

Microgrids - the Concept of Energy Decentralization

Smart Grids
Problems & Solutions

Walid Issa



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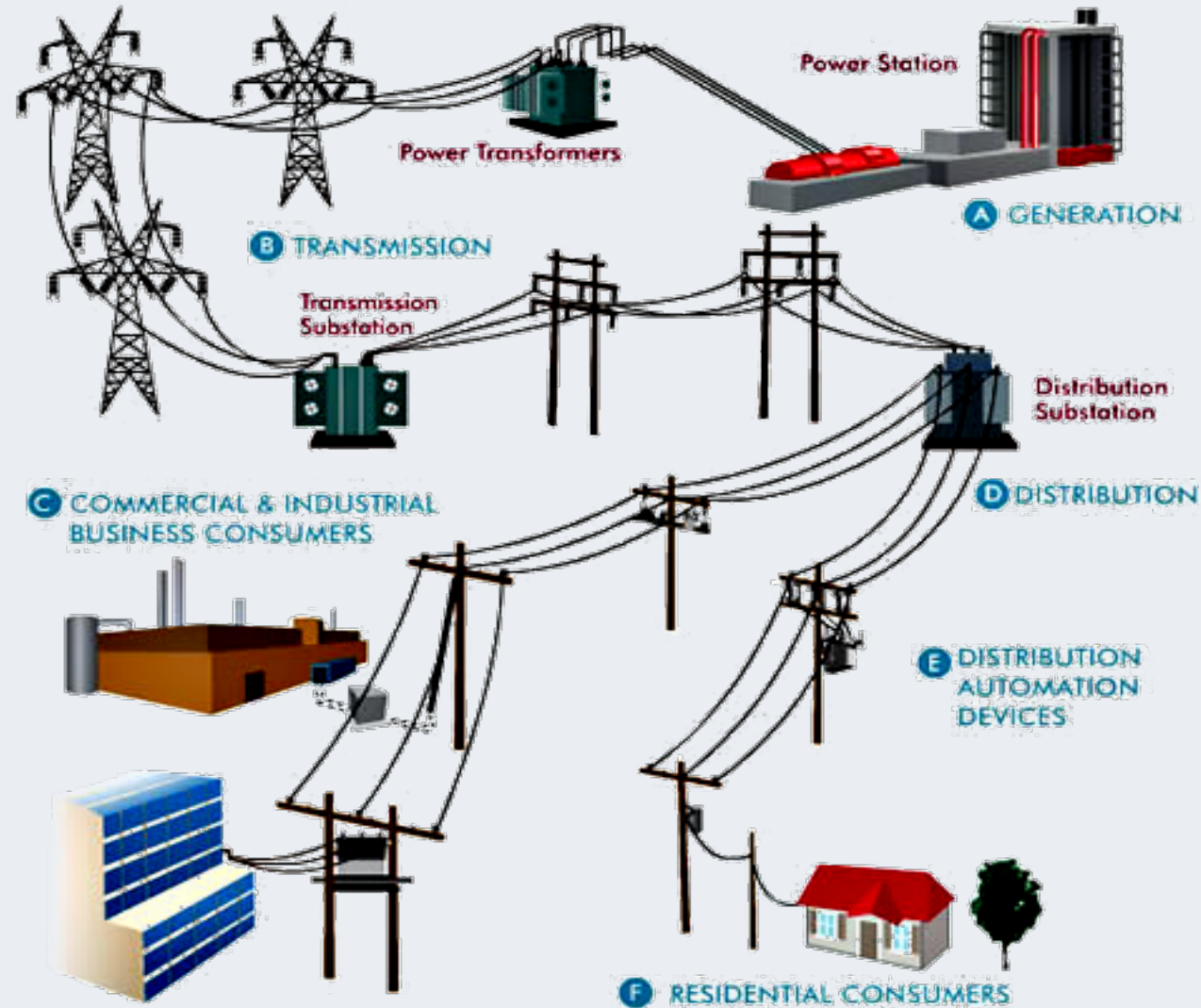
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Do not share illegal or abusive content. Recording is not permitted unless authorised.
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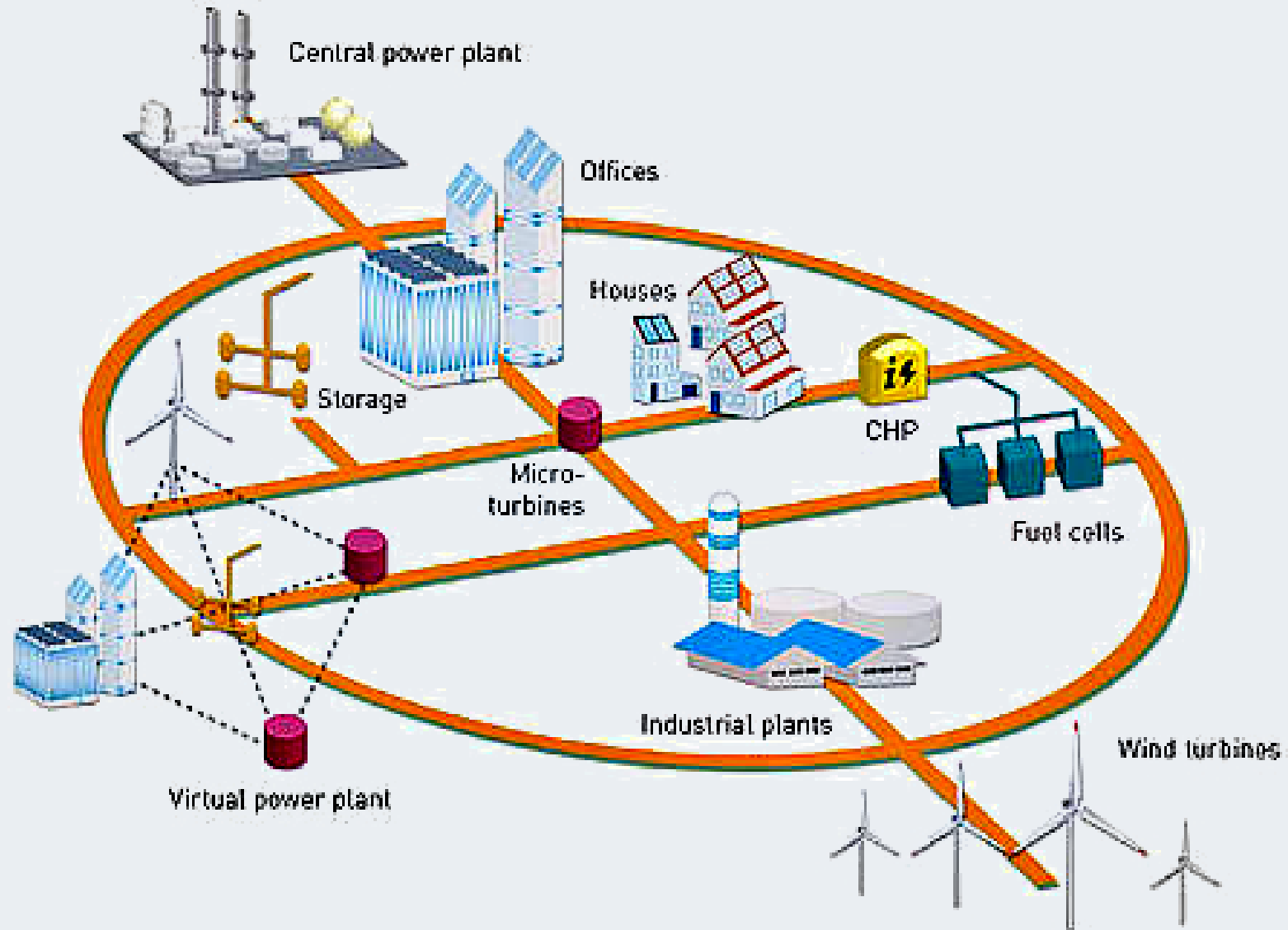
Electrical Grid



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

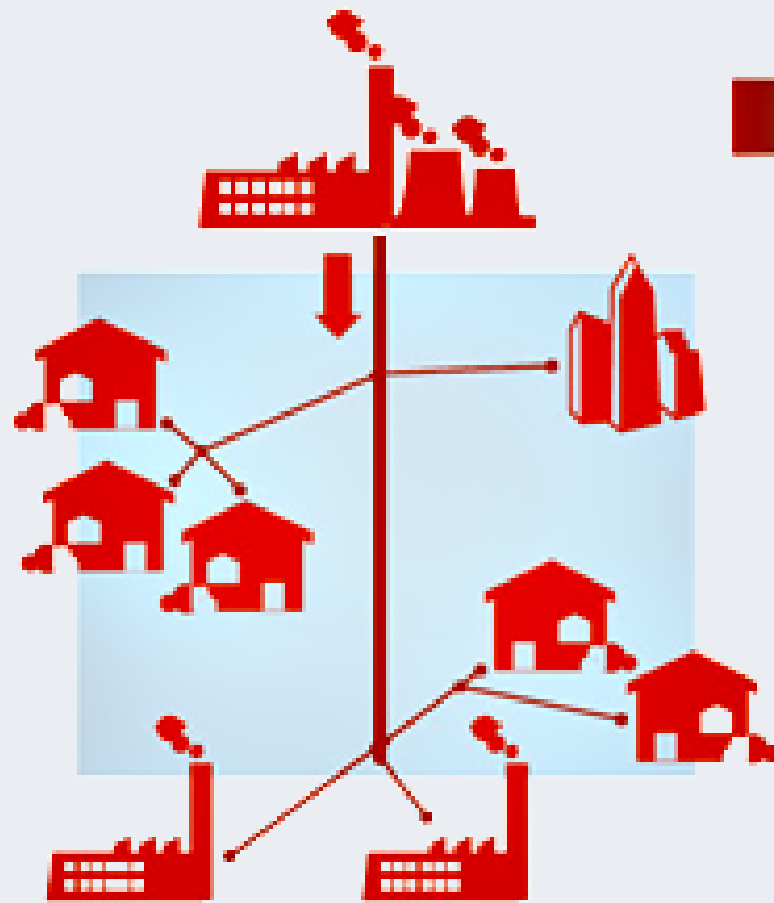
Microgrid



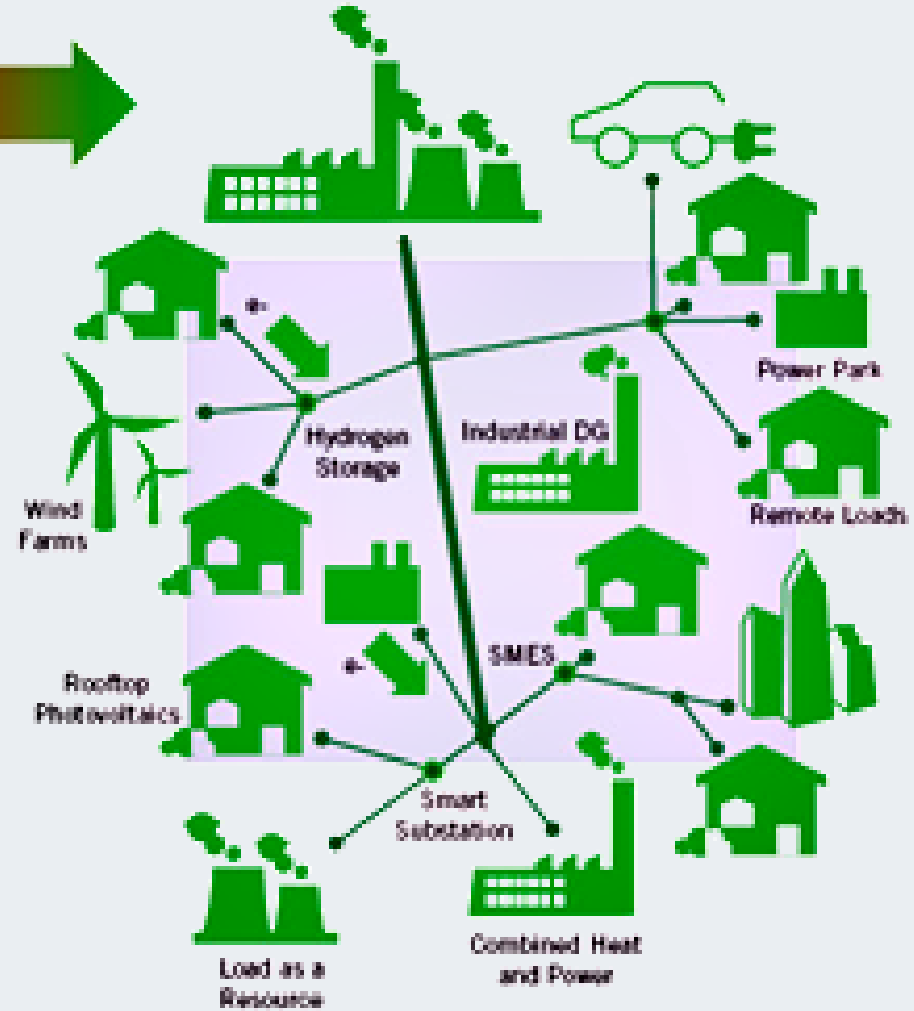
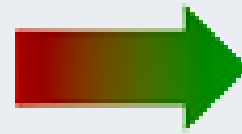
Microgrid

- › Integrate renewable resources
- › Control the flow of power
- › Reduce Carbon emissions
- › Reduce losses
- › Reliable against sudden faults
- › Customer is a part of the grid

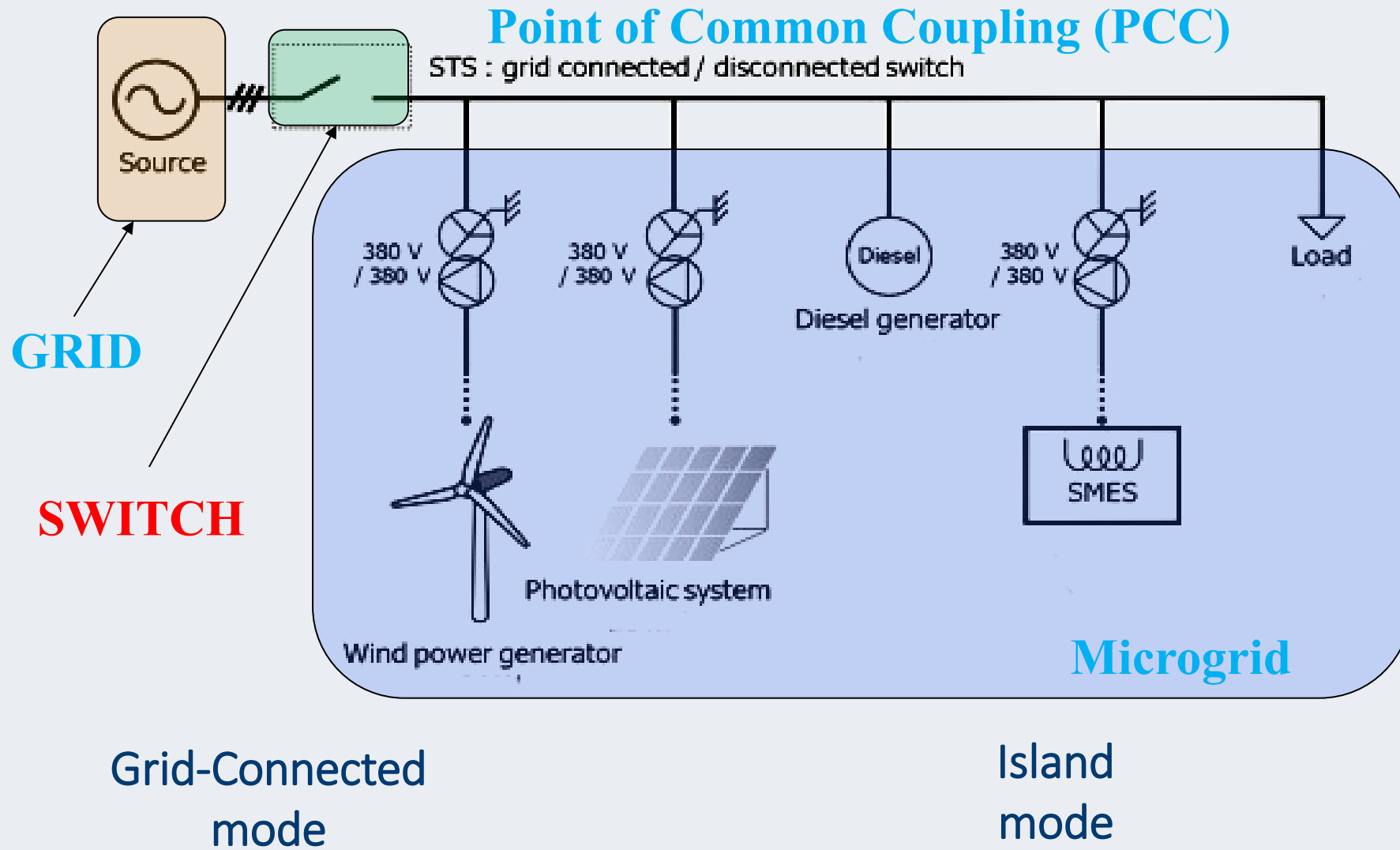
GRID



Micro-GRID



Microgrid Modes



Interfacing



Sources



Battery



DC



INVERTER

AC

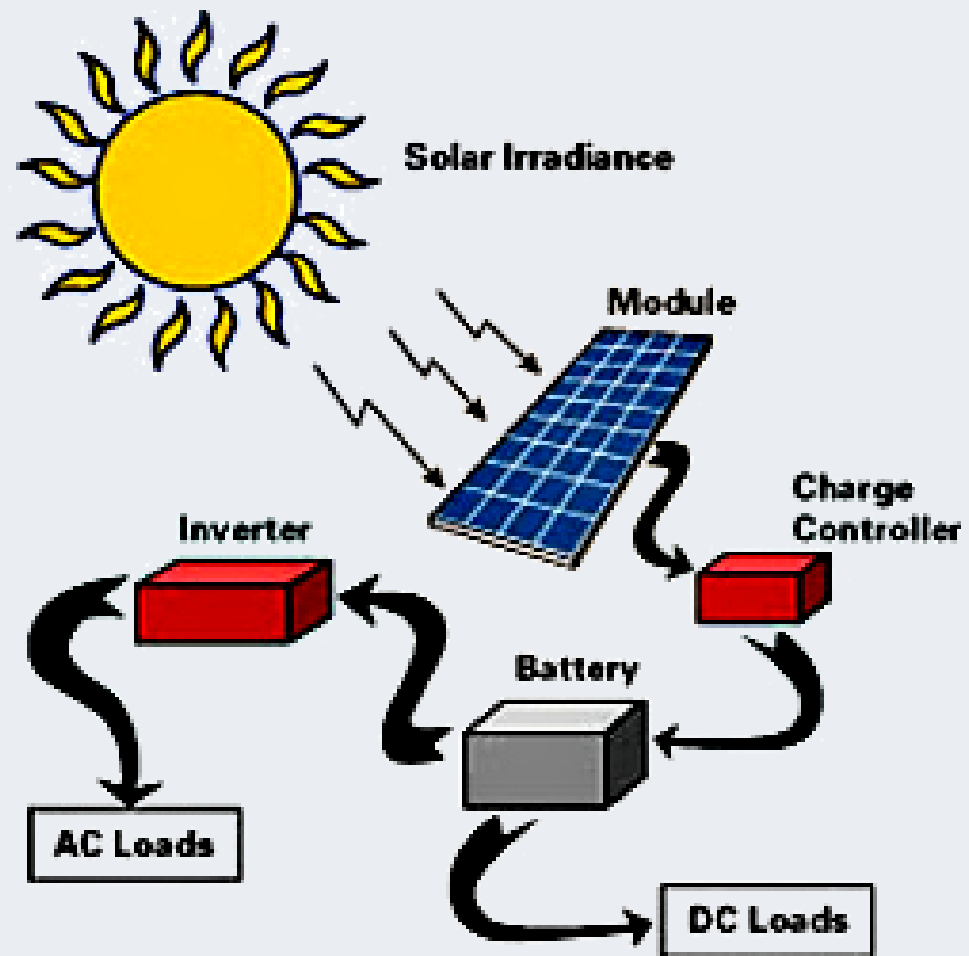


Loads

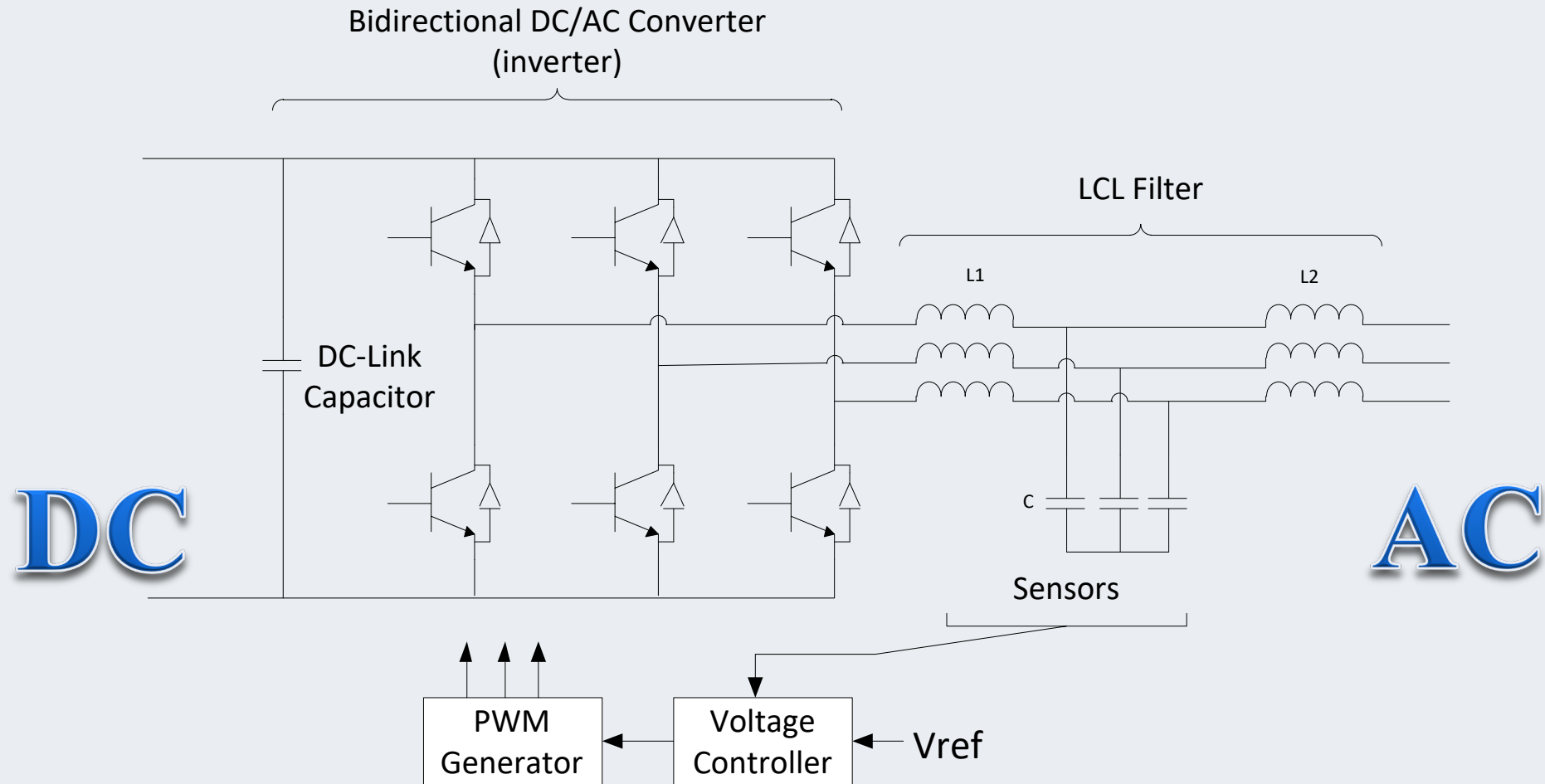


Grid



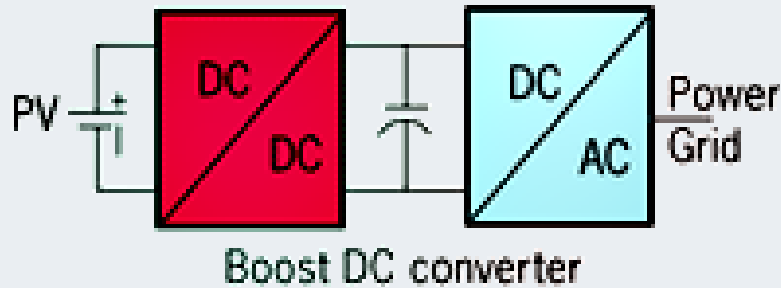


Inverter

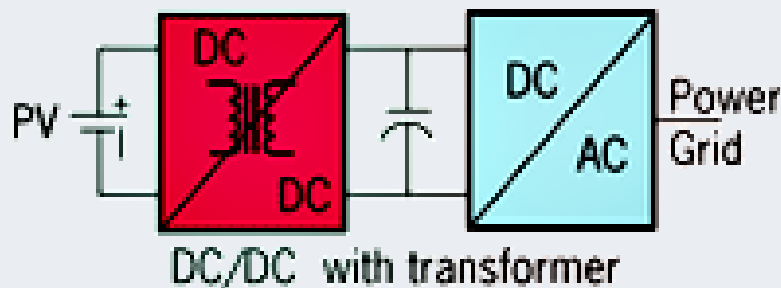
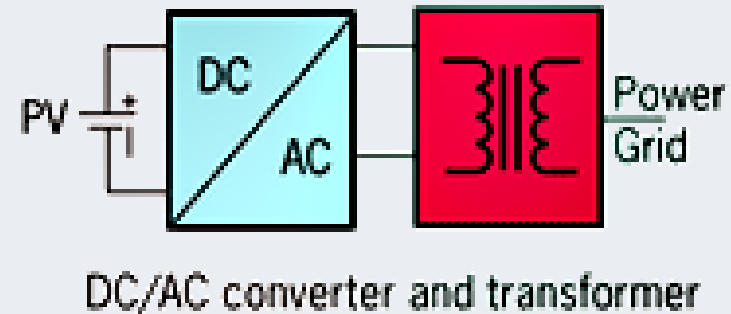


Inverter's Topologies

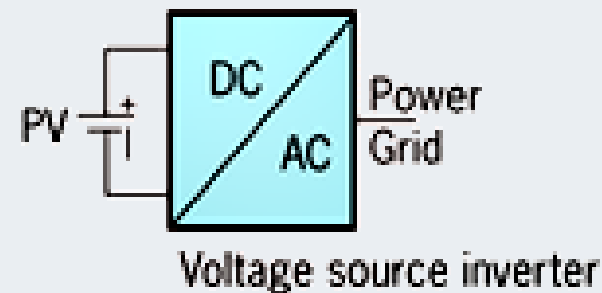
Uses DC Boost to step up the DC voltage



Uses transformer to step up the AC voltage

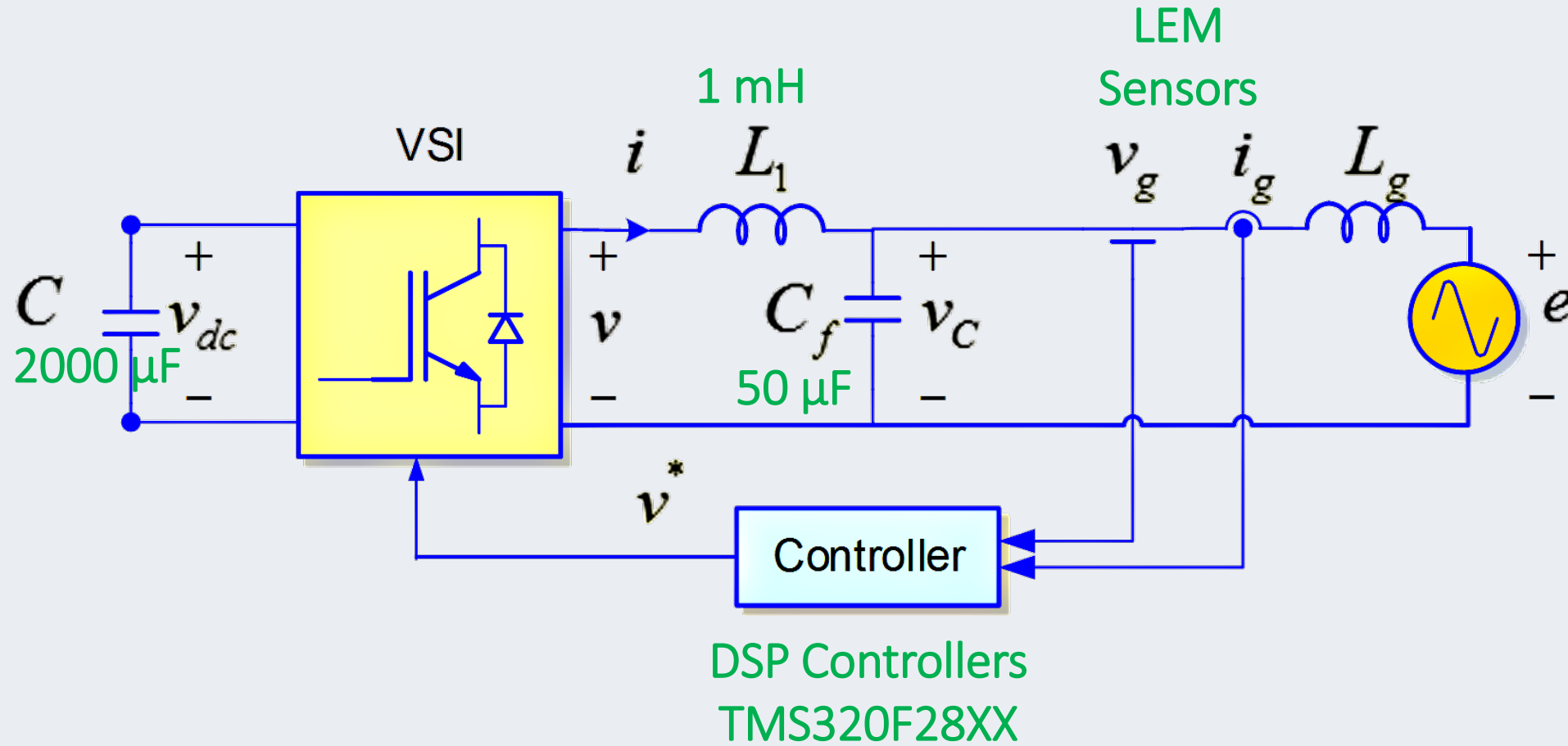


Uses transformer to step up the DC voltage

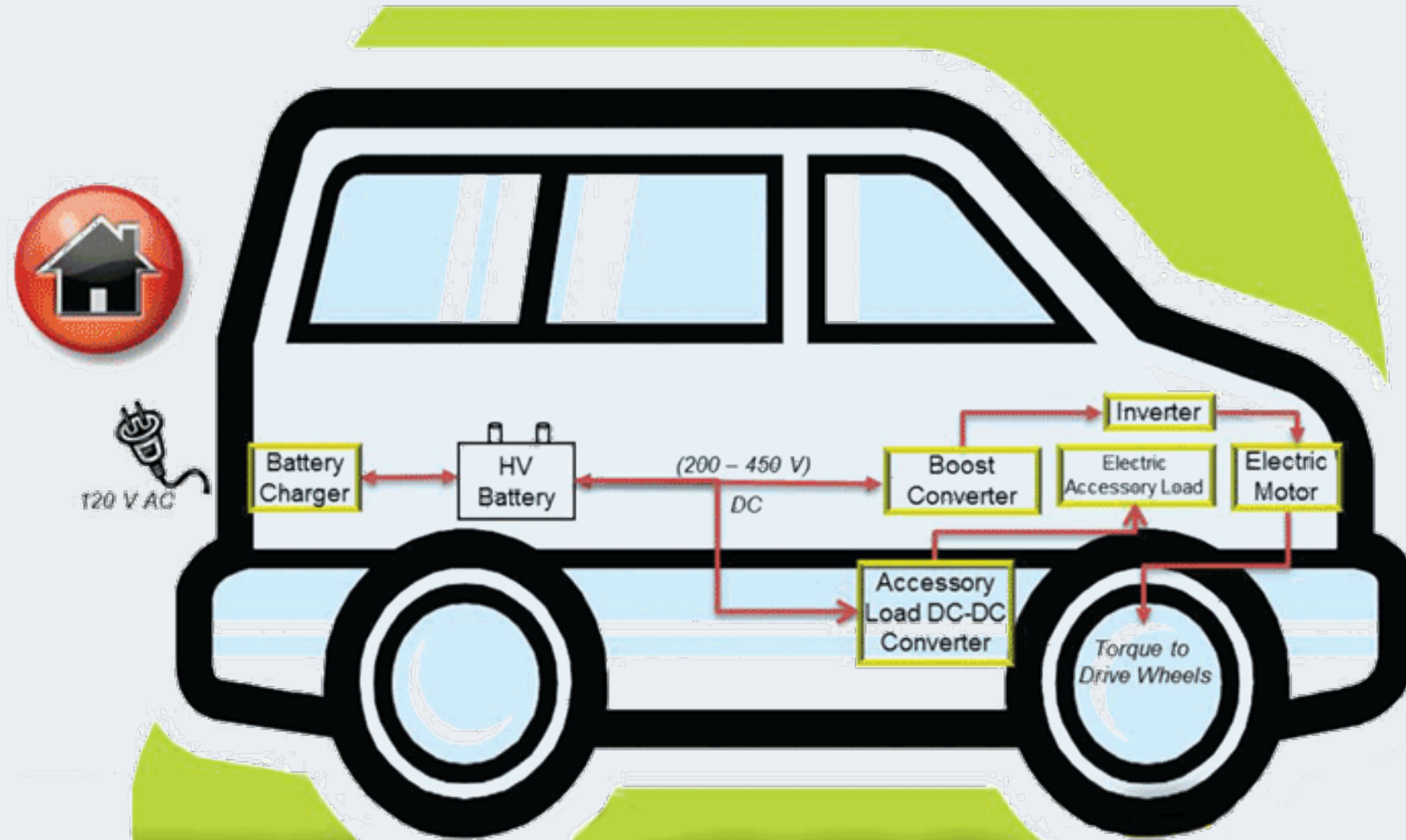


Uses many PV to step up the DC voltage

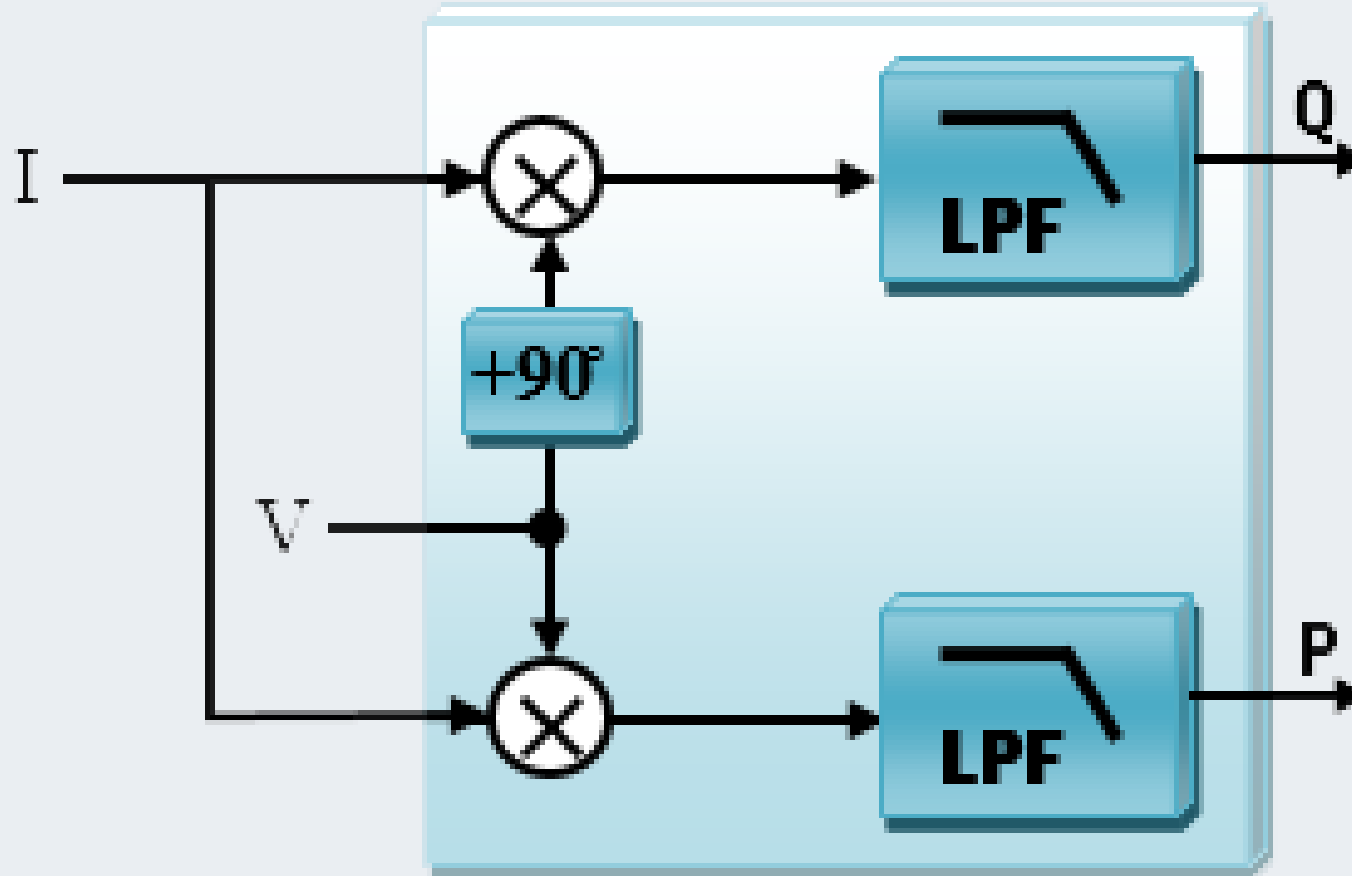
Inverter



Electric Vehicle

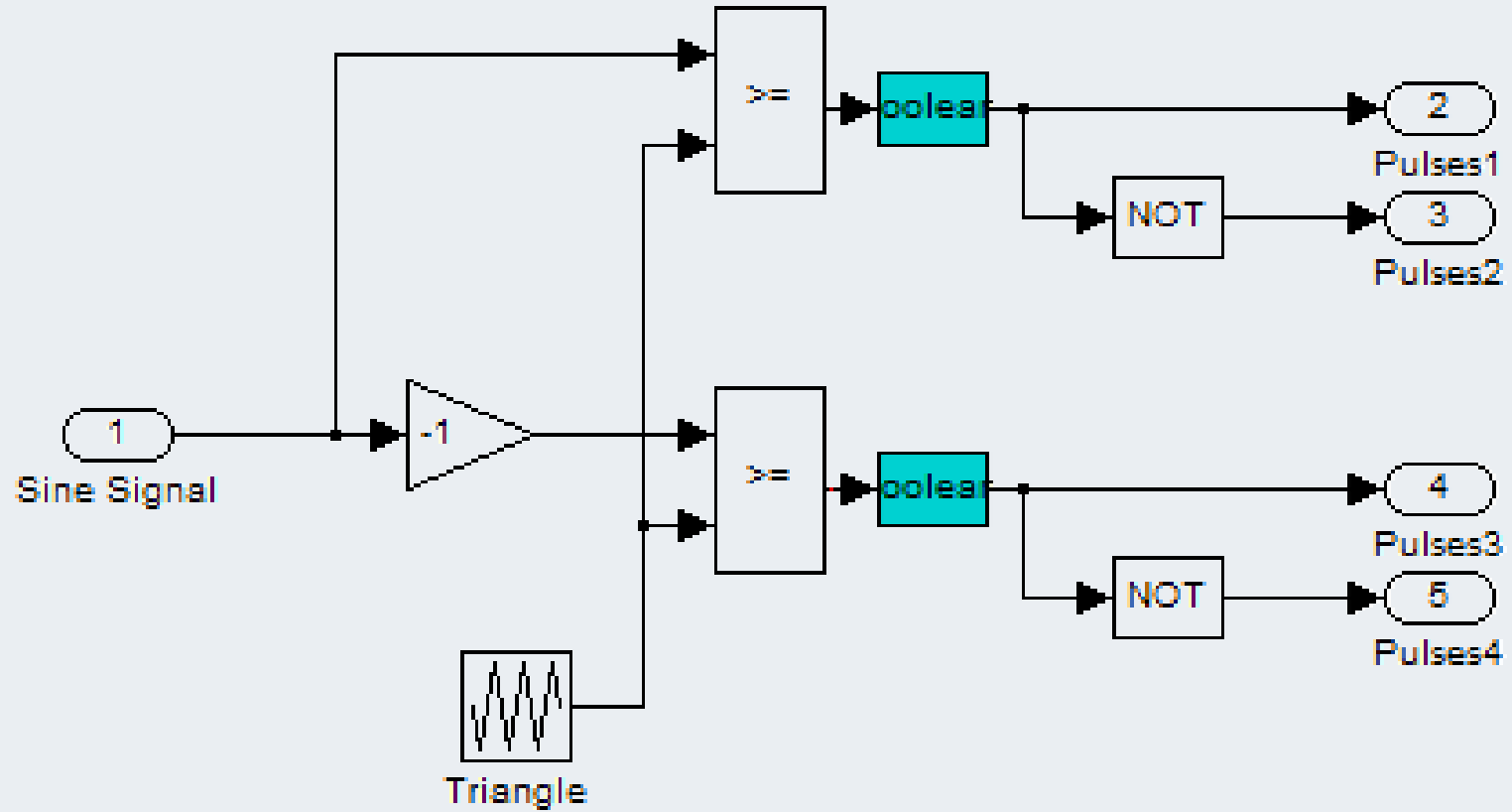


Active & Reactive Power Measurement



$90^\circ \rightarrow \frac{1}{4} \text{ cycle} \rightarrow \frac{1}{4} T$

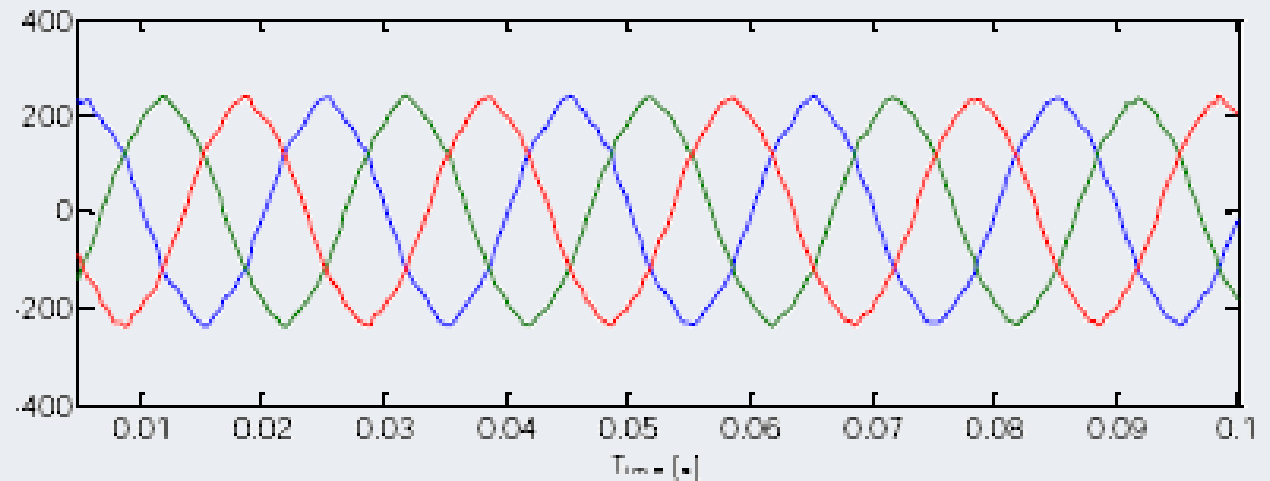
Sine wave PWM Generation



Microgrid Literature

1- Voltage and Current Regulation

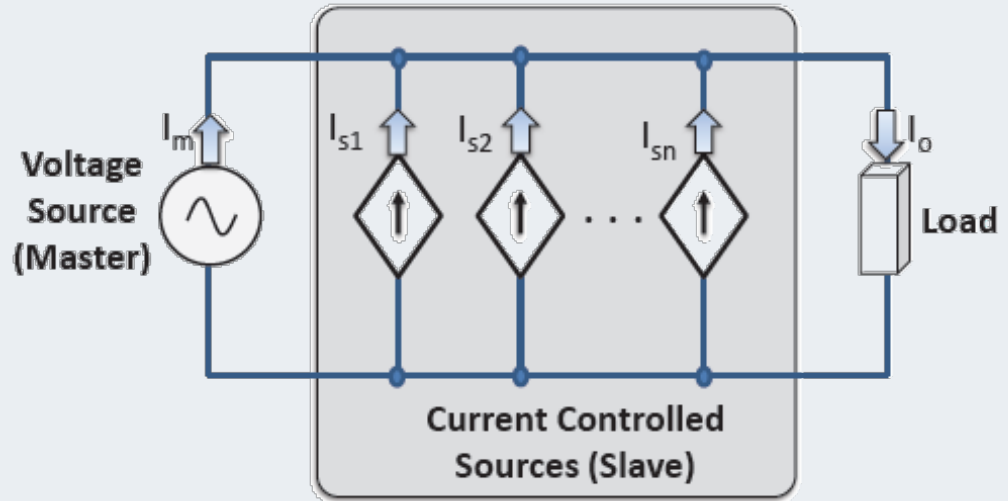
- **Goals:**
 - › Low Distortion
 - › No Resonance
 - › Regulated Voltage
 - › Smooth Step Response
- **Proposed Solutions:**
 - › PI, PID Controllers
 - › P+Resonant Controllers
 - › Adaptive Controllers
 - › Repetitive Controllers



Microgrid Literature

2- Power Sharing

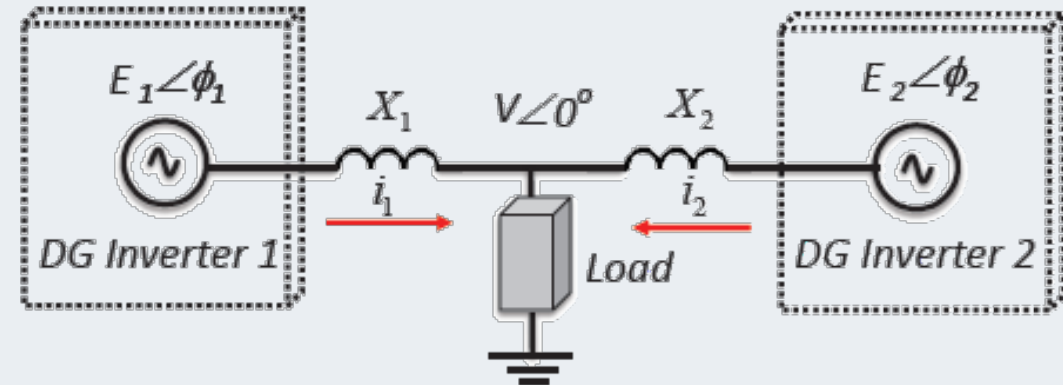
- **Goals:**
 - › Adequate Power sharing
 - › Accurate Power control
 - › Without Communication if possible
 - › Smooth Step Response
- **Proposed Solutions:**
 - › Master – Slave Controllers
 - › Current Chain Scheme
 - › Droop Control



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



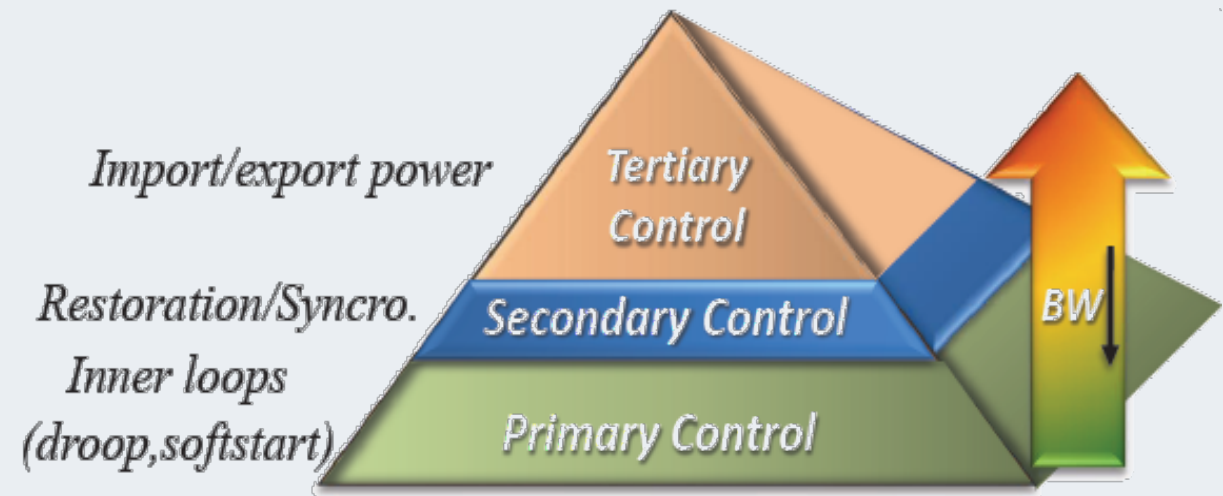
Microgrid Literature

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

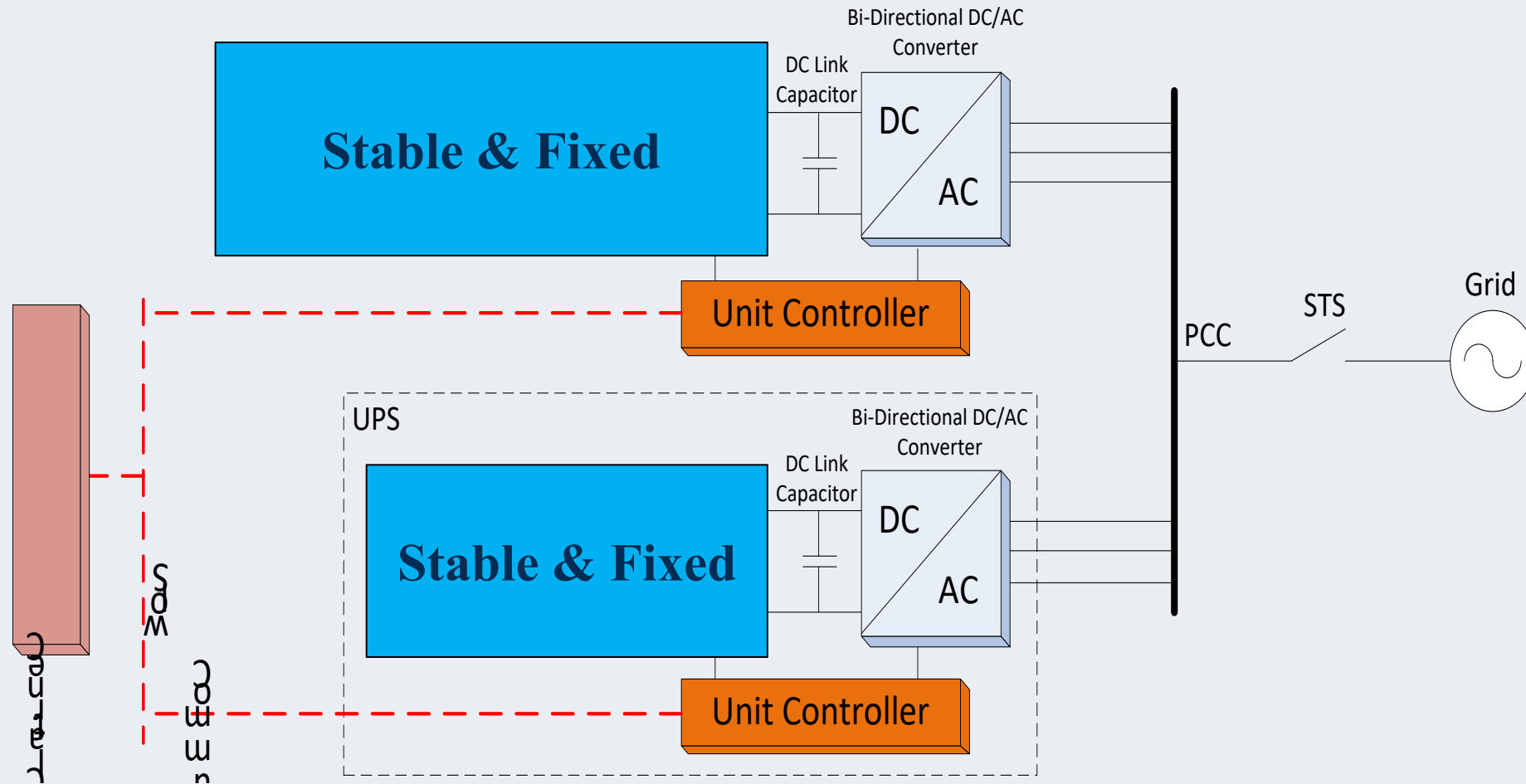


Research Goals

Paralleling Inverters operation in Island Mode

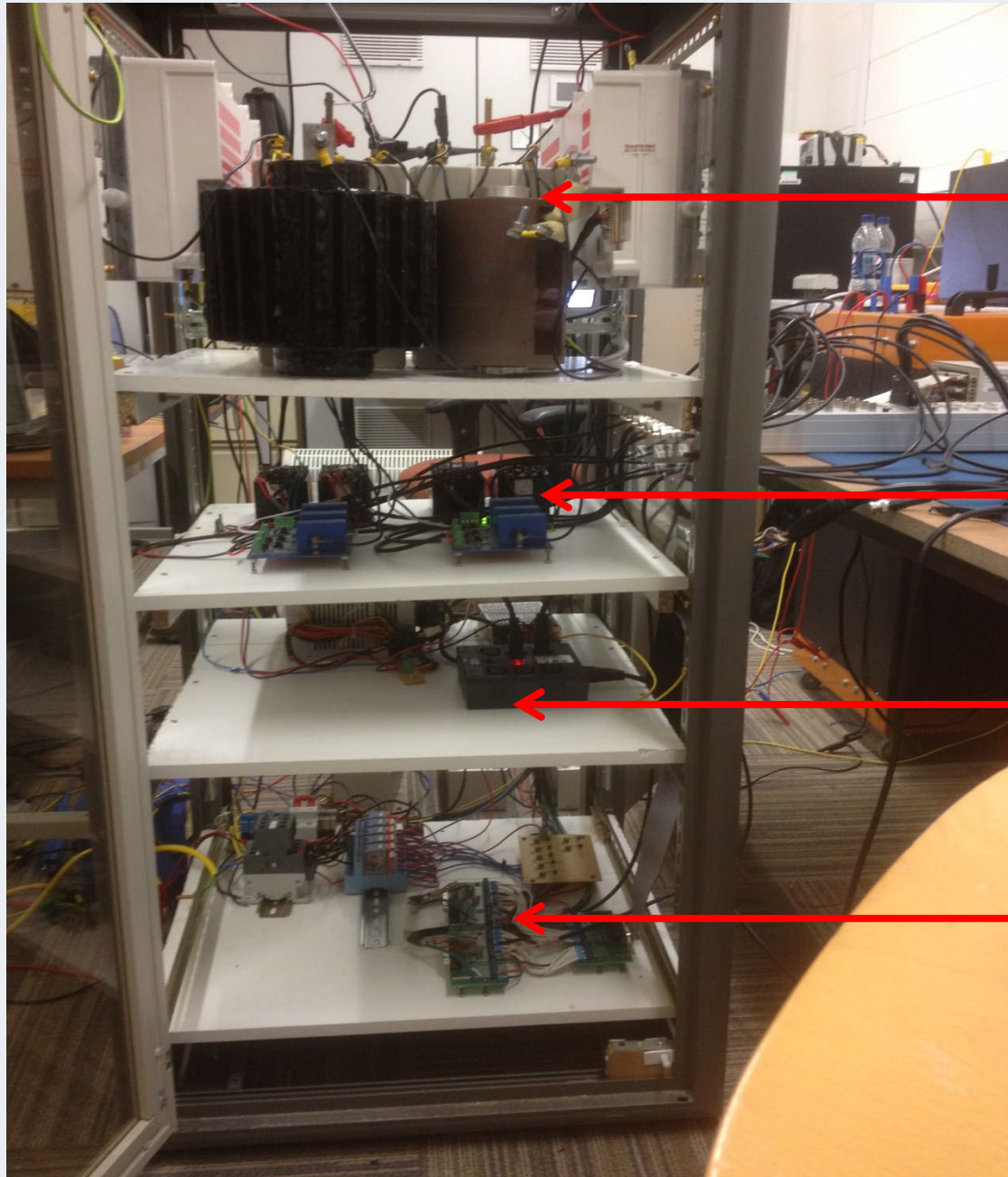
- ✓ Circulation currents
- ✓ Power sharing in island mode
- ✓ Smooth Transition
- ✓ Microgrid stability

Parallel Inverters



Methodology

- › Microgrid Modeling
- › Proposing a controller
- › MATLAB/SIMULINK
- › Practical implementation

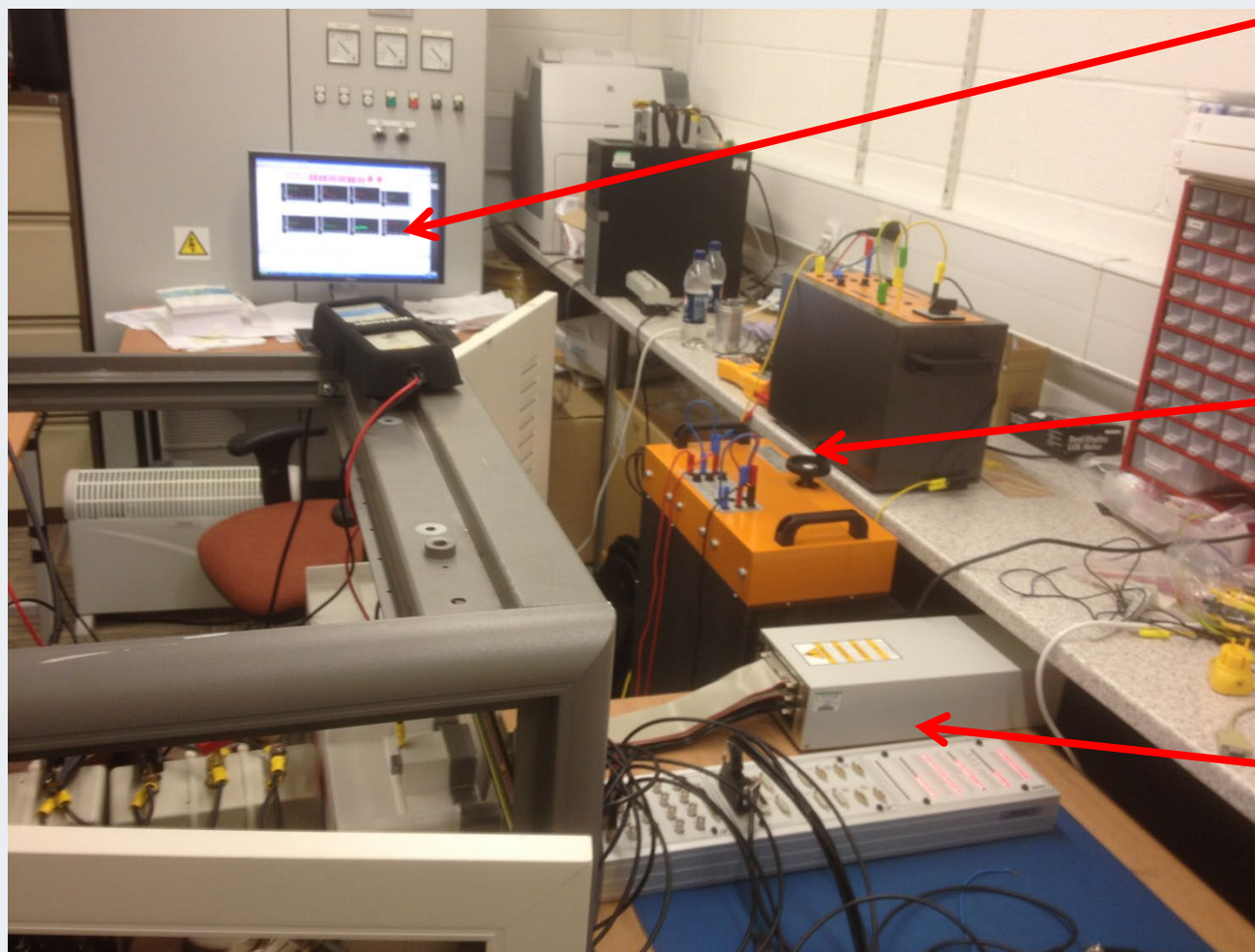


IGBTs and
Filters

Voltage and
current
sensors

Power supply

Interfacing
and switching
boards



Interfacing and
monitoring platform

Loads

dSpace Control unit

Interfacing Platform

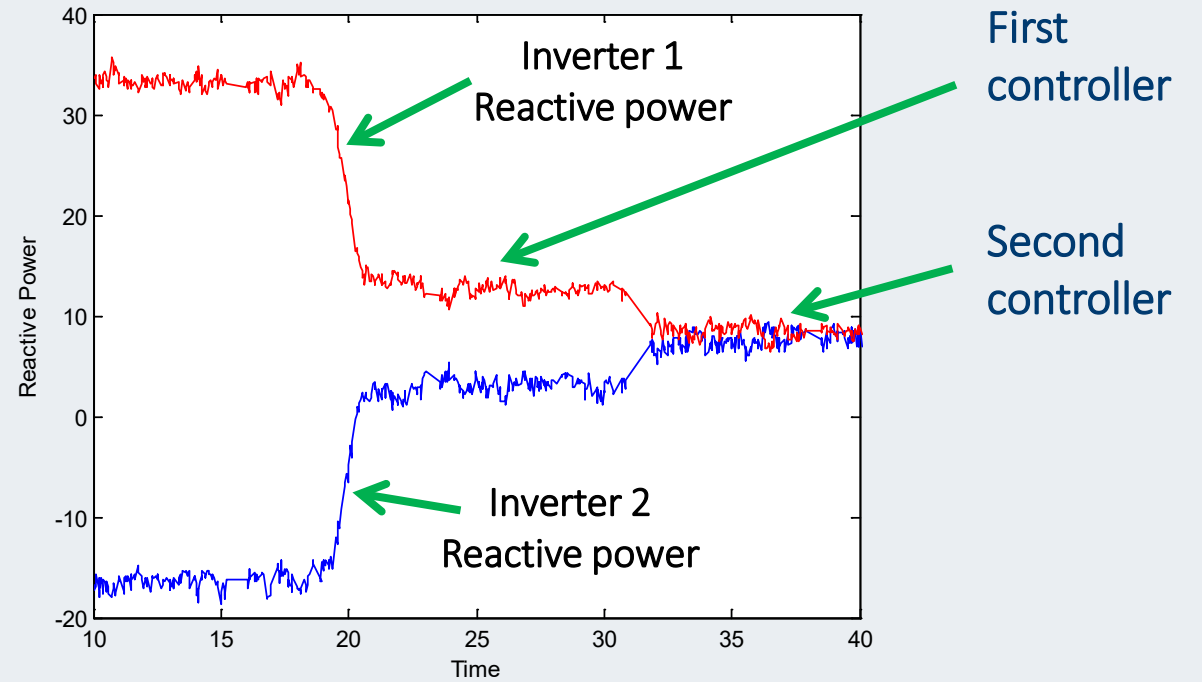
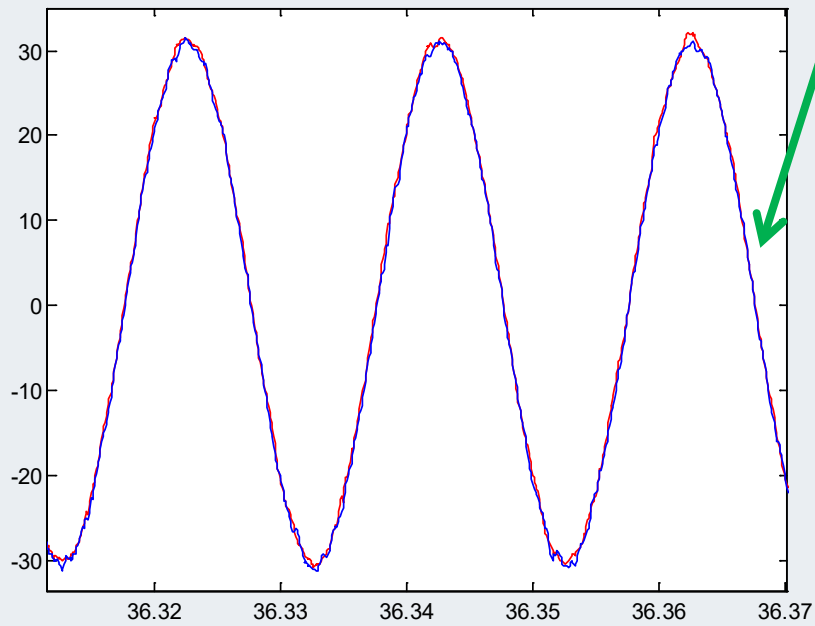


Results

Reactive Power sharing

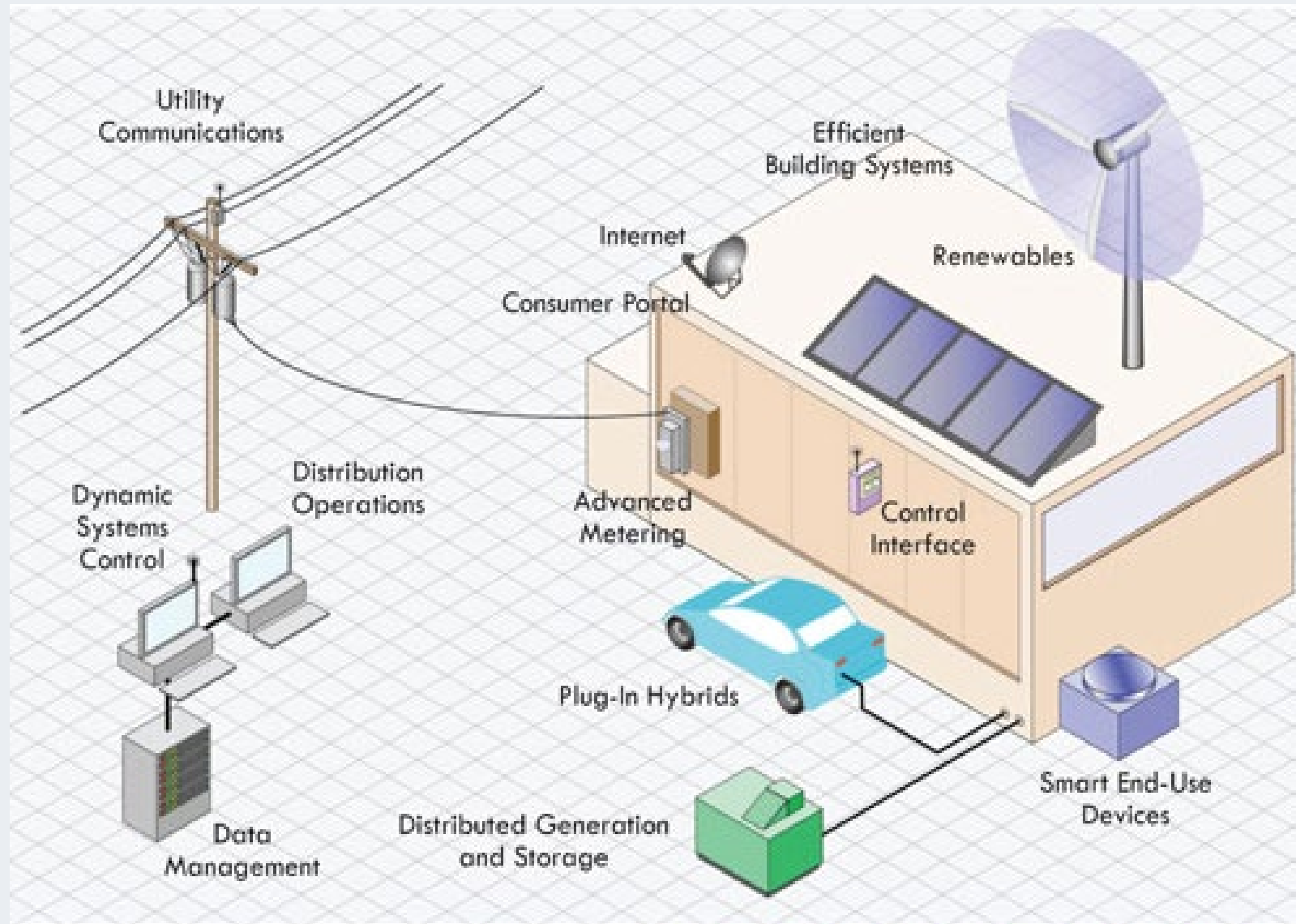
Output Voltage of both inverters

THD = 1.8%



Keywords

- › Droop control
- › Voltage & Current controllers
- › Reactive power sharing in island mode
- › Islanding Detection
- › Supervisory Control
- › MPPT for solar inverters



CAPABILITIES OF A SMART MICROGRID

This revolutionary system design meets U.S. energy challenges and maximizes consumer and business value.

Thank You!

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Engineering College of Technology (ECT) <i>UK-Recognised Qualifications</i>	Start Date
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Bachelor of Engineering (Honours) in Electrical Engineering	16 February 2026
Master of Science (Power System Analysis and Renewable Integration)	9 February 2026
Master of Science (Industrial Automation and Instrumentation Control)	9 February 2026

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