R&D initiatives of DeitY in Smartgrid technology through NaMPET

Second Brainstorming Session on Smart Grids

National Smart Grid Mission

23-5-2016

New Delhi

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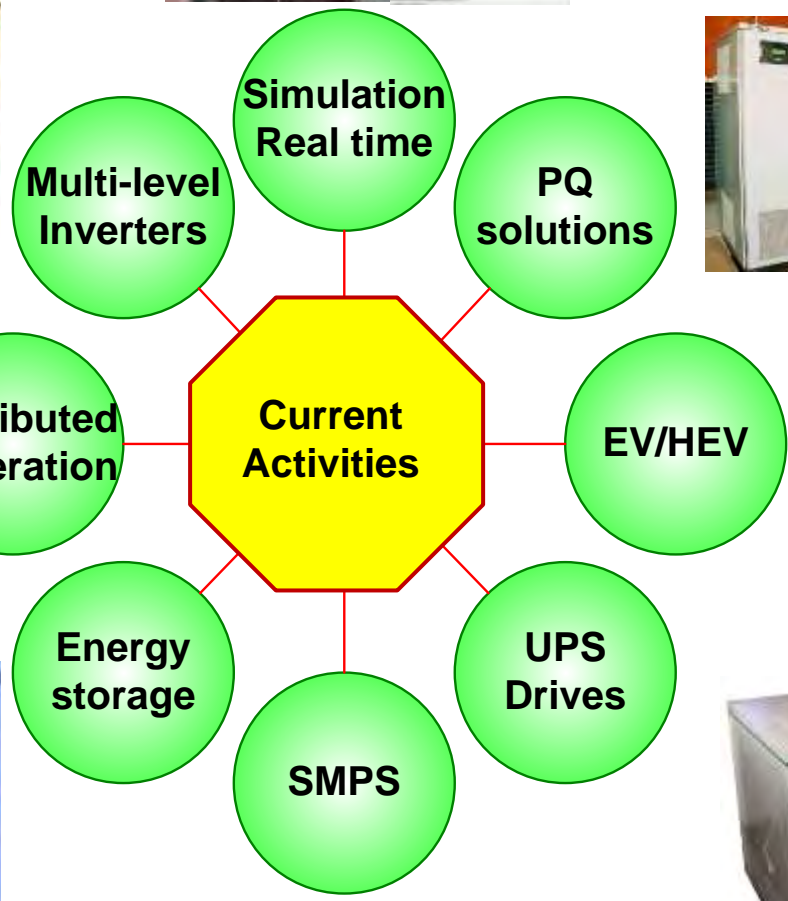# National Mission on Power Electronics Technology(NaMPET)

NaMPET is a multi-institutional programme funded by DeitY involving research, development, deployment/ demonstration and technology transfer for production and commercialization of Power Electronics technology. This is implemented through a network of Academic Institutes, R&D laboratories and Industries with **CDAC Thiruvananthapuram** is the Nodal centre for implementation of this programme.

Technology focus area
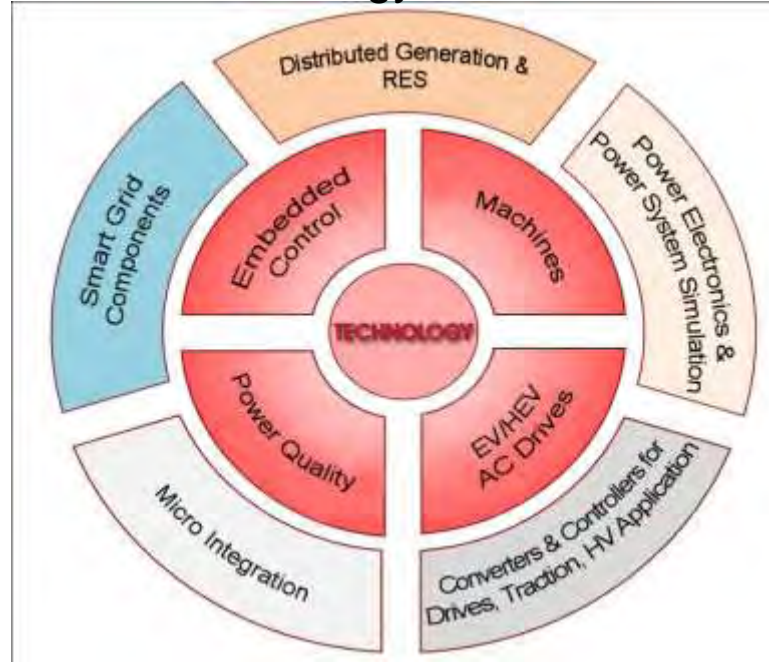
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NaMPET Phase 1(completed)- 5 Years, ~ Rs 25 Crore
NaMPET Phase II(Ongoing) ~Rs 50 Crore

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Simulation Real time

PQ solutions

Multi-level Inverters

Distributed Generation

Current Activities

EV/HEV

Energy storage

UPS Drives

SMPS

Smartgrid initiatives by DeitY through NaMPET

- Renewable energy integration, microgrids
- Power Quality mitigation technology
- Phasor Measurement Units, Wide Area Monitoring
- Smart Energy Meters
- Net Zero Energy Building(NZEB)
- Low Voltage DC system

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Smartgrid

Considered as Energy Internet with increased efficiency, availability, response and security

Larger use of renewable energy sources with positive impact on environment

Transforms the way power is delivered, consumed and accounted for

Major impact will be the reduction in peak demand

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Renewable Energy Integration

- Grid Interactive Solar Photovoltaic Power Plants & WEG
- Microgrid Technology-Universal Front End for renewable energy sources

Grid interactive solar PV power plants

Features

- Capability to ride through faulty and disturbed grid conditions(LVRT)
- Voltage stabilization by reactive power support
- Improved Power Quality, Efficiency, reliability, modularity & redundancy
- Stiff control over active power like in conventional rotary generators
- Communication features and remote controllability
- Paralleling of Inverters and DC-DC converters
- Maximum Power Point Tracking for SPV systems
- Power export to grid at UPF and programmed PF
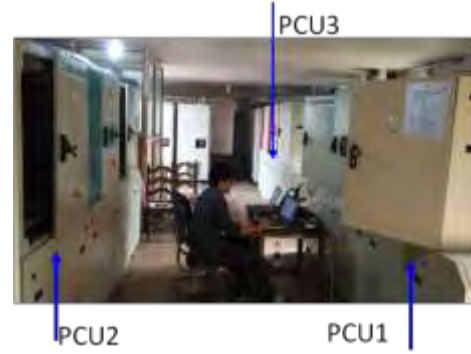- Protections as per standard IEEE-929-2000 (Anti islanding protection)

Technology available

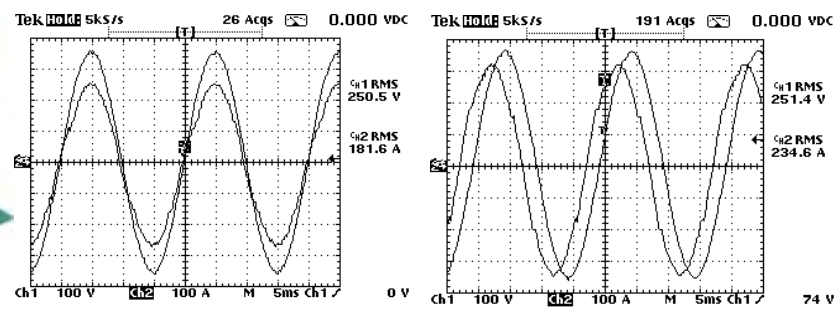- ✓ 25 kW Power Conditioning Unit(PCU) for roof top application
- ✓ MW Level PCUs

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Renewable Energy Integration

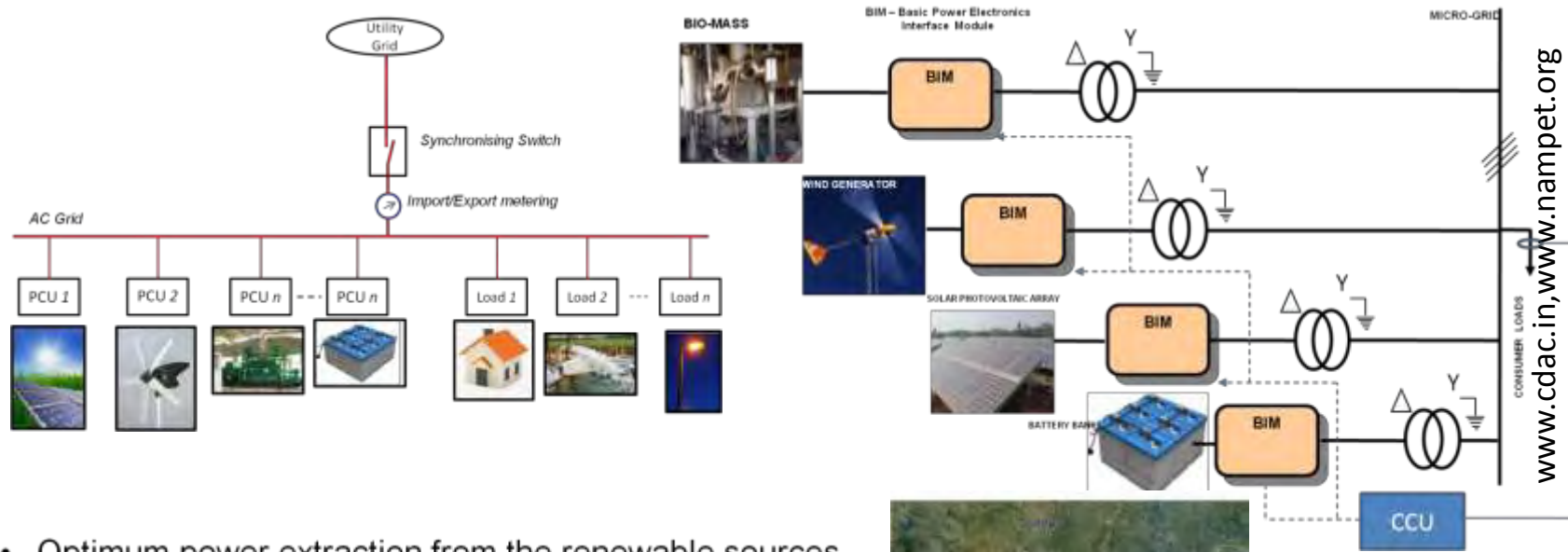**Digital Controller**

PCU3

PCU2   PCU1

25 kW System

1 MW System

Renewable Energy Integration

Microgrid technology with universal front end power conditioning unit

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- Optimum power extraction from the renewable sources.
- Power flow management (Active and reactive)
- Monitoring of thermal performance of circuit elements.
- Communication between individual blocks of the system and the central control unit.
- Control during short circuits
- Maintenance of synchronism of the micro grid during grid interactive operation
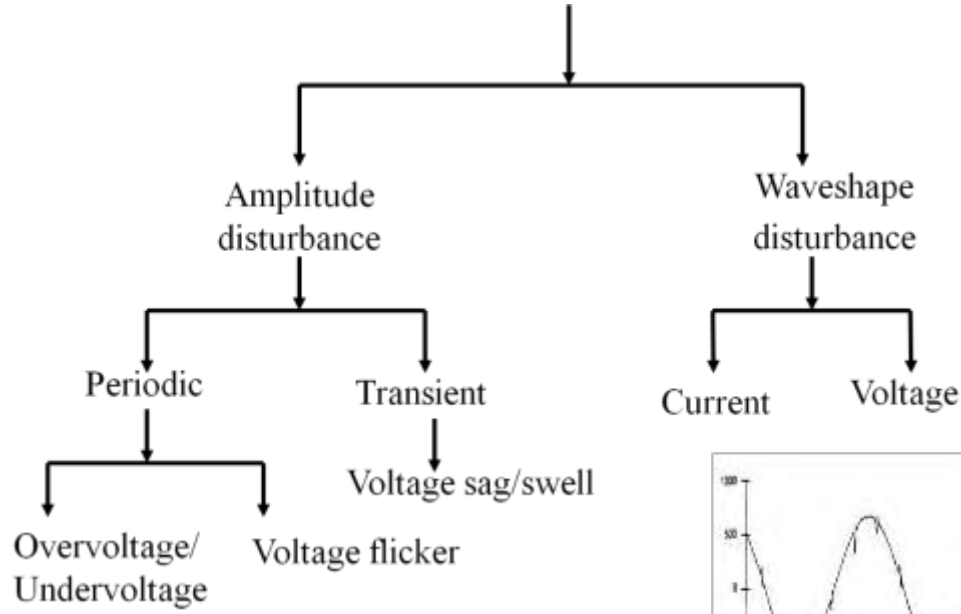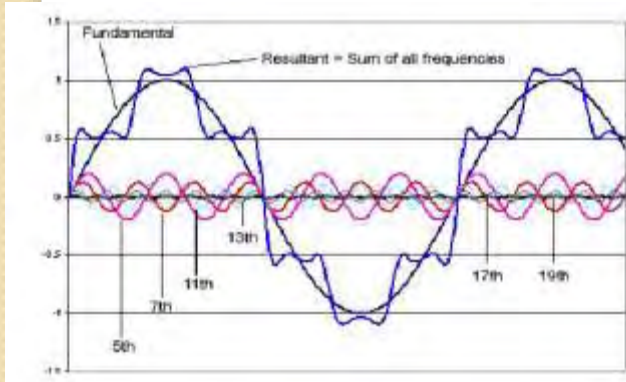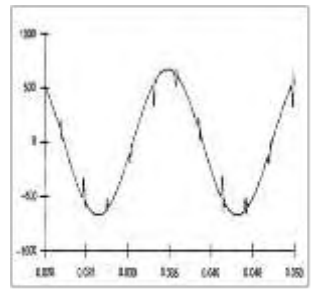- Control during the islanding events

Moushuni island

PCU

Power Quality Technology

The dream!

Amplitude disturbance

Waveshape disturbance

Periodic

Transient

Current

Voltage

Overvoltage/ Undervoltage
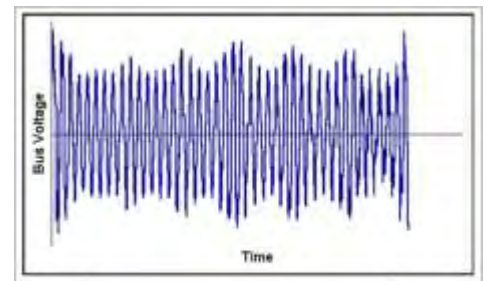
Voltage flicker
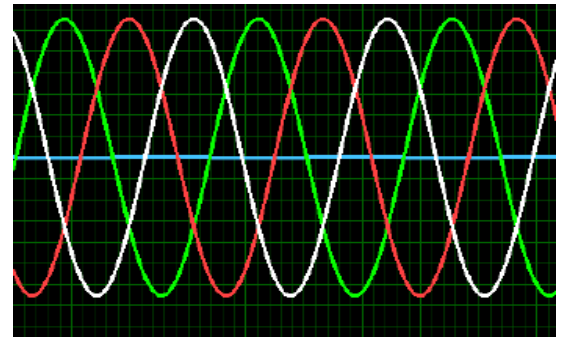
Voltage sag/swell

Voltage Sag & Swell

Voltage Notching

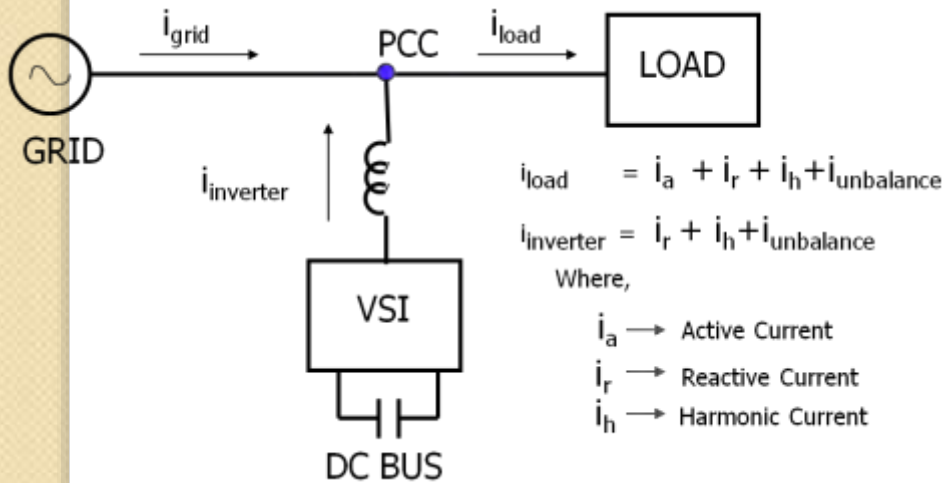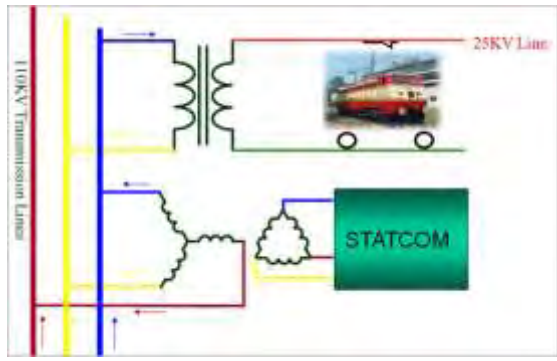Harmonics

Voltage Interruption

Voltage Flicker

Power Quality Solutions

Custom Power devices

Inverter based solutions with very high dynamics to compensate

✓ Reactive currents(single phase and three phase)
✓ Harmonic currents
✓ Unbalance currents
✓ Neutral currents
✓ Voltage stabilisation with reactive power compensation

$$i_{load} = i_a + i_r + i_h + i_{unbalance}$$

$$i_{inverter} = i_r + i_h + i_{unbalance}$$

Where,

i_a → Active Current
i_r → Reactive Current
i_h → Harmonic Current

- Single phase Active filter/STATCOM(100kVA)
- Three phase three wire AF(750 kVA)
- Three phase four wire AF(2 MVA)
- Static Power balancer (50 kVA)
- Shunt hybrid filter (50 kVA)
- Dynamic Voltage Restorer (50 kVA)
- Unified Power Quality Controller(250 kVA)

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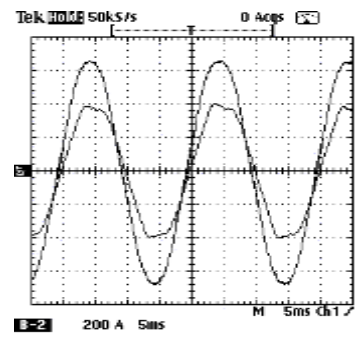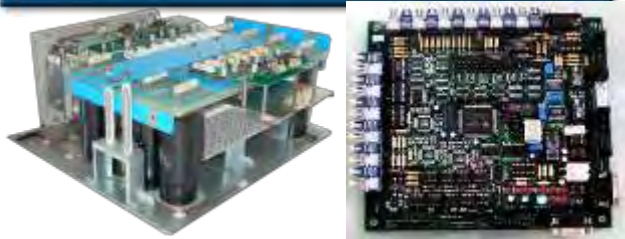
Power Quality Solutions

Static Power Balancer-50 kVA
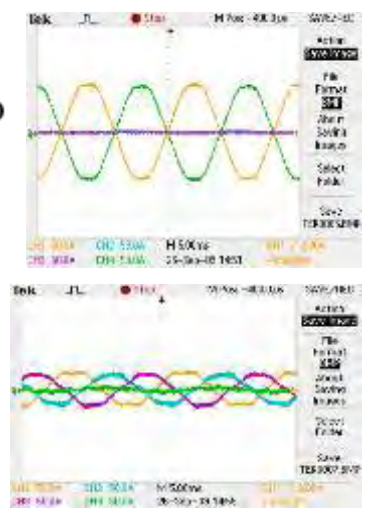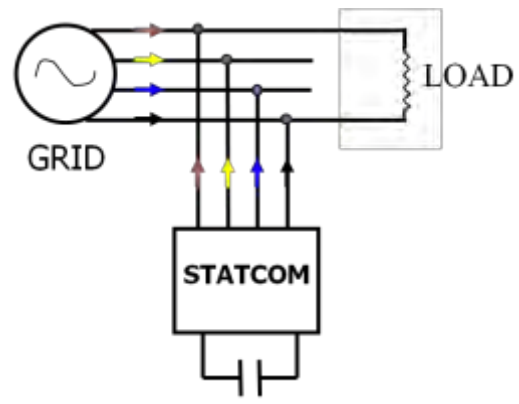
AF for Steel mills-750 kVA
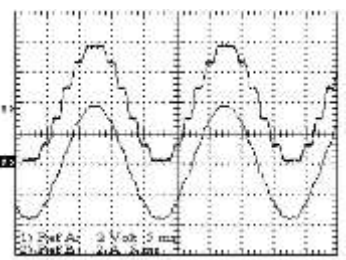
STATCOM for Process industries

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Power Quality Solutions-STATCOM for IT Parks(2 MVA)

Synchronised Phasor Measurement Unit

- A device that samples analog voltage and current in synchronism with a GPS clock
- Samples are used to estimate the corresponding phasors
- Measure frequency & rate of change of frequency
- Timestamps all measurements
- Transmits time-stamped data to central control centre
- PMUs installed at widely dispersed locations can estimate phasors simultaneously with GPS clock synchronism
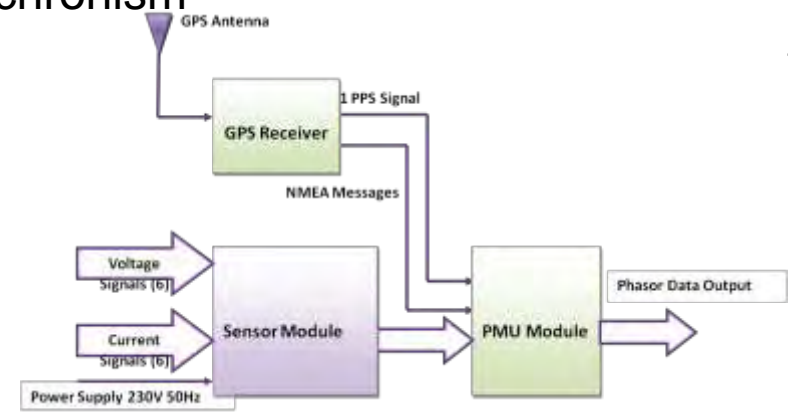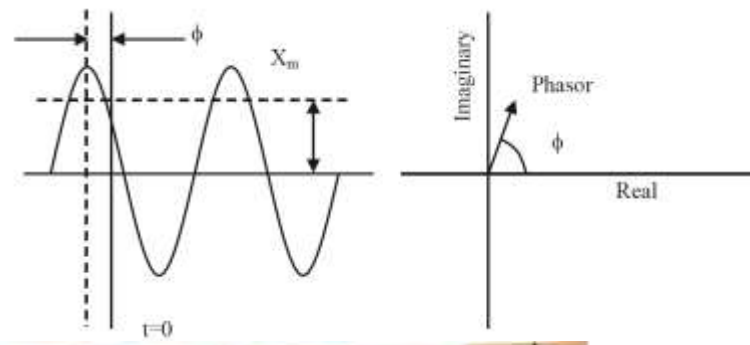
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Wide Area Monitoring

Project funded by DeitY
CDAC-T, IITB, CPRI KSEB

Deployment of indigenously developed PMUs in the 220 kV network of KSEB and establishment of WAM system

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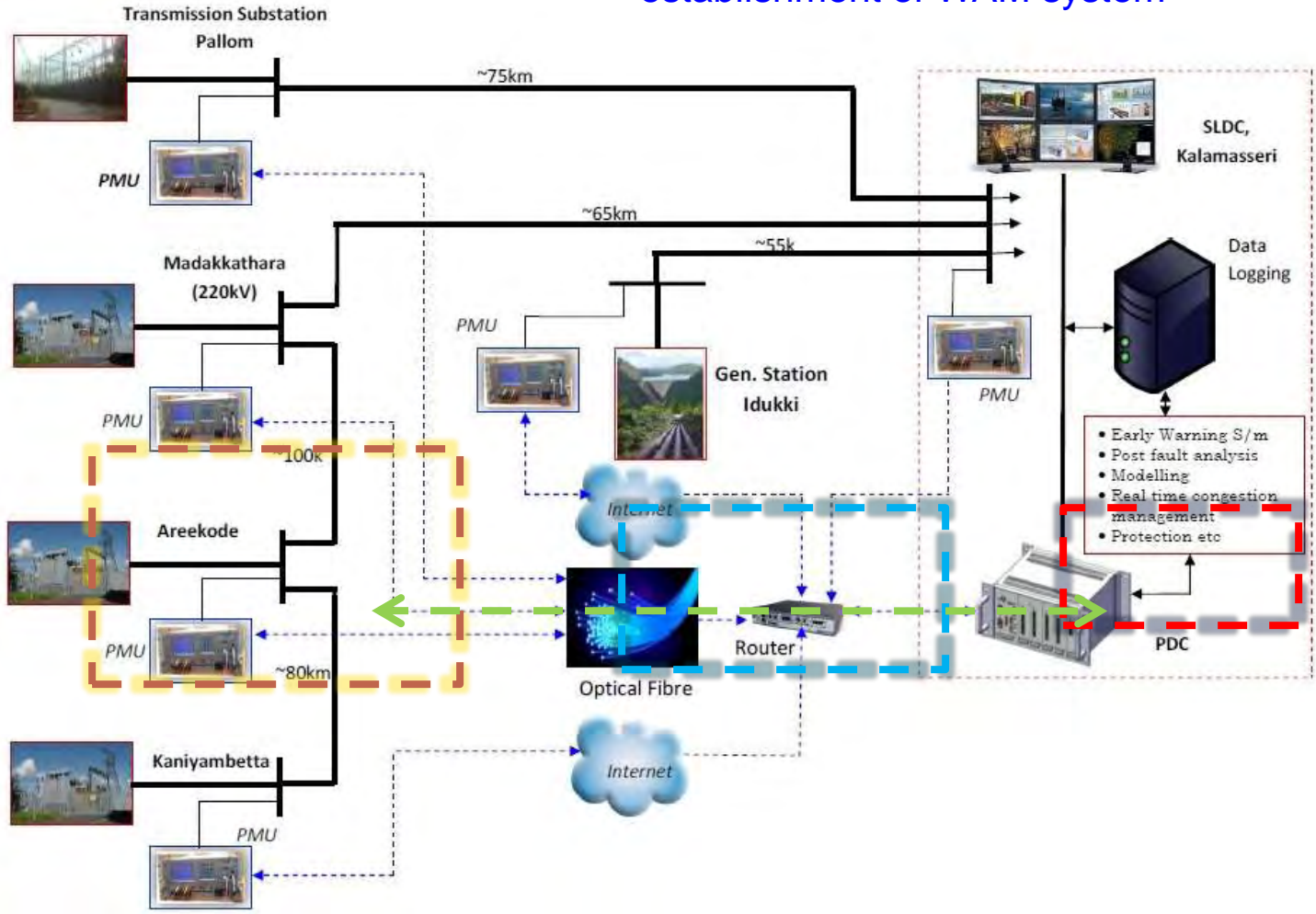
Wide Area Monitoring(Contd)

PMU panel frond side

PMU panel -Back side

PT connections from KSEB's measurement PTs

Cable laying

Clamp CT

Signal conditioning PCB enclosure

PC installed at LDC

Parameter monitoring software

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Development of Smart Energy Meter

Specifications – Single phase category 1

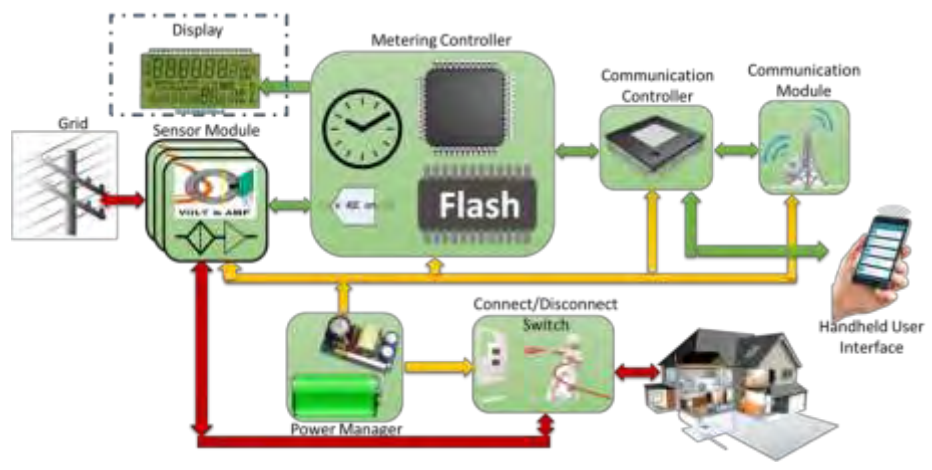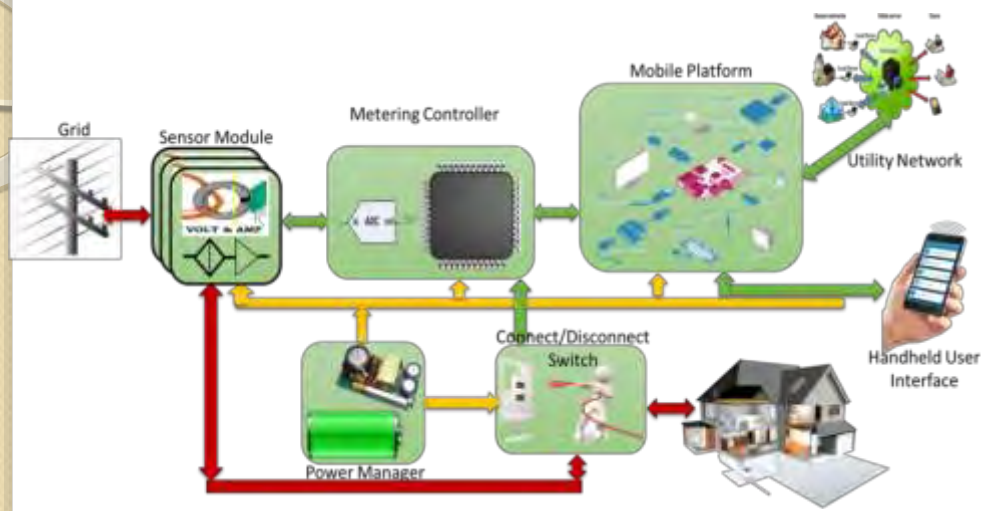| Connection Type	Single phase 2 wire direct connected
Standards	IS 13779, IS 15959, IS 15884, IEC 62056-21,42,46,47,53,61,62
Metrology Accuracy	Class 1
Rated Voltage	240 V (-40% to +20%) Single Phase
Rated Current	Ib (Imax)A = 5(30)A , withstands 120% Imax
Starting Current	0.2% Ib
Frequency	50 Hz ±5%
Burden Voltage Circuit	2W / 8VA
Burden Current Circuit	<4VA
Load Contactor	Latching relays (optional)
Display	LCD
LED indicators	LED pulse 3200 imp/kWh LED Network status
Communication port/methods	GSM/RF/WiFi
Communication protocol	DLMS COSEM
Operating Temperature Range	-10 °C to +55 °C
Storage temperature range	-25 °C to +70 °C
Operating humidity	Up to 95% non-condensing
Degree of Protection	IP51

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Development of Smart Energy Meter

Specifications – Three phase category IV

Connection Type	Three phase 4 wire direct connected
Standards	IS 13779, IS 15959, IS 15884, IEC 62056-21,42,46,47,53,61,62
Metrology Accuracy	Class 1
Rated Voltage	240 V (-40% to +20%) Single Phase
Rated Current	Ib (Imax)A = 10(60)A, withstands 120% Imax
Starting Current	0.2% Ib
Frequency	50 Hz ±5%
Burden Voltage Circuit	2W / 8VA
Burden Current Circuit	<4VA
Load Contactor	Latching relays
Display	LCD
LED indicators	LED pulse 3200imp/kWh LED Network status
Communication port/methods	GSM/RF/WiFi
Communication protocol	DLMS COSEM
Operating Temperature Range	-10 °C to +55 °C
Storage temperature range	-25 °C to +70 °C
Operating humidity	Up to 95% non-condensing
Degree of Protection	IP51

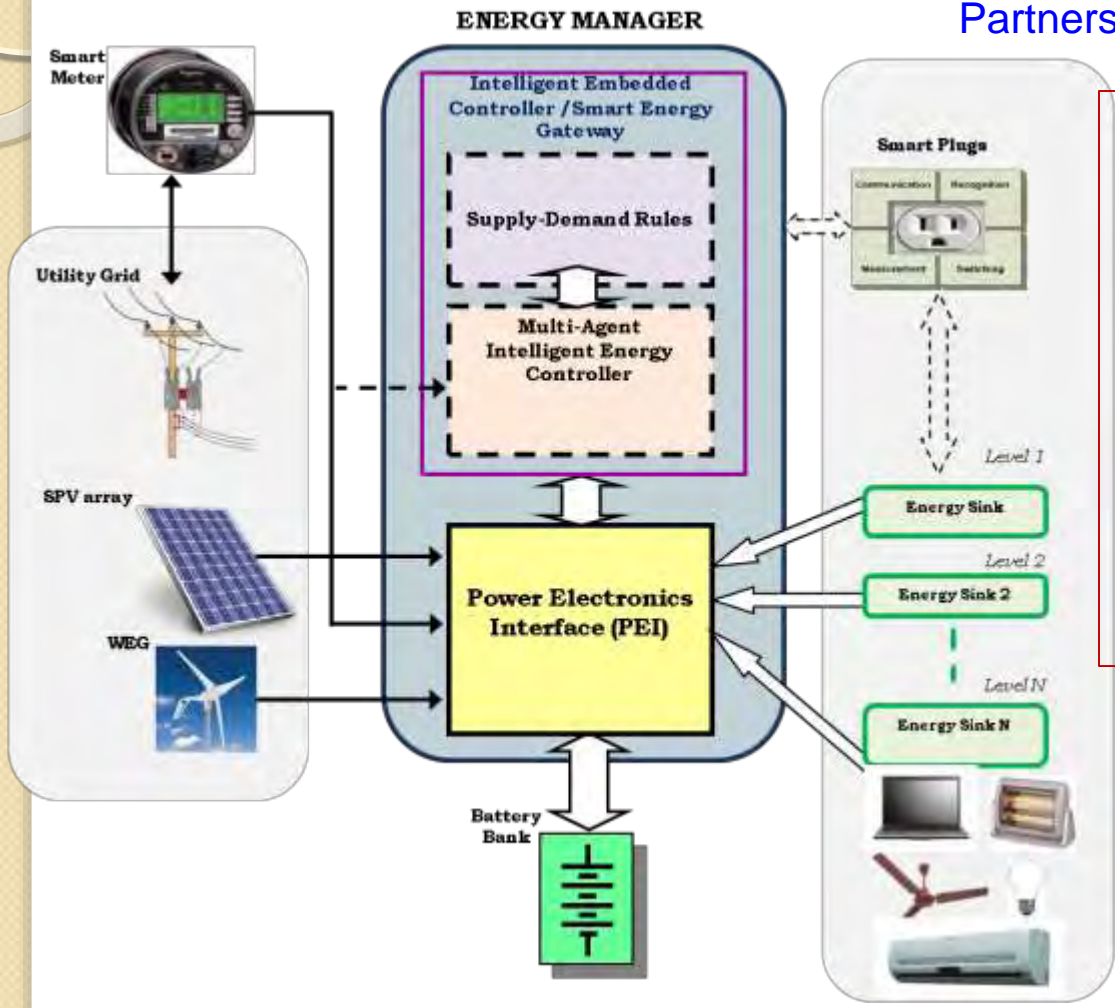www.cdac.in, www.nampet.org

Development of Smart Energy Meter

1GHz, ARM Cortex-A8 based circuit can support android and Linux OS Having 4GB internal and 512MB DDR3 RAM Expandable up to 32GB uSD

Net Zero Energy Building(NZEB)

Project funded by DeitY through NaMPET
Partners - CDAC-T & EMC

ENERGY MANAGER

✓ Reducing the energy
  consumption
  Using suitable NZEB energy
  management
  architecture with Intelligent
  embedded controller platform
✓ Smart integration of
  Non-conventional energy
  sources along with Battery
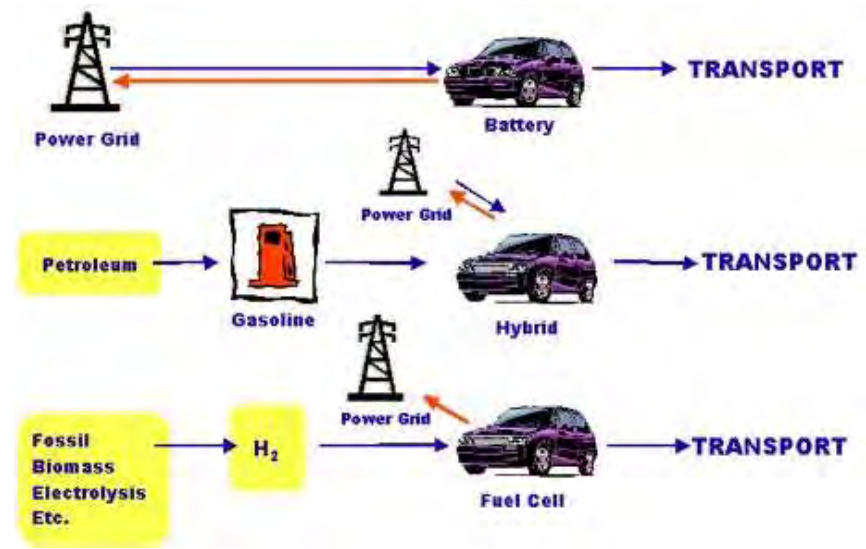 storage using
  Power Electronics interface
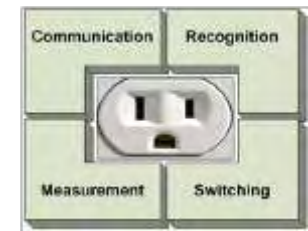
Smart plug

- Communication   - Zigbee
- Recognition   - software
- Measurement   - CT
- Switching   - PCB relay

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Vehicle to Grid Technology(V2G)

Most Extended form of V2G

- 100% Bi-directional Charger
- Power level of charge/discharge controllable
- Communication of Battery SOC to aggregator
- Location of Car aggregator
- Facility settings of Range for present & future drive
- The ability of the system to use large part of the battery SOC for power feeding

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Vehicle to Grid Technology(V2G)

V2G
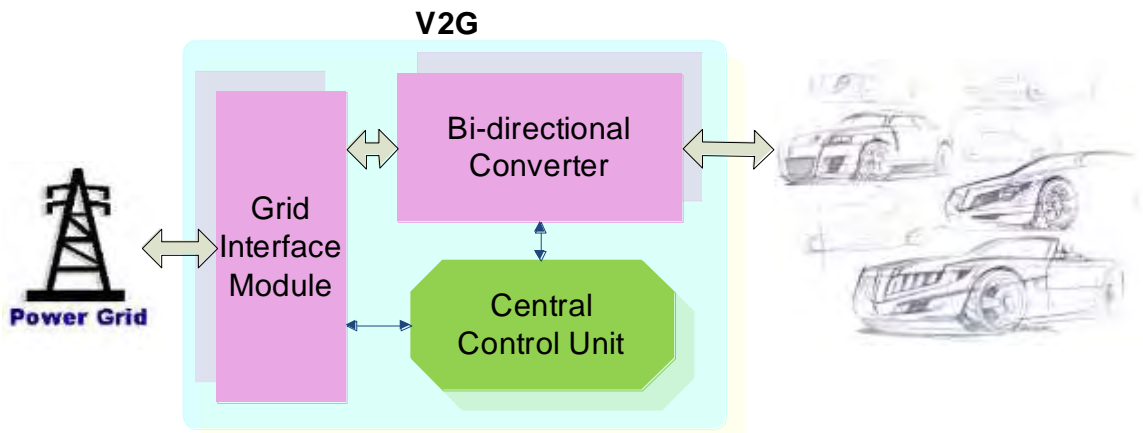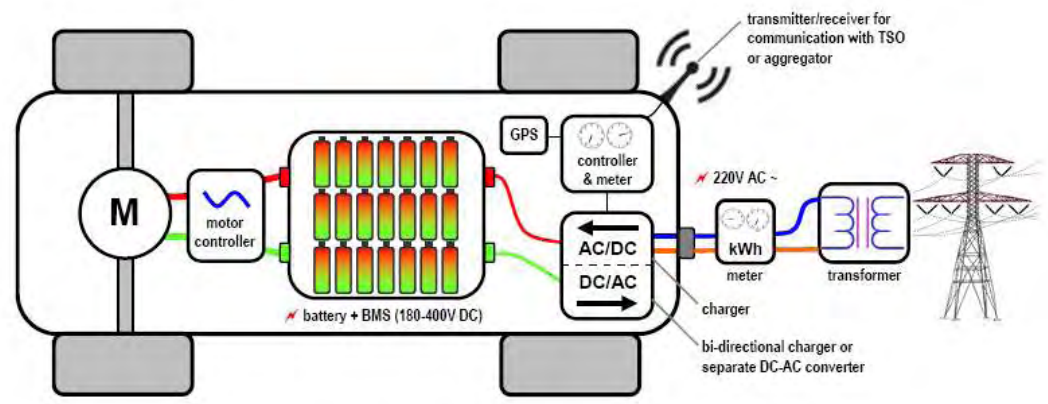

Bi-directional Converter
        Power Electronic Equipment can be external or inside the vehicle
Grid Interface Module
        Smart metering and other interface for connecting Aggregators
Central Control Unit
        Digital controllers for EV & HEV operations & V2G

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Vehicle to Grid Technology(V2G)

CDAC-T expertise towards V2G

Battery powered Electric vehicle with AC propulsion – M/s BHEL Bhopal

India's First HEV (bus) for passengers – Jointly with M/s Ashok Leyland

India's First 3 wheeler HEV (auto for passengers) – jointly with M/s KAL

Grid connected PV Solar powered Inverter - CDAC-T
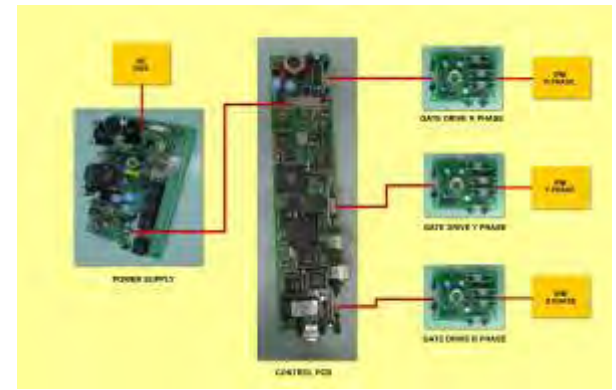
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Low Voltage DC(LVDC)

LVDC Power and control architecture

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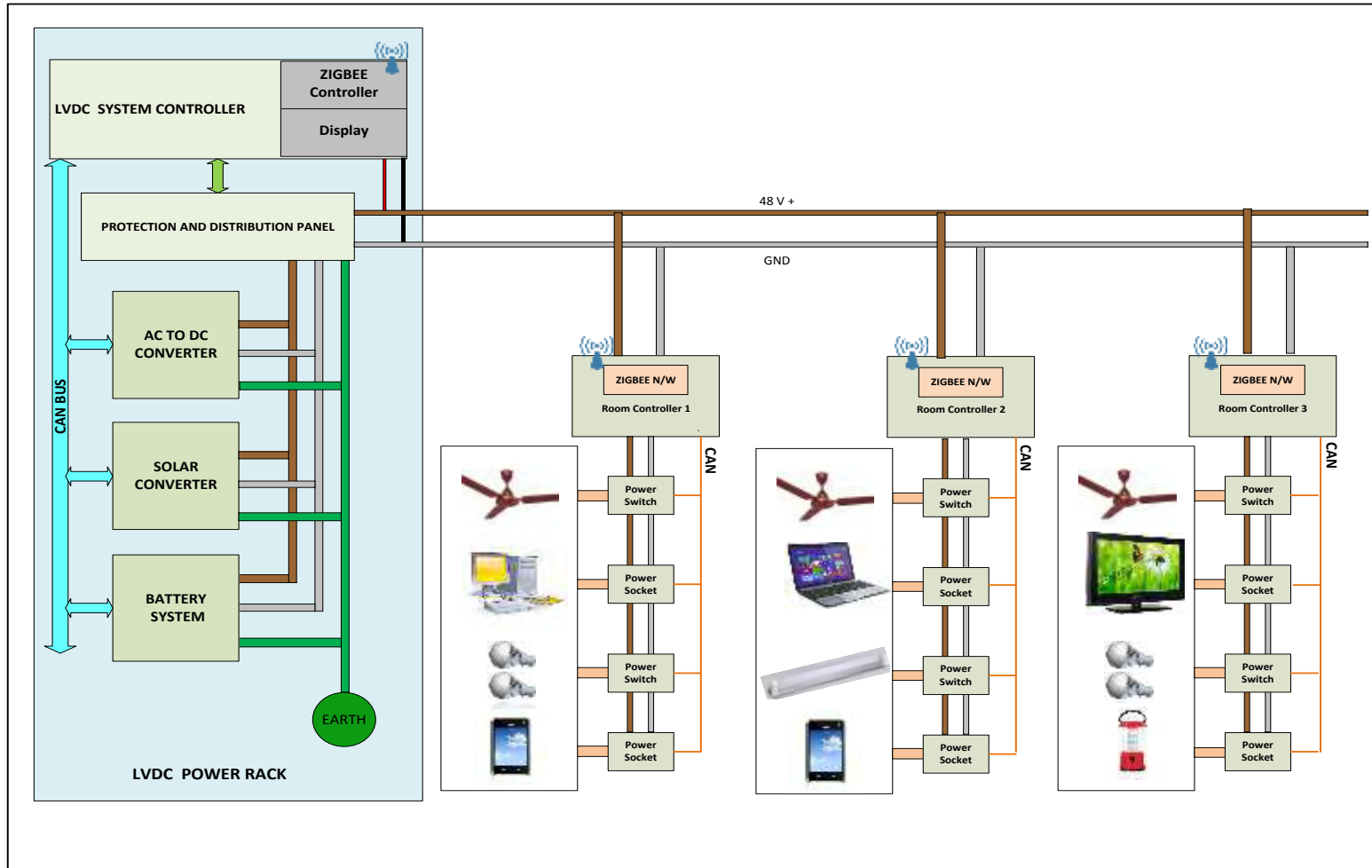
Low Voltage DC(LVDC)

Features

- ✓ Wireless control and connectivity with a smart Devices
- ✓ Scheduling functions to reduce energy consumption
- ✓ LVDC socket and switch can be switched ON/OFF using remote device
- ✓ One touch button to shutdown all the DC appliances.
- ✓ Group and simultaneously control is possible
- ✓ Appliance current & voltage can be monitored and recorded
- ✓ Saving energy and money

Solar PV Array

DC- DC Converter

Battery

DC Loads

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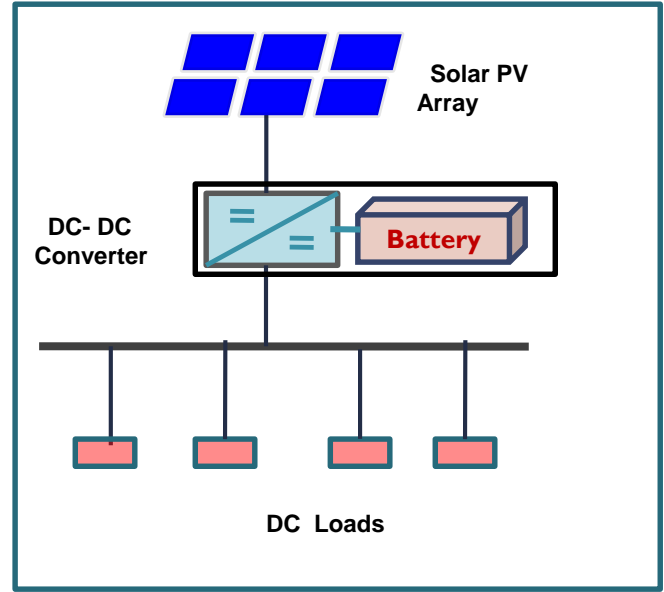
LVDC Module Development

LVDC System Controller : A dedicated controller for LVDC power and communication network management

LVDC power plug & Socket : Power outlet with 48V based on IEC TC 23 standard for a DC plug and socket outlet

LVDC power switch: Connecting fixed type of loads like BLDC fans and DC tubes lights

LVDC Power Converter: Supply the power required for the LVDC system. Dual Input with Solar PV & Battery. Rated power for 3Kw

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Thank You