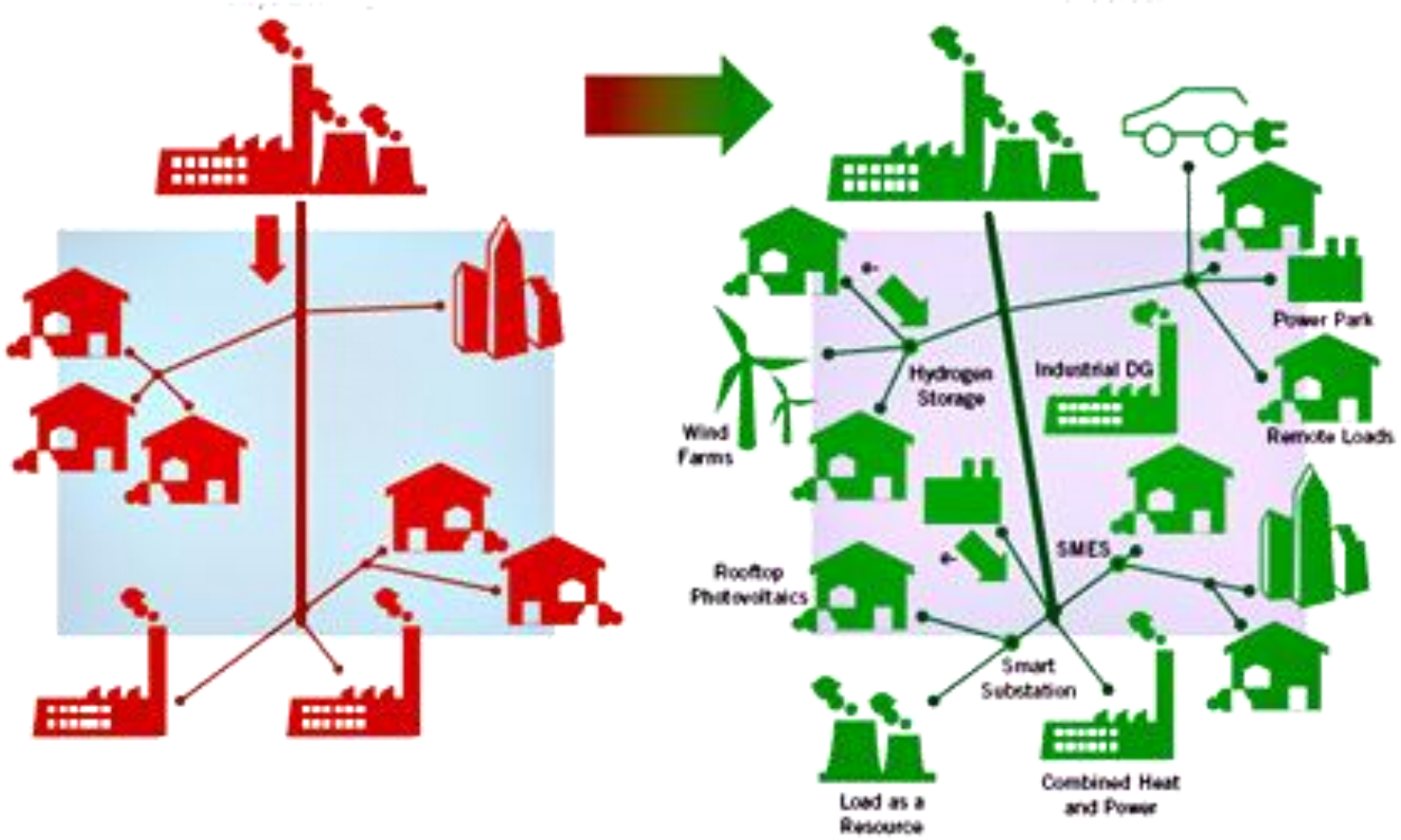
Microgrid

- Integrate renewable resources
- Control the flow of power
- Reduce Carbone emissions
- Reduce losses
- Reliable against sudden faults

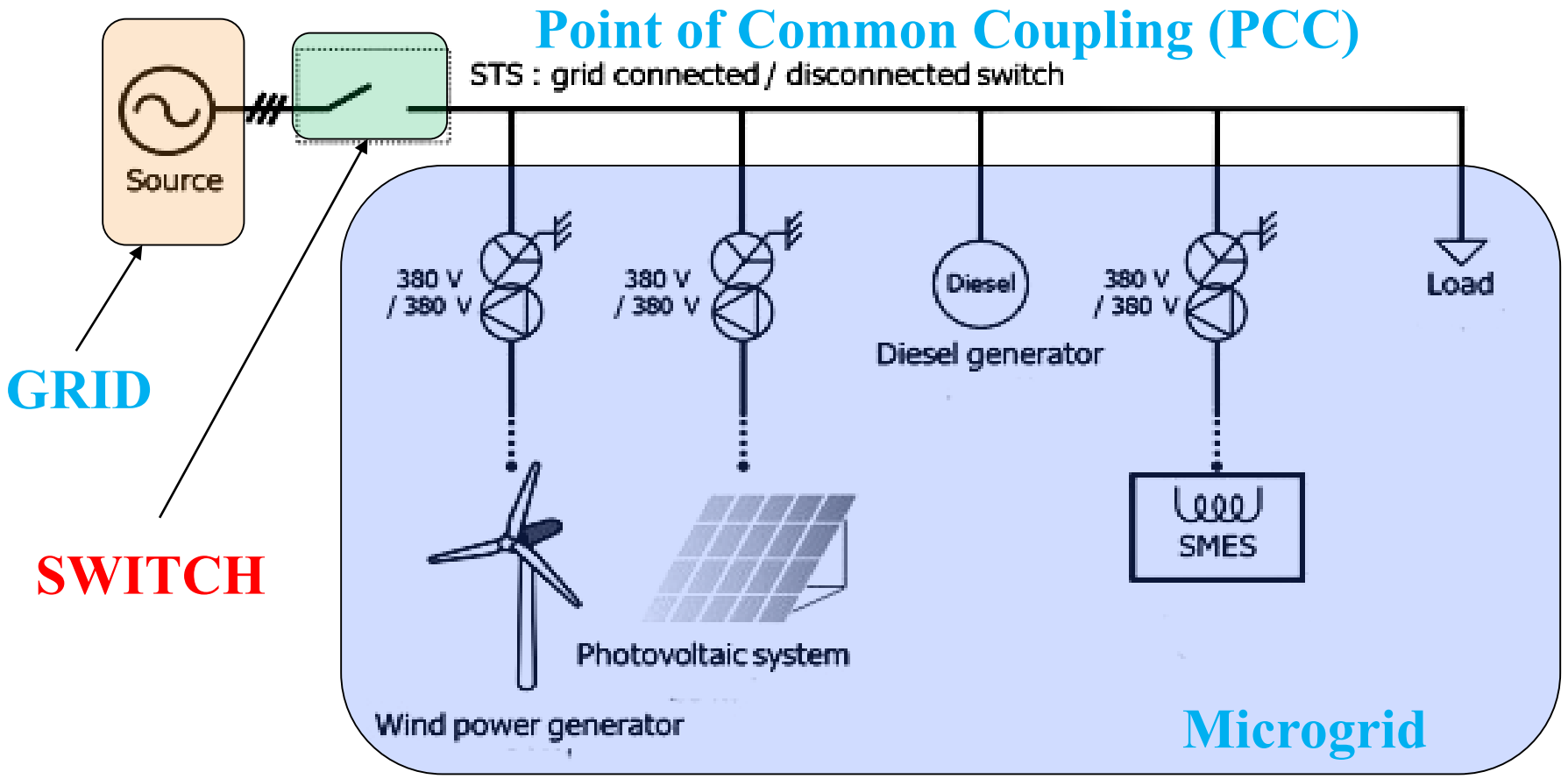
- Customer is a part of the grid

GRID

Micro-GRID



Microgrid Modes



Grid-Connected mode

Island mode

Interfacing

Sources

Battery

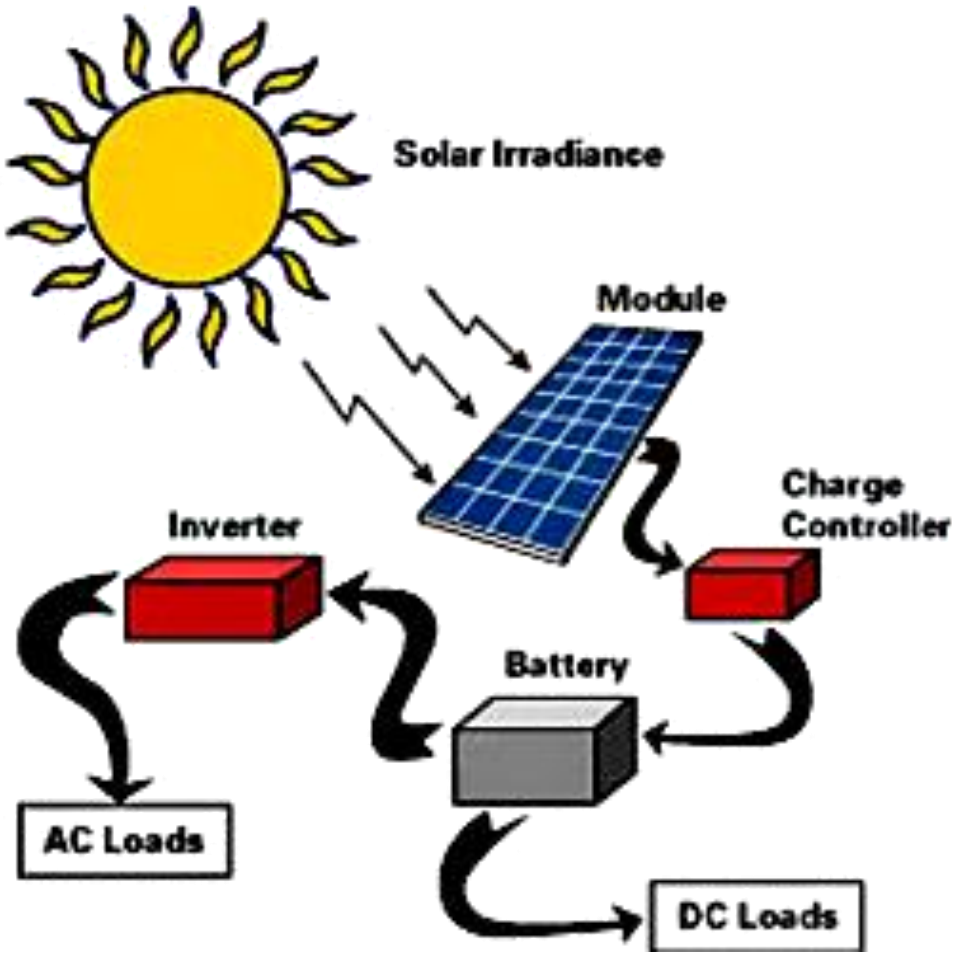
DC

INVERTER

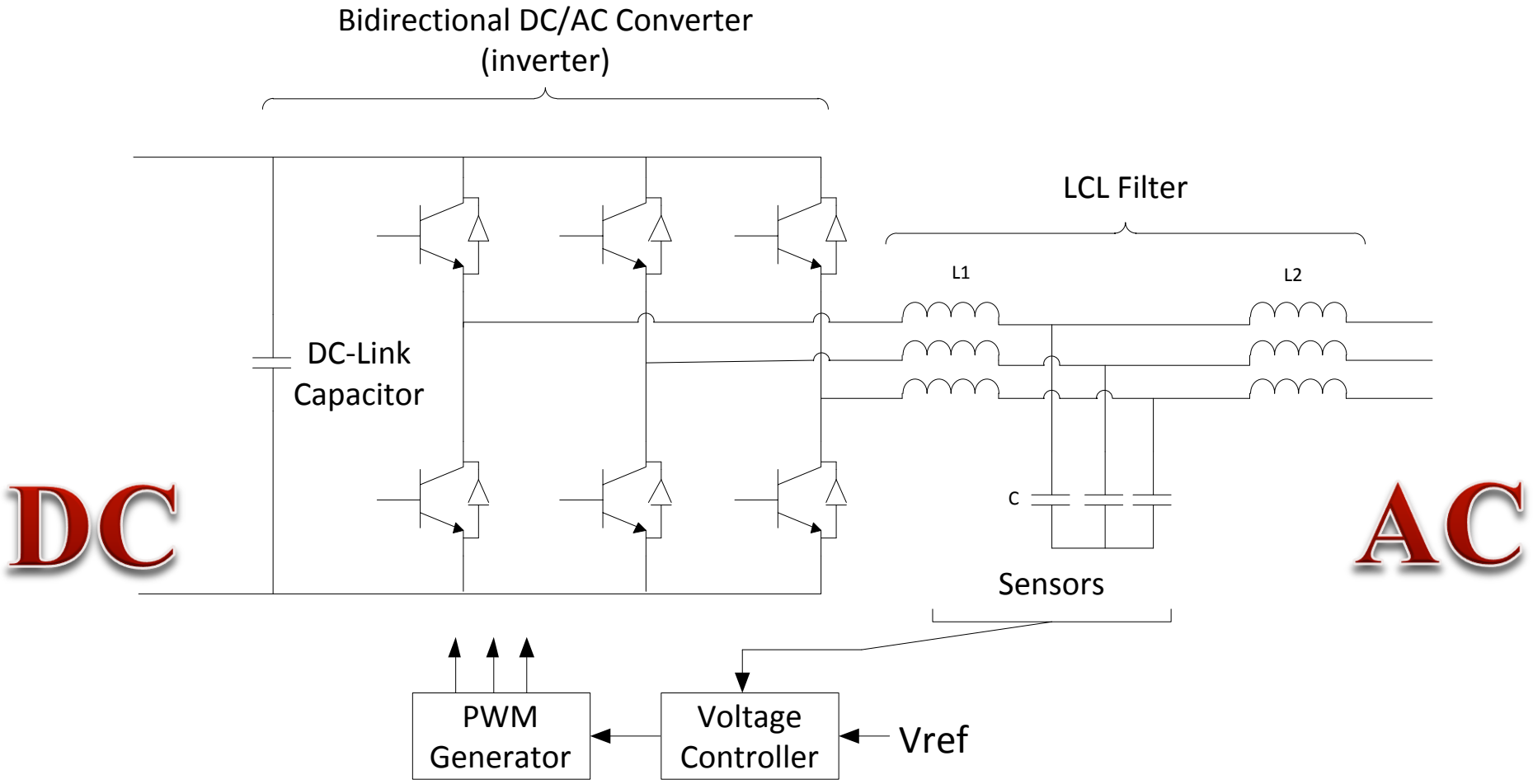
AC

Grid

Loads

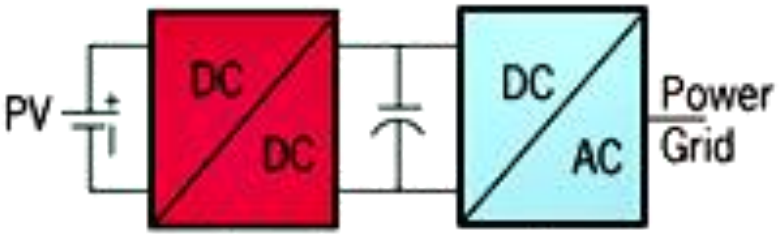

Solar Irradiance
Module
Charge Controller
Inverter
Battery
AC Loads
DC Loads

Inverter


Bidirectional DC/AC Converter
(inverter)
LCL Filter
L1
L2
DC-Link
Capacitor
C
DC
AC
Sensors
PWM
Generator
Voltage
Controller
Vref

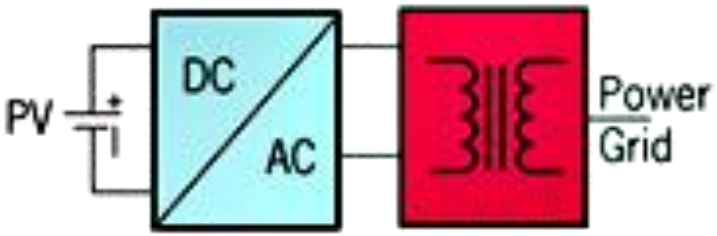
Inverter's Topologies

Uses DC Boost to step up the DC voltage

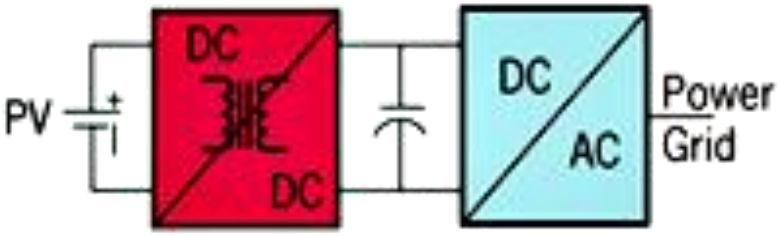


Boost DC converter

Uses transformer to step up the AC voltage

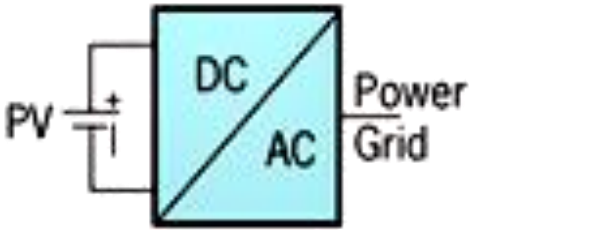


DC/AC converter and transformer



DC/DC with transformer

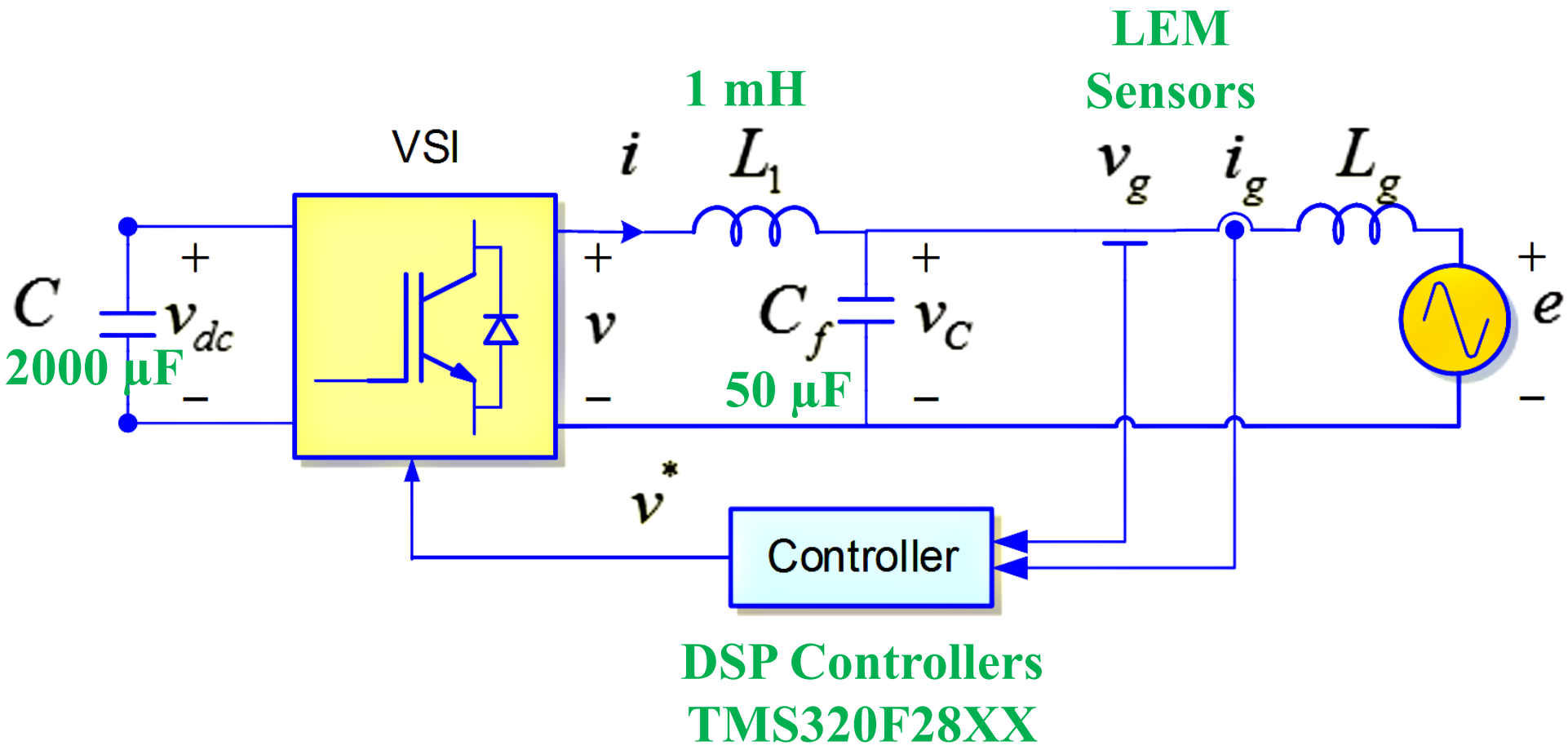
Uses transformer to step up the DC voltage



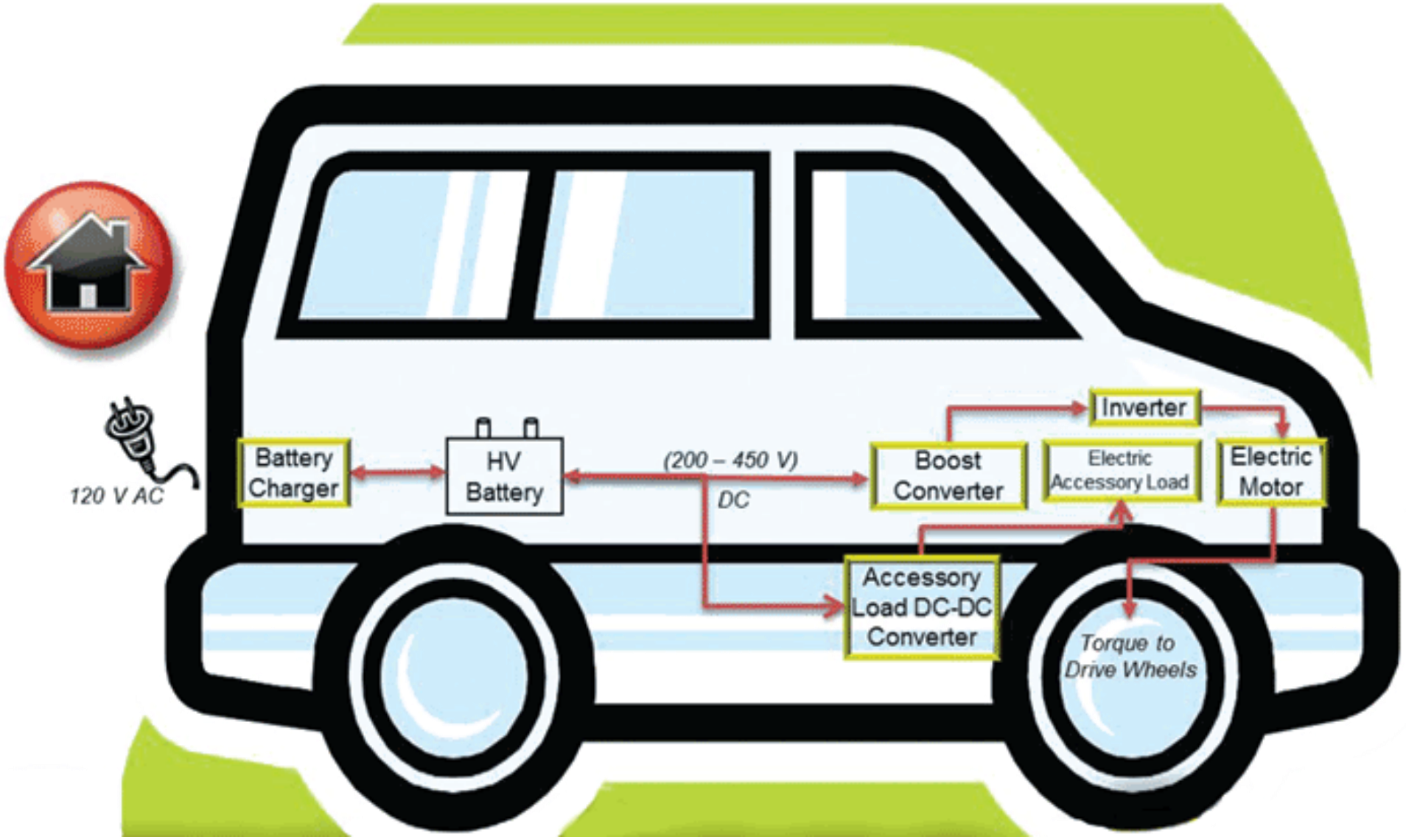
Voltage source inverter

Uses many PV to step up the DC voltage

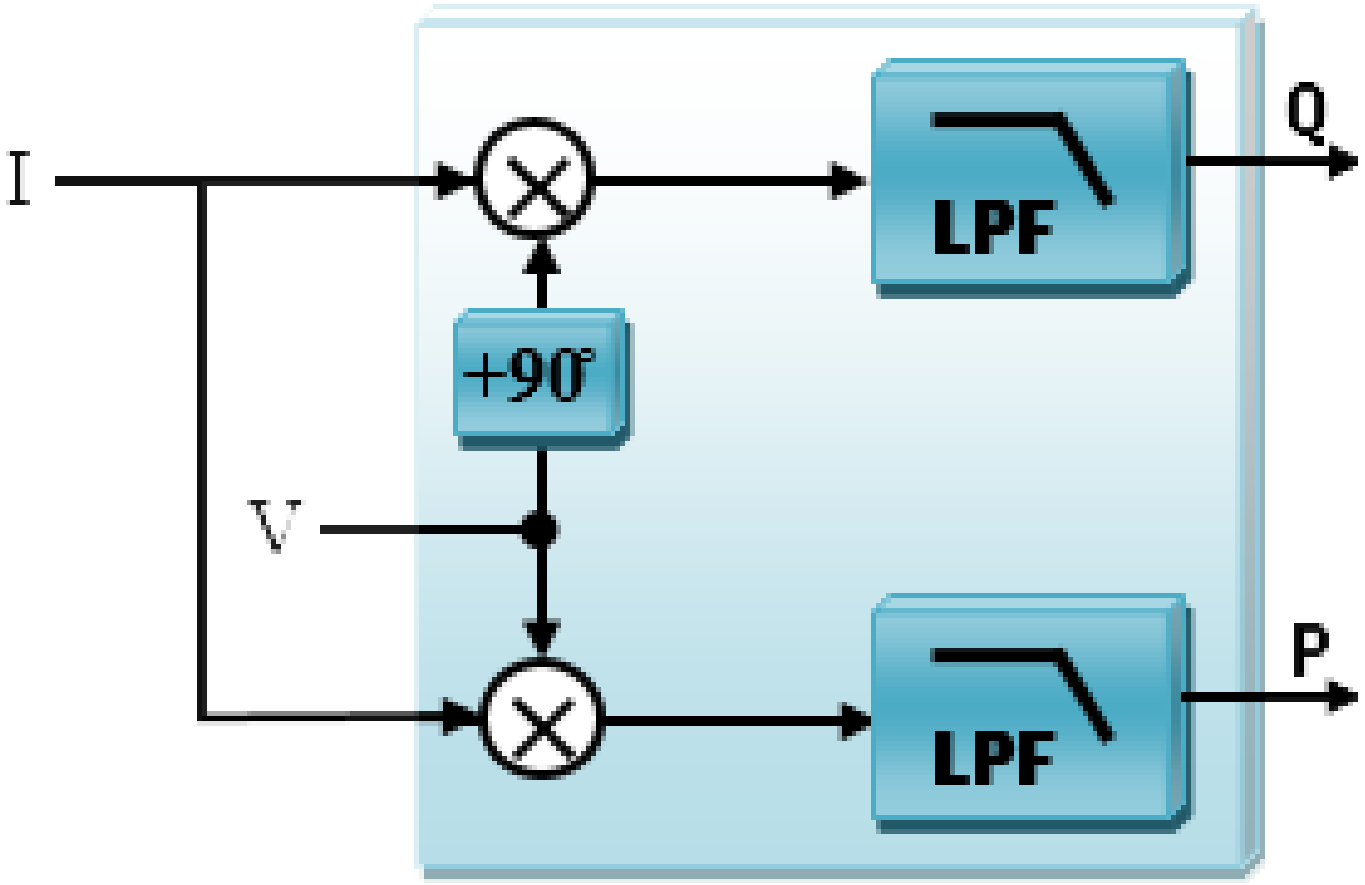
Inverter


LEM
Sensors
1 mH
VSI
i
L_1
v_g
i_g
L_g
C
v_{dc}
2000 µF
v
C_f
v_C
50 µF
e
v^*
Controller
DSP Controllers
TMS320F28XX

Electric Vehicle



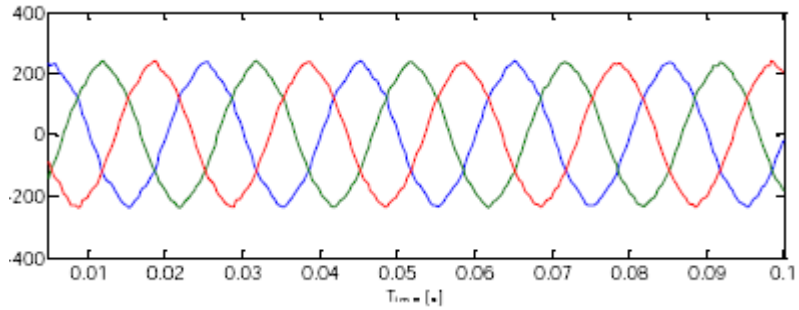
Active & Reactive Power Measurement



90° → ¼ cycle → ¼ T

Microgrid Literature

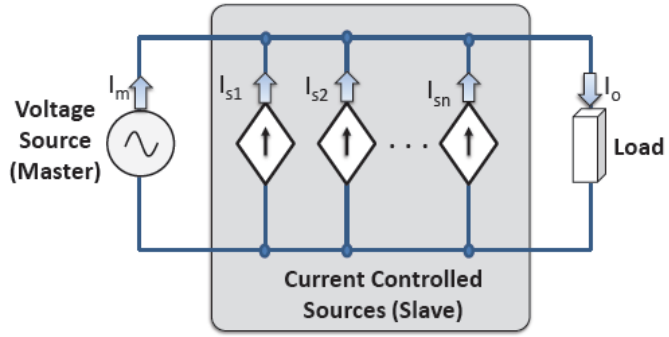
1- Voltage and Current Regulation



- **Goals:**
  - Low Distortion
  - No Resonance
  - Regulated Voltage
  - Smooth Step Response
- **Proposed Solutions:**
  - PI, PID Controllers
  - P+Resonant Controllers
  - Adaptive Controllers
  - Repetitive Controllers

Microgrid Literature

2- Power Sharing

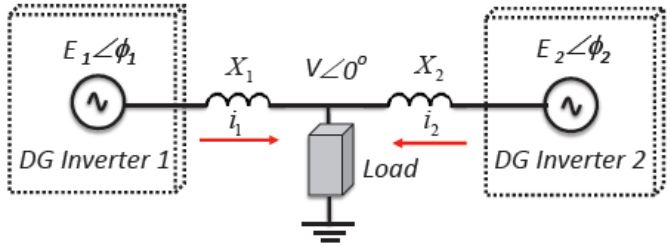


- **Goals:**
  - Adequate Power sharing
  - Accurate Power control
  - Without Communication if possible
  - Smooth Step Response
- **Proposed Solutions:**
  - Master – Slave Controllers
  - Current Chain Scheme
  - **Droop Control**

Microgrid Literature

3- Power Sharing (‘*Droop Control*’)

- **Goals:**
  - Accurate Reactive Power control
  - Small Frequency and voltage deviations
  - Harmonics Sharing
  - Smooth Step Response
- **Proposed Solutions:**
  - PID Control
  - Angle droop controller
  - External supplementary loops



Microgrid Literature

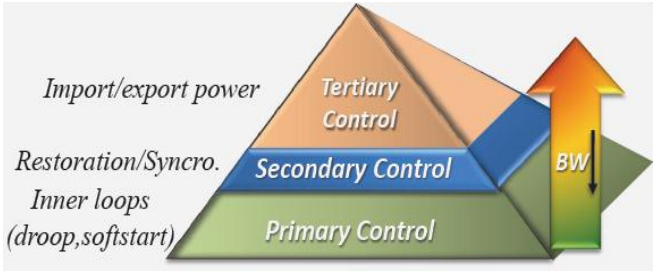
4- Islanding Detection

- **Goals:**
  - Detect the grid absence within 2 sec
- **Proposed Solutions:**
  - Passive Methods
    - Voltage, Frequency, phase deviations
  - Active Methods
    - Positive Feedback, harmonic injection, …

Microgrid Literature

5- Power Management and Central Control

- **Goals:**
  - A manager should decide the power for each inverter
  - Mode Controlling
- **Proposed Solutions:**
  - Hierarchical Control
    - Primary Control
    - Secondary Control
    - Tertiary Control



RESEARCH GOALS

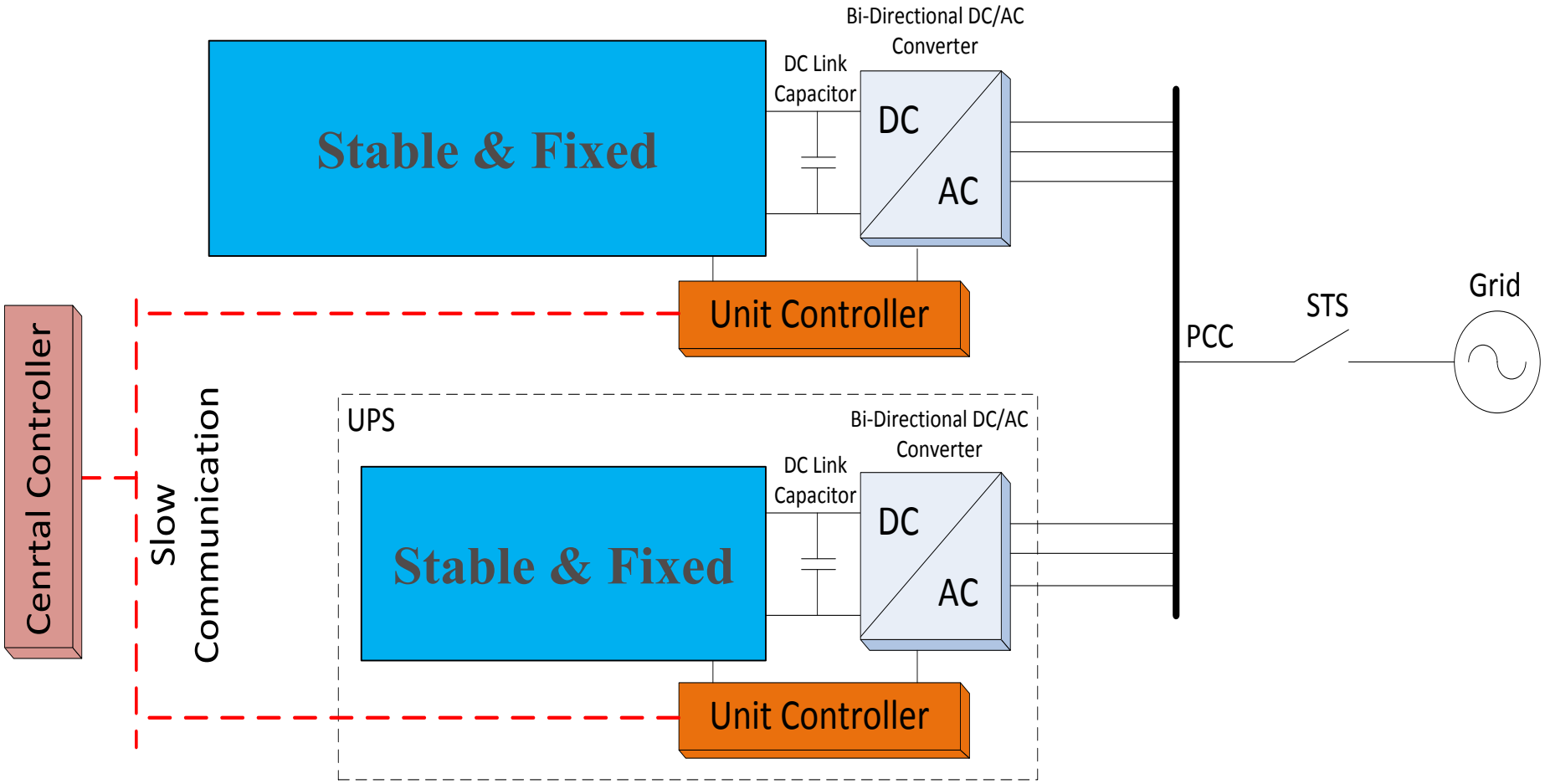
- Not concerned about energy sources
- Not concerned about sources fluctuations

BUT .. .. .

Paralleling Inverters operation in Island Mode

- ✓ Circulation currents
- ✓ Power sharing in island mode
- ✓ Smooth Transition
- ✓ Microgrid stability

Parallel Inverters



Thank You