A FIELD PILOT FOR RESEARCH AND DEVELOPMENT ON SMART CITY

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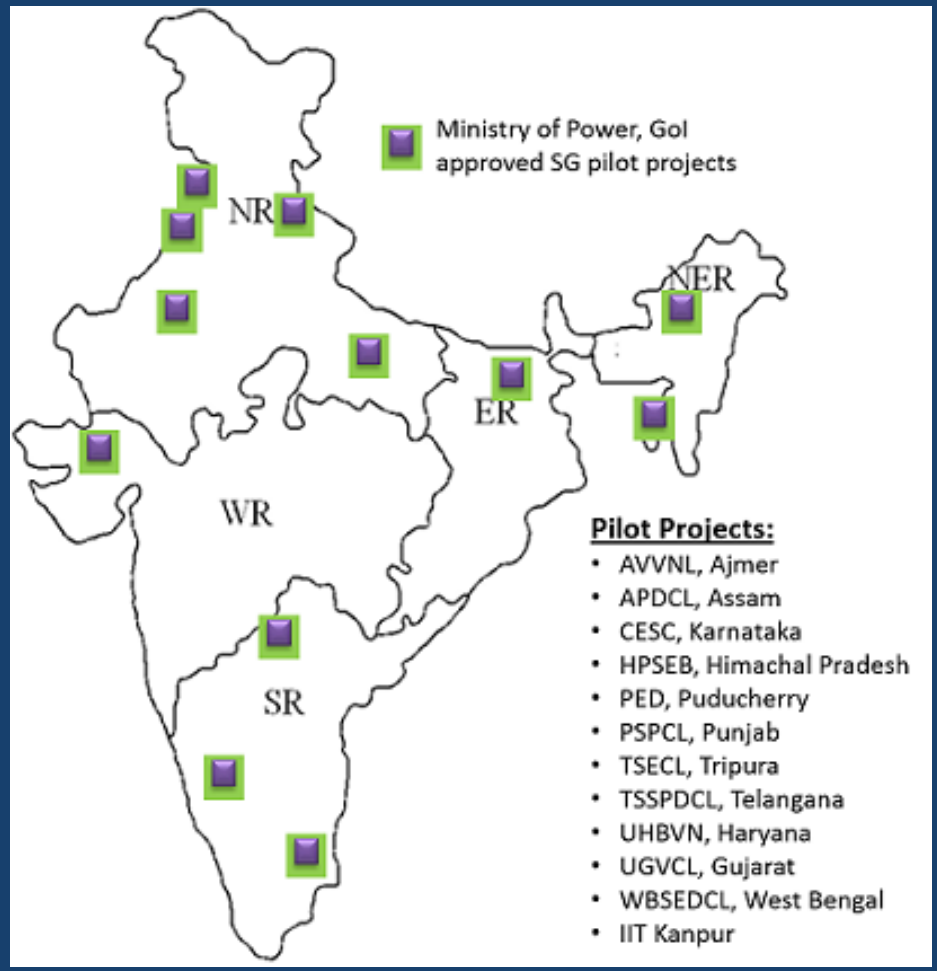
Smart city pilot project in IITK

- 12 pilot projects partially funded by the Ministry of Power (MOP) reached execution stage
- IITK 'Smart City' project is equally funded by the MOP and IITK
- The project looked into only the 'electrical' aspects of a smart city



Project highlight, objective, and scope

- IITK campus is chosen as the installation site
- The campus spans around 1000 acre (~4 km^2), accommodating close to 10,000 people.
- The electrical infrastructure of a prototype smart city is installed using state-of-the-art technologies, keeping in mind typical Indian market and consumer behavior.
- Identification of key challenges in smart city deployment, and development of innovative solutions
- Test-bed for future research in smart city/ smart grid related areas

Project highlight…contd.

- Installation/upgradation of key enablers of smart distribution system:
  - supervisory control and data acquisition (SCADA) system
  - advanced metering infrastructure (AMI) including smart meters
  - home automation (HA) system
  - integration of household rooftop PV systems
  - System integration (SI) is done on ESB architecture
- Training and demonstration for utilities, industries and academic institutions

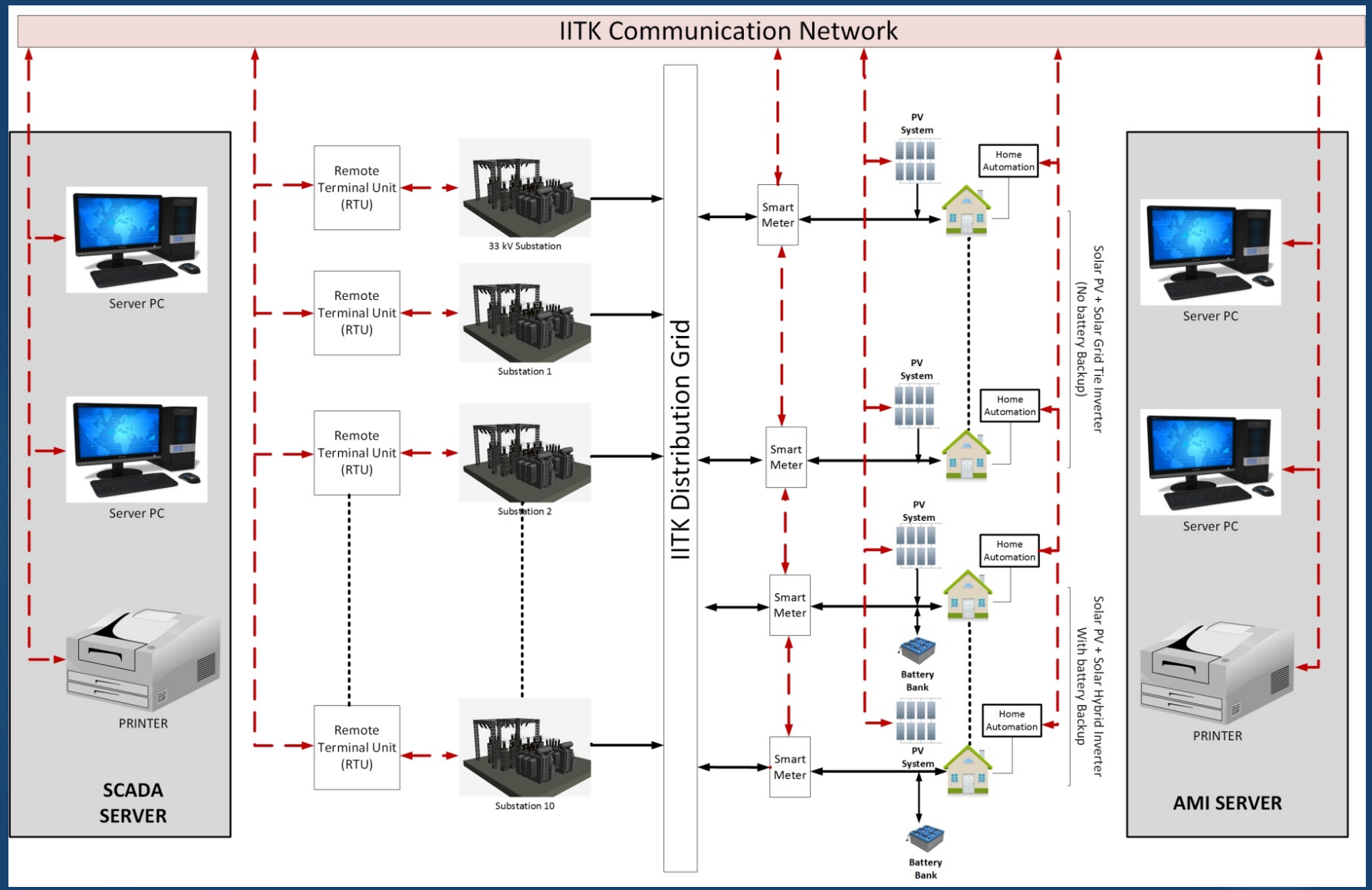
Electrical system

- IITK receives power at its 33/11 kV substation
- Total sanctioned load: 10.5 MVA; 10 no. of 11 kV/415 V substations to distribute power in the campus
- Distribution system is mostly underground
- RTUs installed in all substations as part of project, and the entire distribution network including LT feeders are now under SCADA
- Rooftop 5 kWp solar PV and HA system installed in 20 residential houses and the smart city control centre
- AMI includes these 20 houses, and also in 7 student hostels

Functionalities

- Smart home
- Advanced Metering Infrastructure (AMI)
- Smart city substation
- Smart city control centre
- Renewable integration
- Advanced IT infrastructure
- Enterprise Service Bus (ESB)
- Storage management

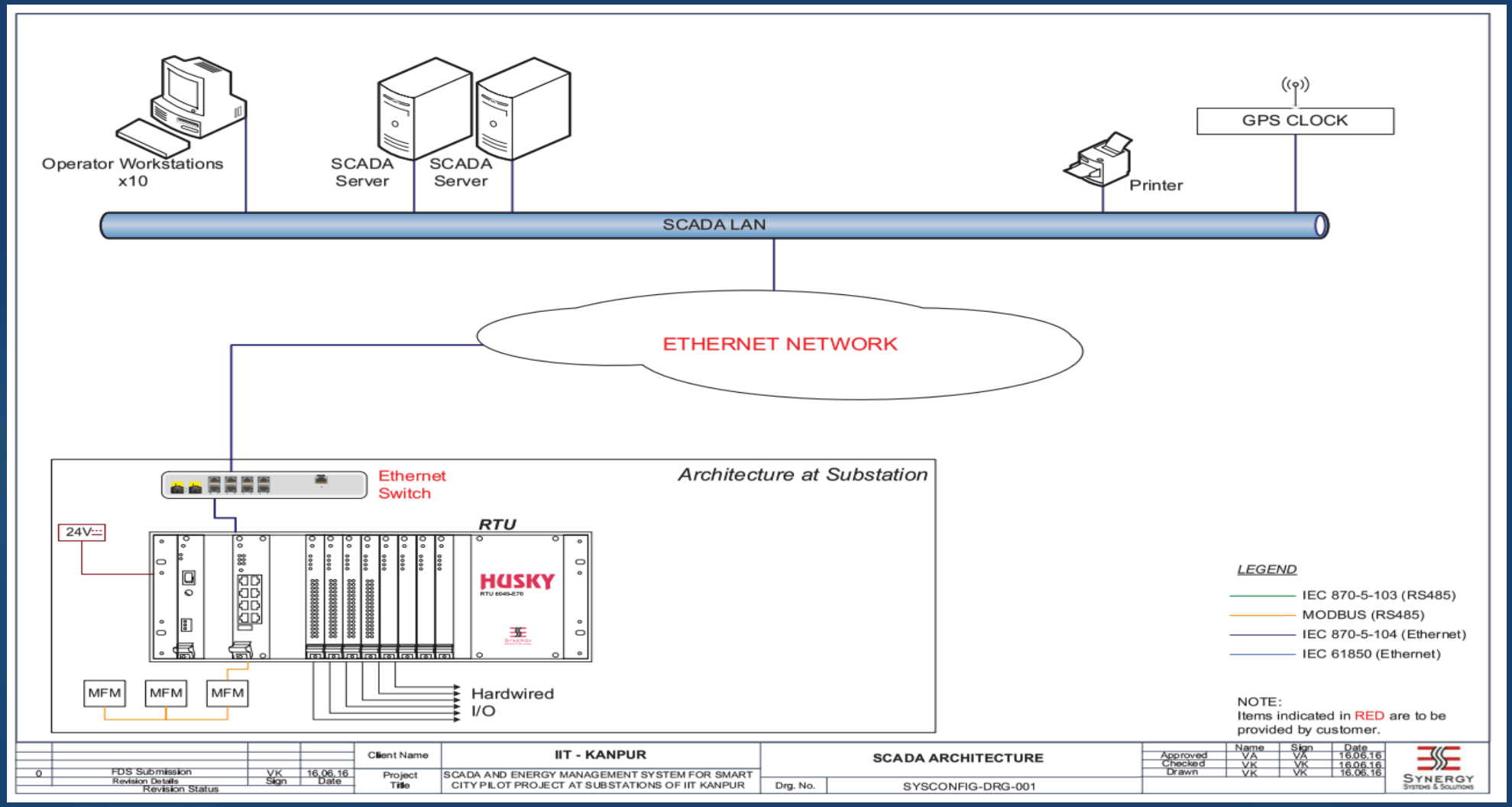
System Architecture



SCADA Functionalities

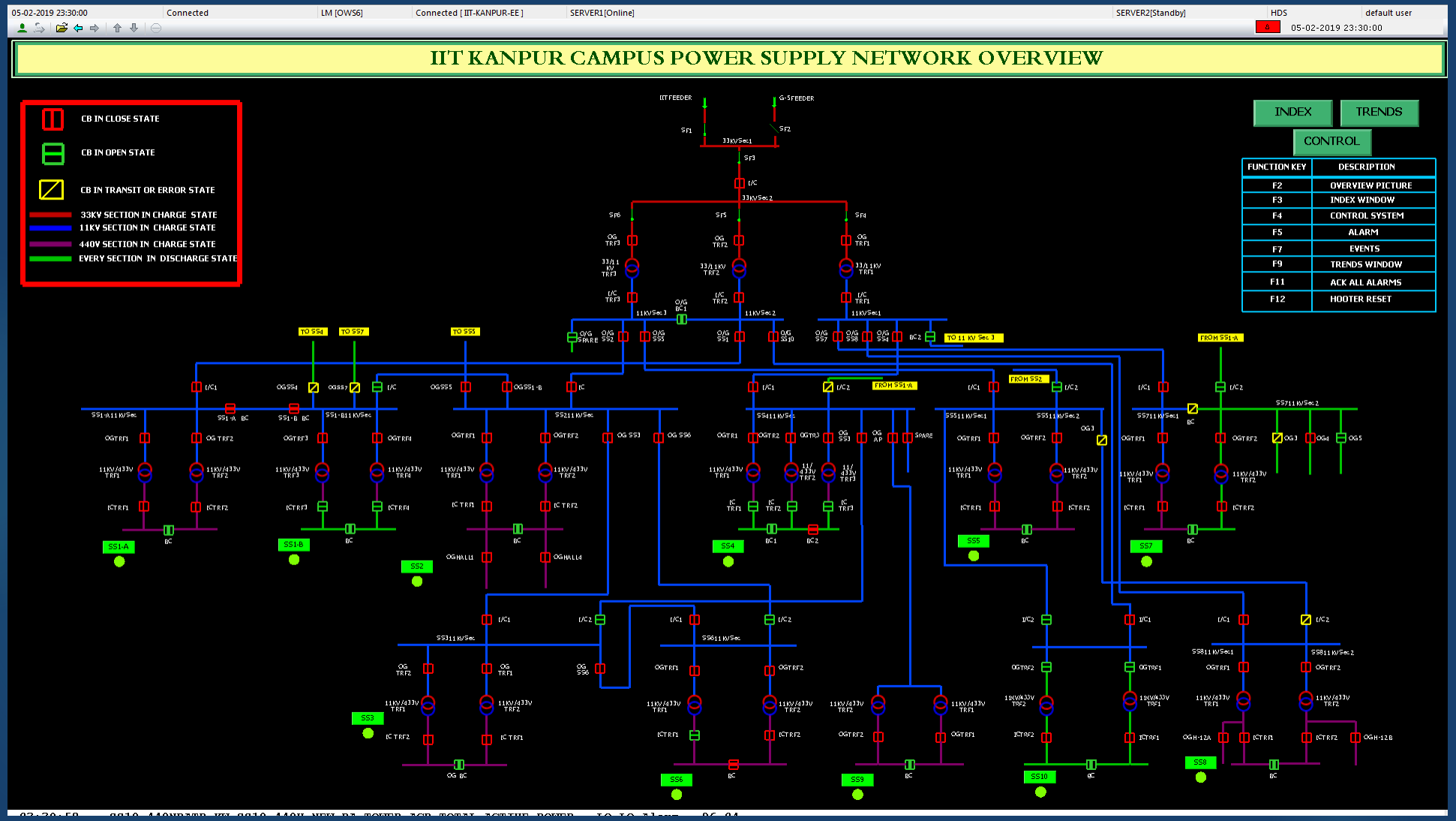
- Communications with RTUs
- Data processing, alarm/event handling
- Historical data storage
- Transfer of control commands to RTUs
- Energy management of metered feeders
- Graphical display of electrical switchgear at each station, dynamically colored network diagram to depict power flows, Analog parameters
- Control Functions: Switchgear control, Sector-wise Trip/Restore commands, Permit to work

SCADA Architecture

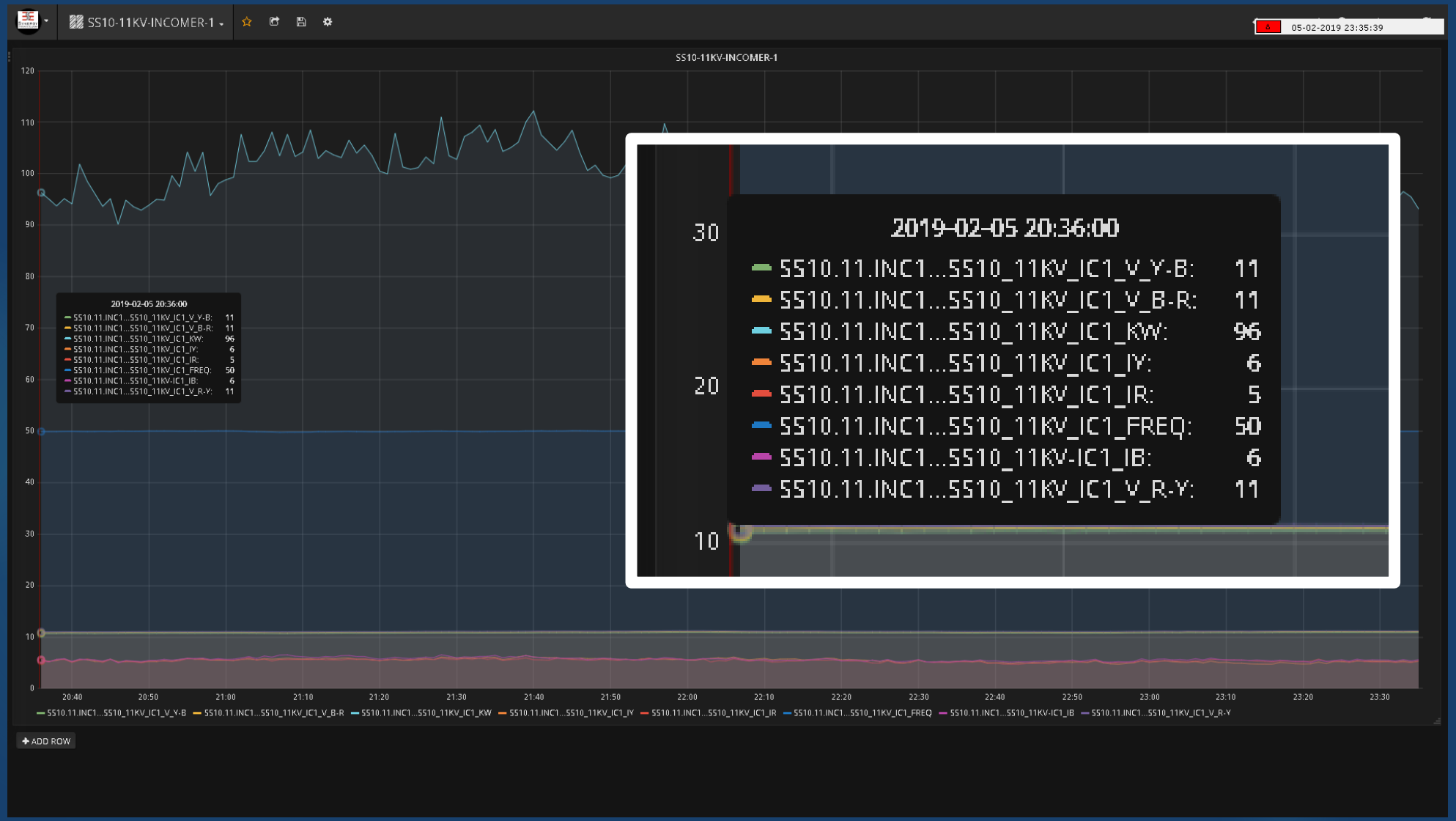


Control room

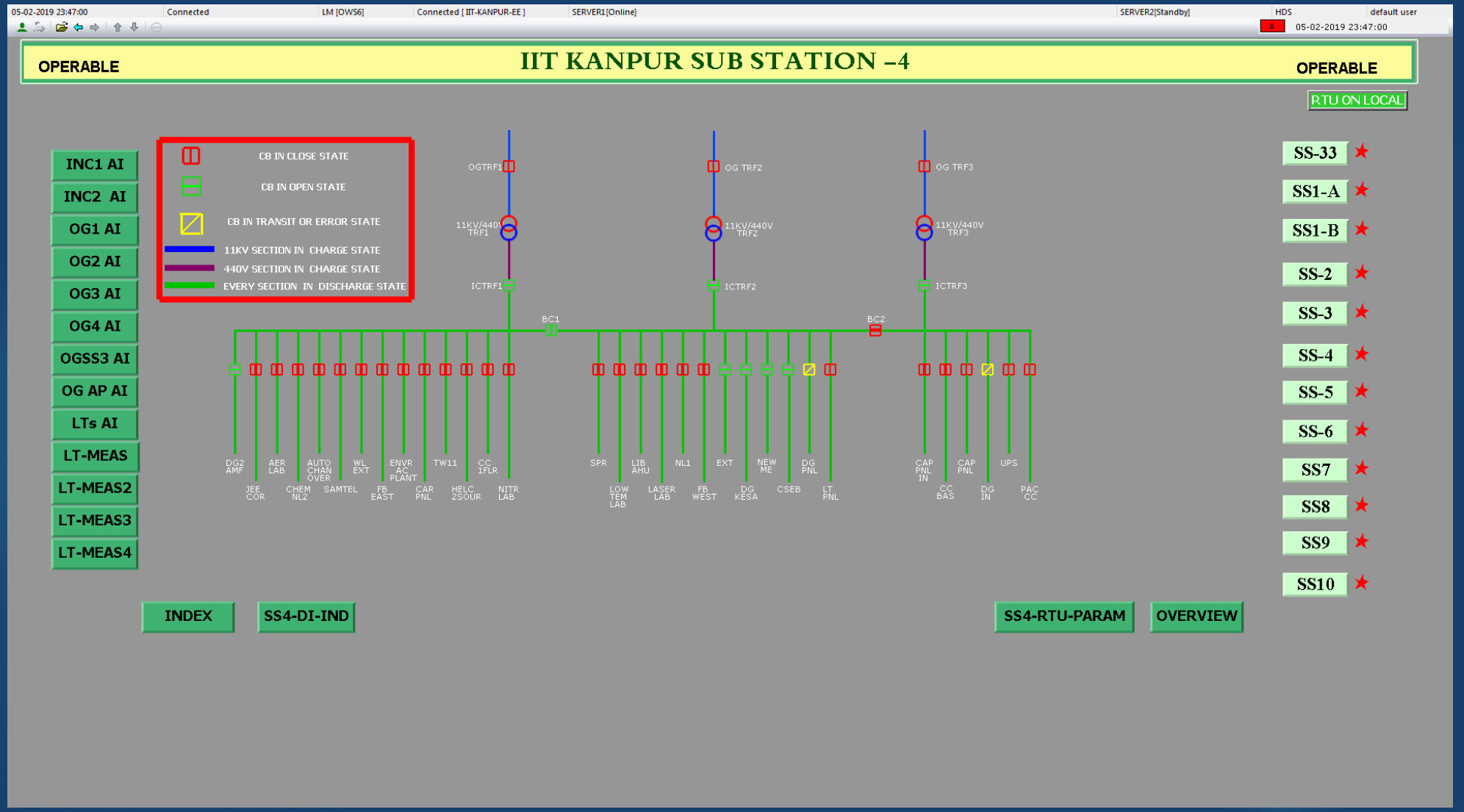
SCADA Single Line Diagram



Substation 10 Trends for Incomer-1



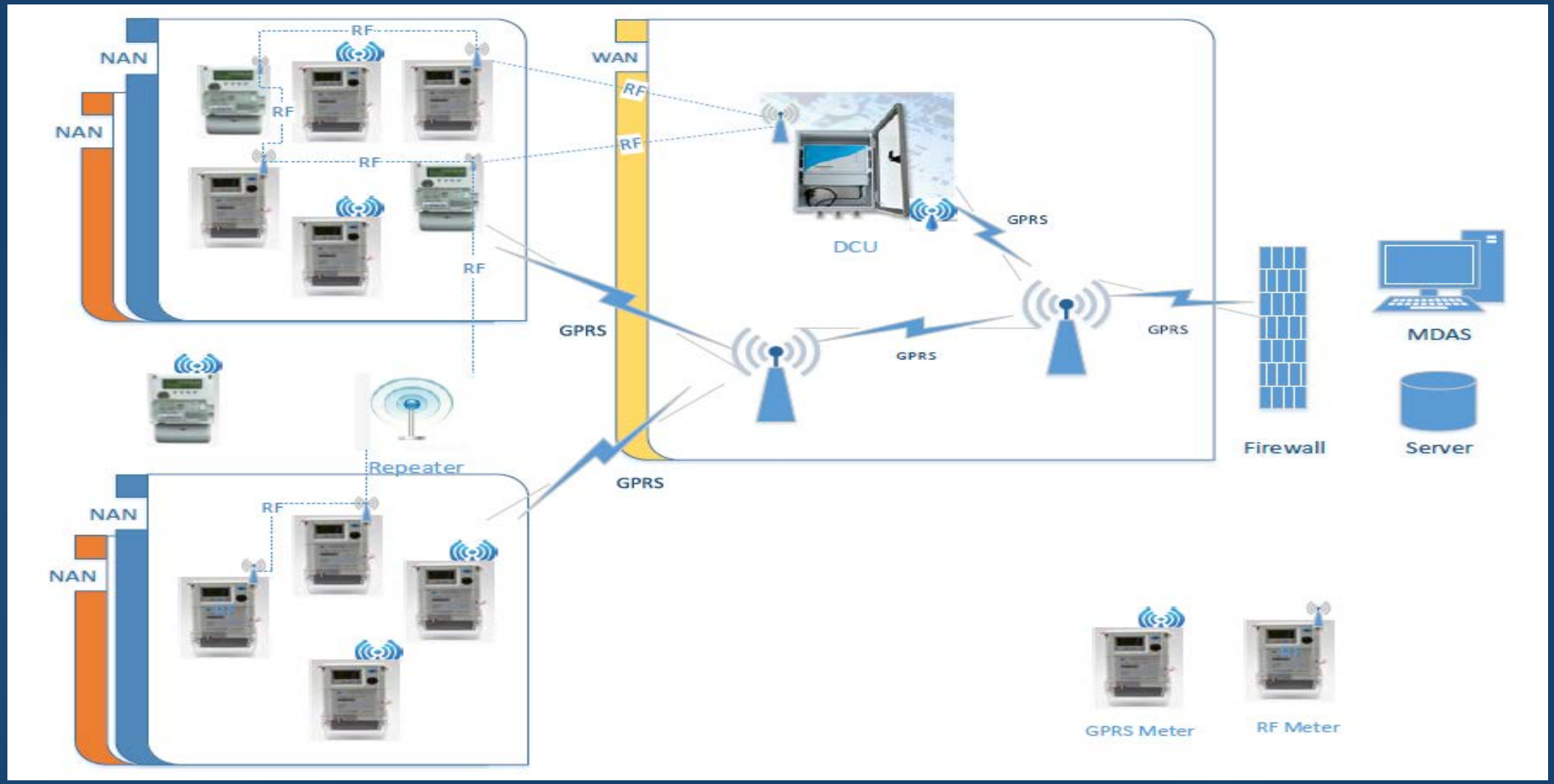
Single Line Diagram of Substation No. 4



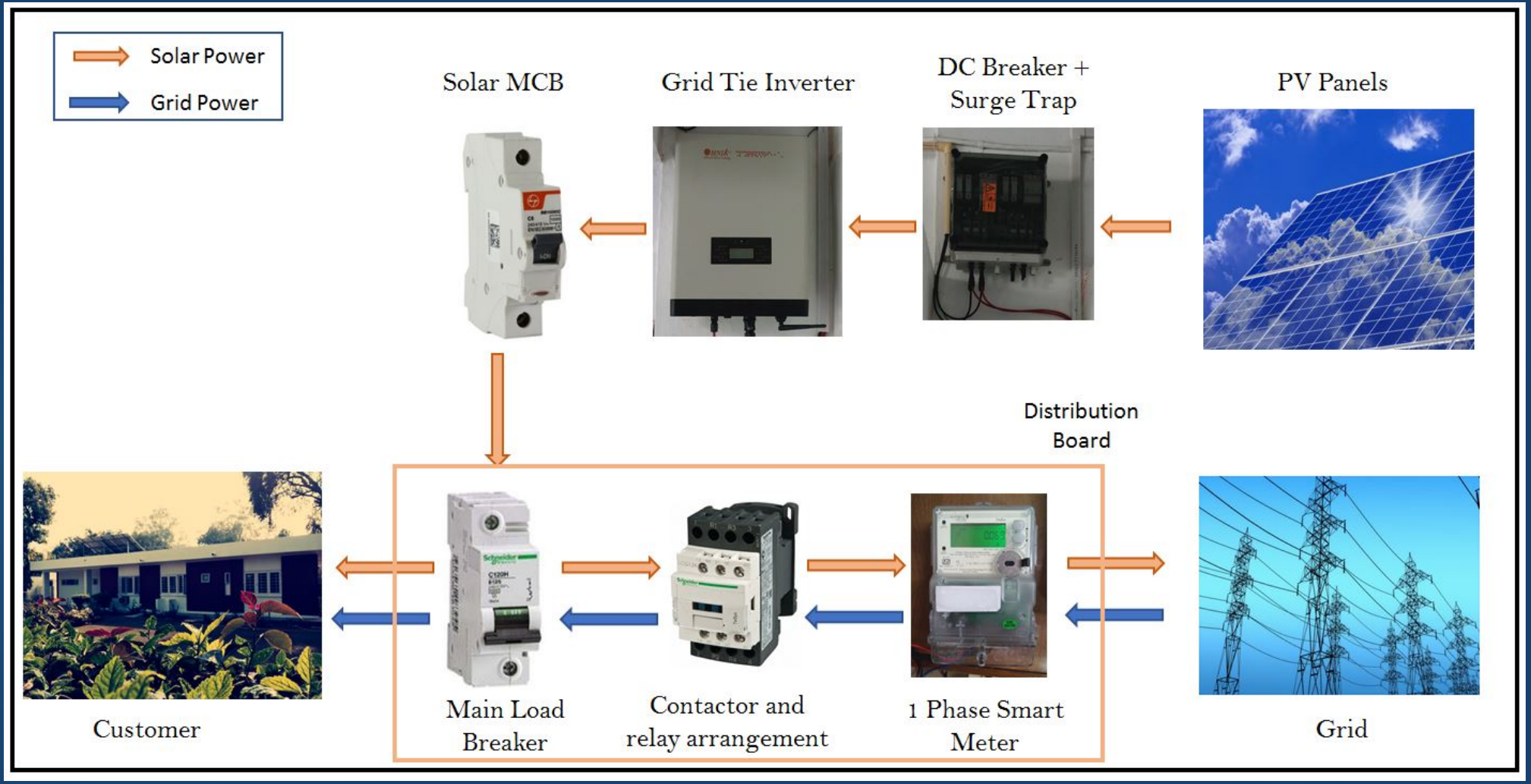
Advanced Metering Infrastructure

- Smart meters (1 phase, 3 phase)
  - IS 16444 compliance
  - Net metering, tamper-proof, remote connect/disconnect
  - GSM/WiFi/Ethernet connectivity
- Smart meter network
  - WiFi/RF/Ethernet network
  - DCUs communicate to smart meters
- Meter data management system (MDMS)
- Integration of MDMS with SCADA
- IT infrastructure for the MDMS

AMI implementation



Renewable Integration



Renewable Integration…contd.

- Solar PV system of capacity 5 kWp each, installed on the rooftop of 20 houses
- 16 houses are installed with Grid Tie Inverter and 4 with storage batteries & grid connected hybrid inverters
- The design of the hybrid inverters in these 4 houses was unique in the Indian market
- These battery-connected solar PV systems can feed to the grid, as and when required

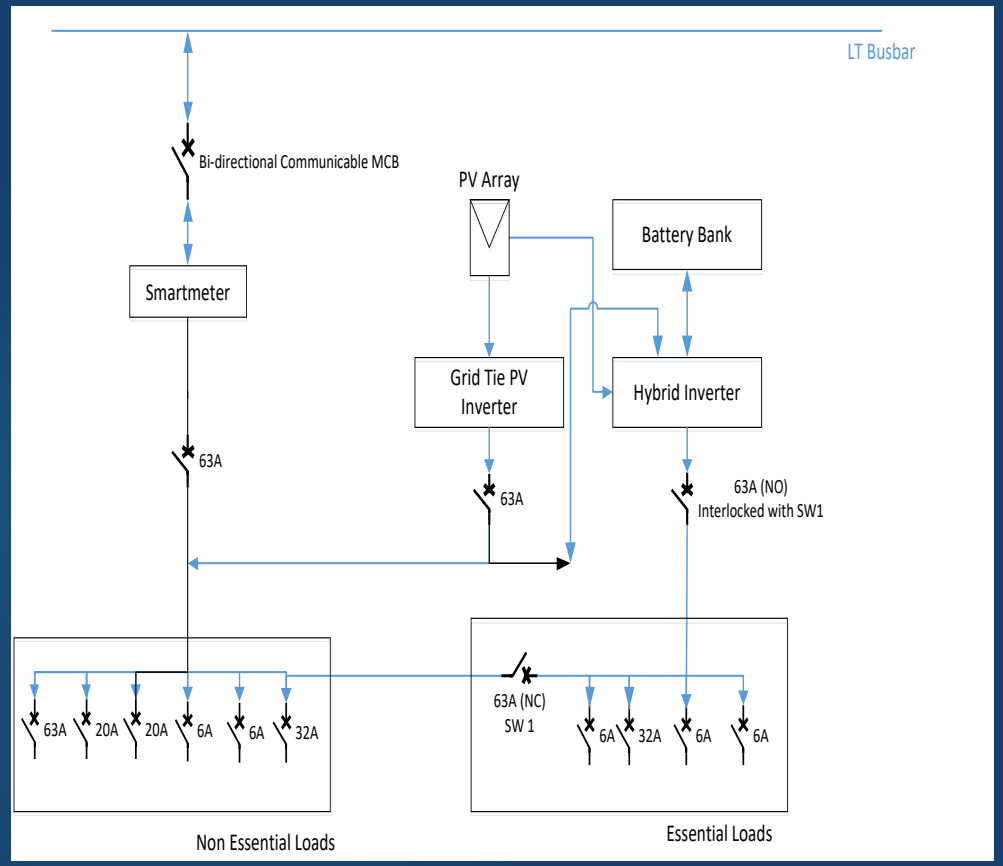
Smart home

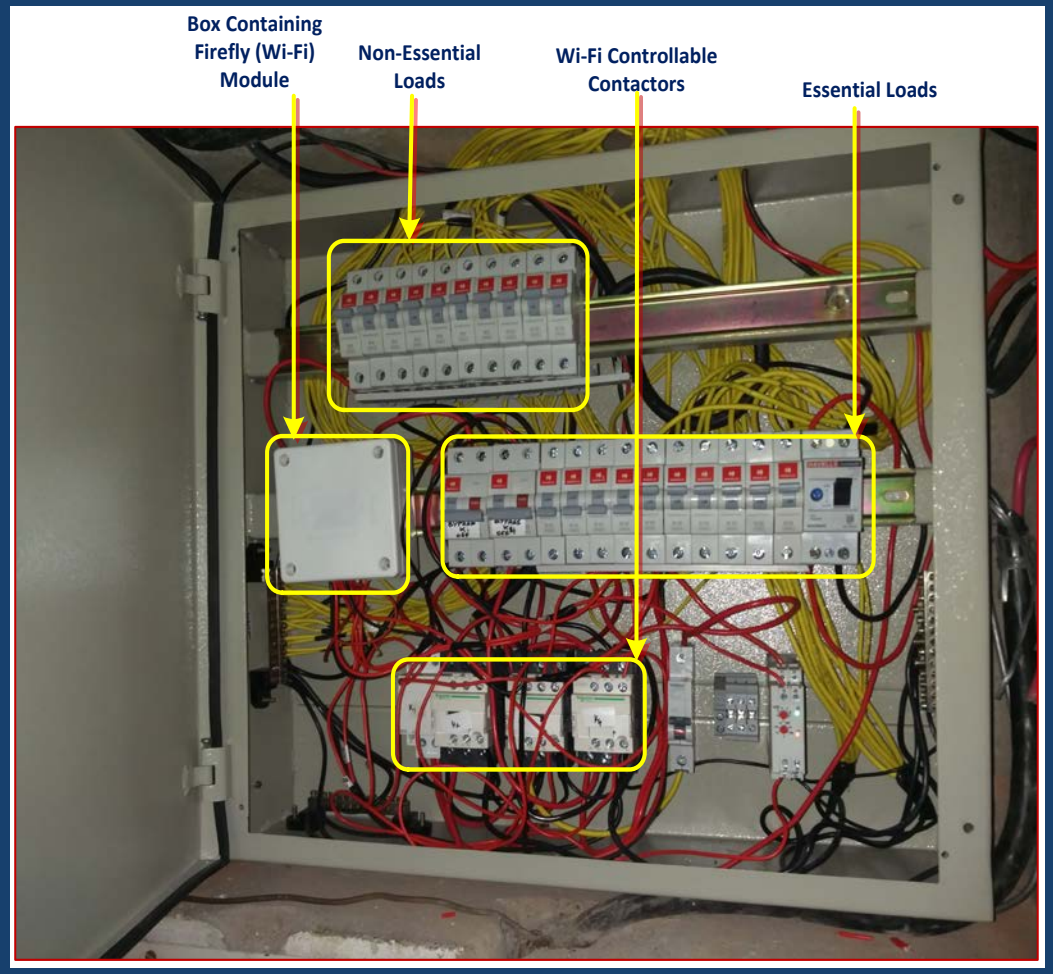
- Home Area Network
  - RF/Wifi based network within house
  - Sensors for monitoring and control
  - Smart lighting and cooling system
  - Remotely controllable electrical appliances
- Central Controller of Smart Home
  - Run energy efficiency applications
  - Facility to do peak load clipping
  - To provide real time energy usage details
  - To communicate with smart meters

System Integration (SI) & Home Automation (HA)

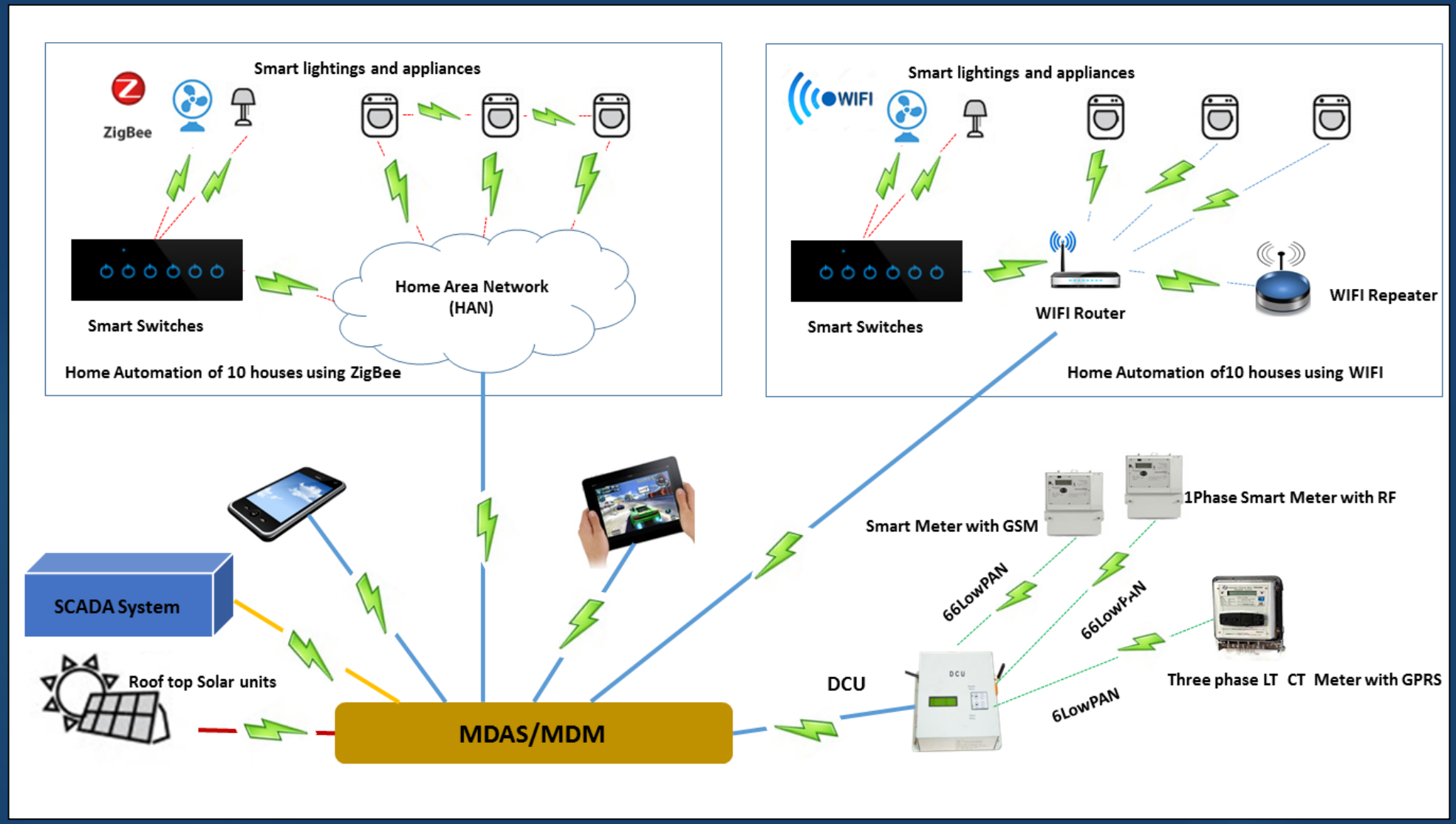
- SI software installed in control centre: integrates data coming from SCADA, AMI, HA, and solar inverters
- Functionalities: meter data management, automated billing, peak load management, and demand response
- HA communication technologies: wi-fi, Zigbee and Z-Wave
- Home appliances are controlled through the SI software or mobile apps.
- Customized distribution boxes (DBs) designed and installed in smart houses
- Non-essential and essential loads are segregated, and controlled through communicable MCBs placed in the DB

Customized distribution box for houses with Hybrid Inverters

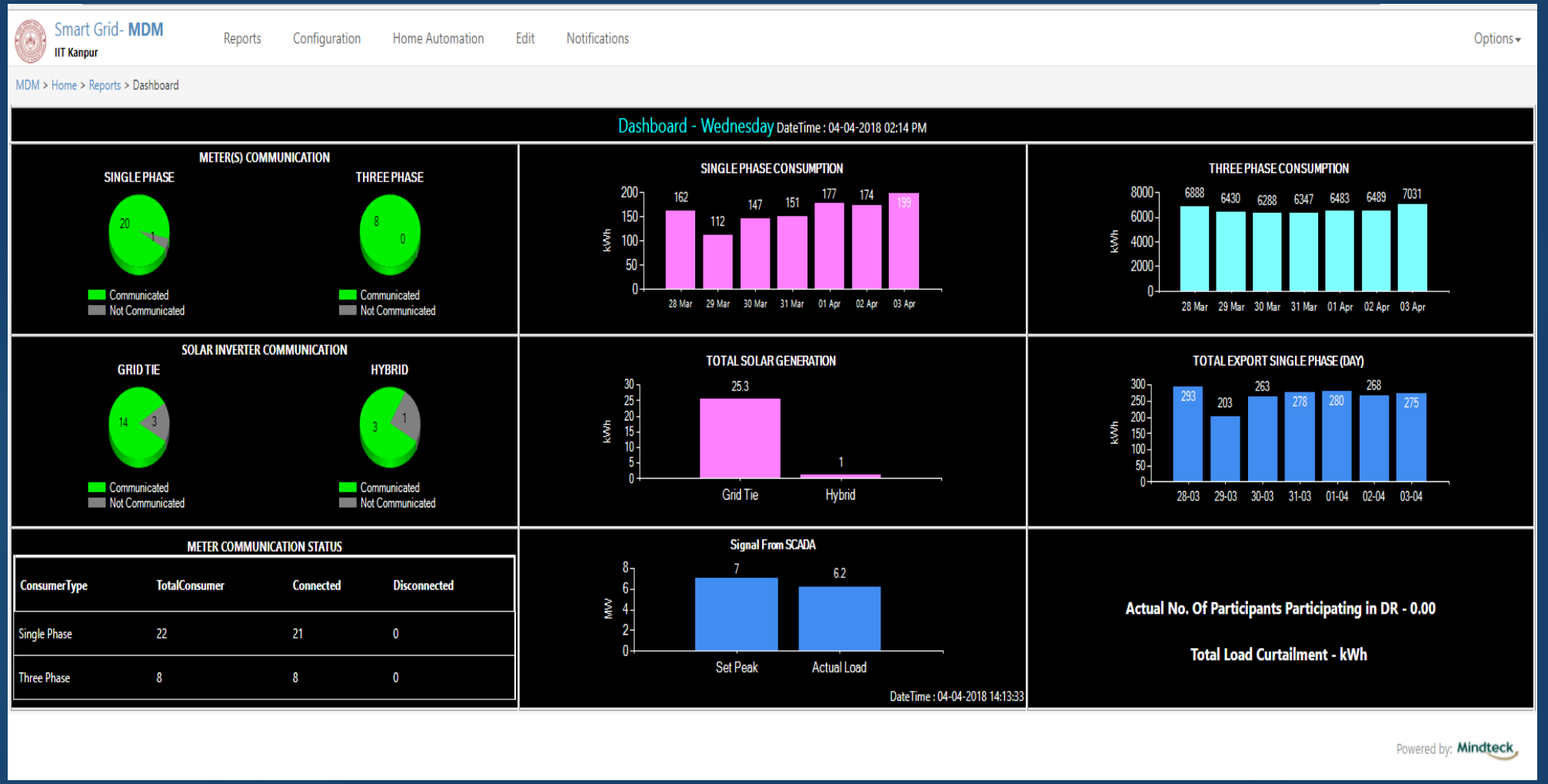




SI scheme


Smart lightings and appliances
ZigBee
Smart Switches
Home Area Network
(HAN)
Home Automation of 10 houses using ZigBee
Smart lightings and appliances
WIFI
Smart Switches
WIFI Router
WIFI Repeater
Home Automation of10 houses using WIFI
SCADA System
Roof top Solar units
MDAS/MDM
Smart Meter with GSM
1Phase Smart Meter with RF
66LowPAN
66LowPAN
DCU
6LowPAN
Three phase LT CT Meter with GPRS

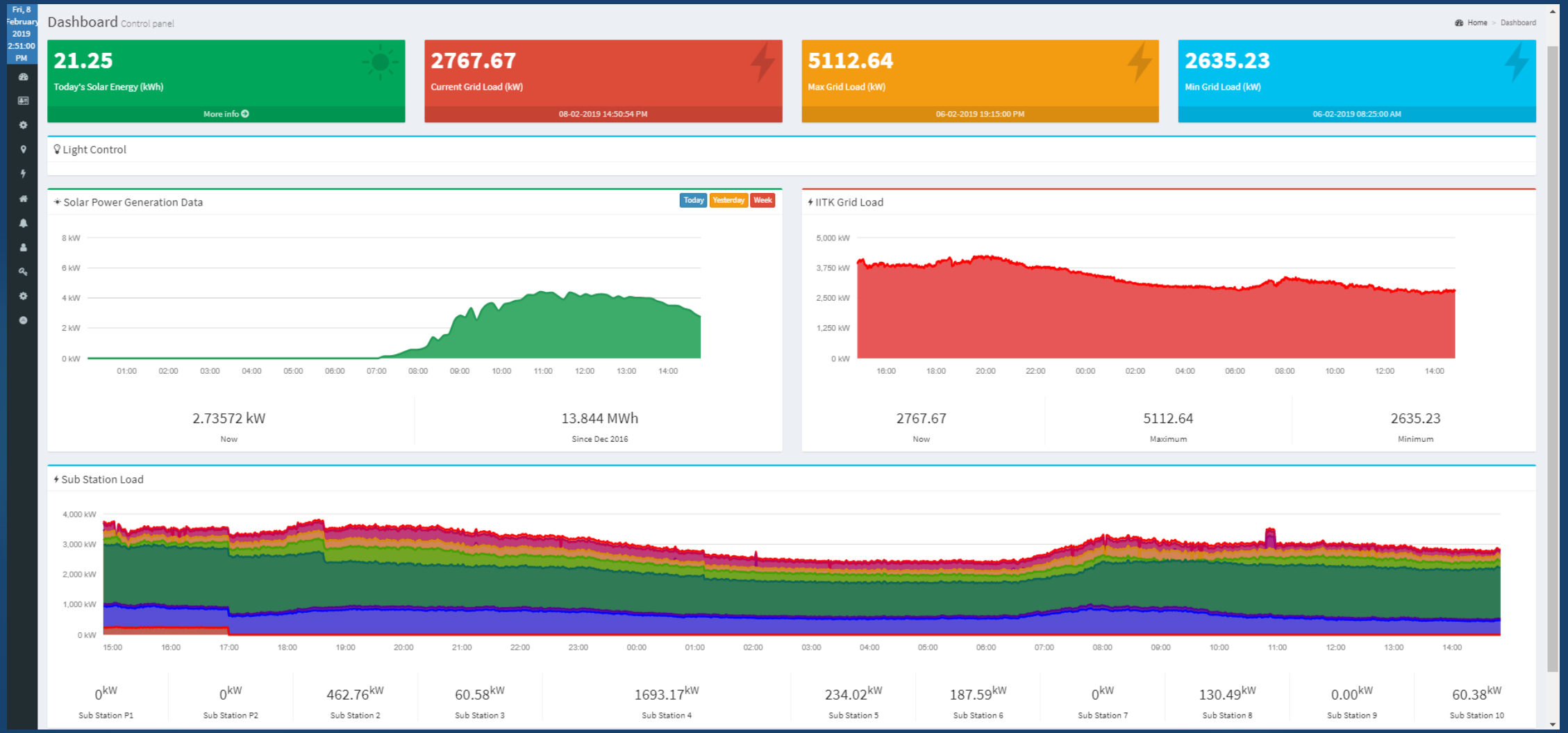
SI software dashboard



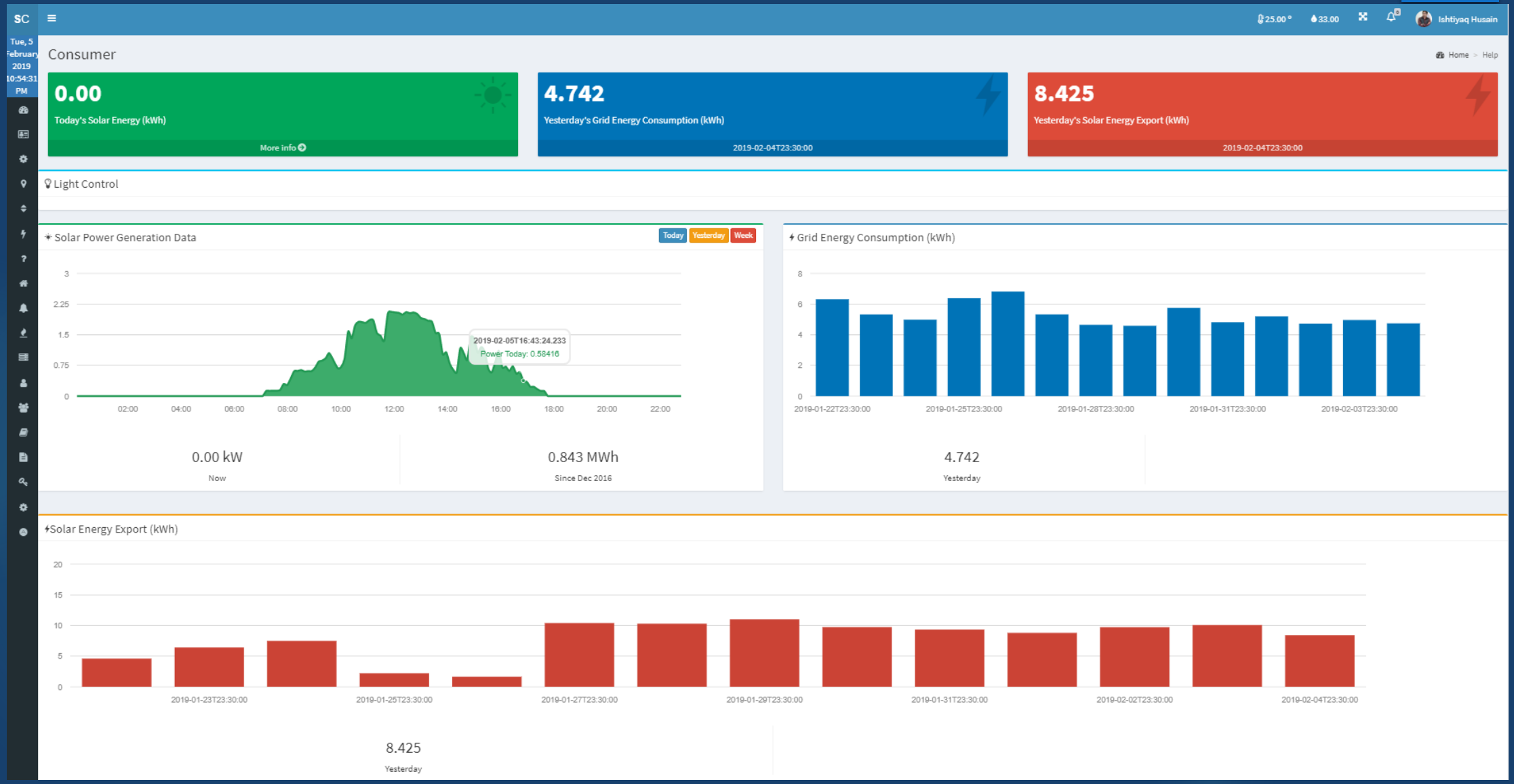
Research activities

- Remote monitoring & control applications for smart homes
- Distribution state estimation
- Load forecasting
- Distribution reconfiguration
- Fault detection, isolation, and restoration
- Intelligent billing system
- Demand response management
- Power extraction control from solar PV during grid-connected and off-grid operation

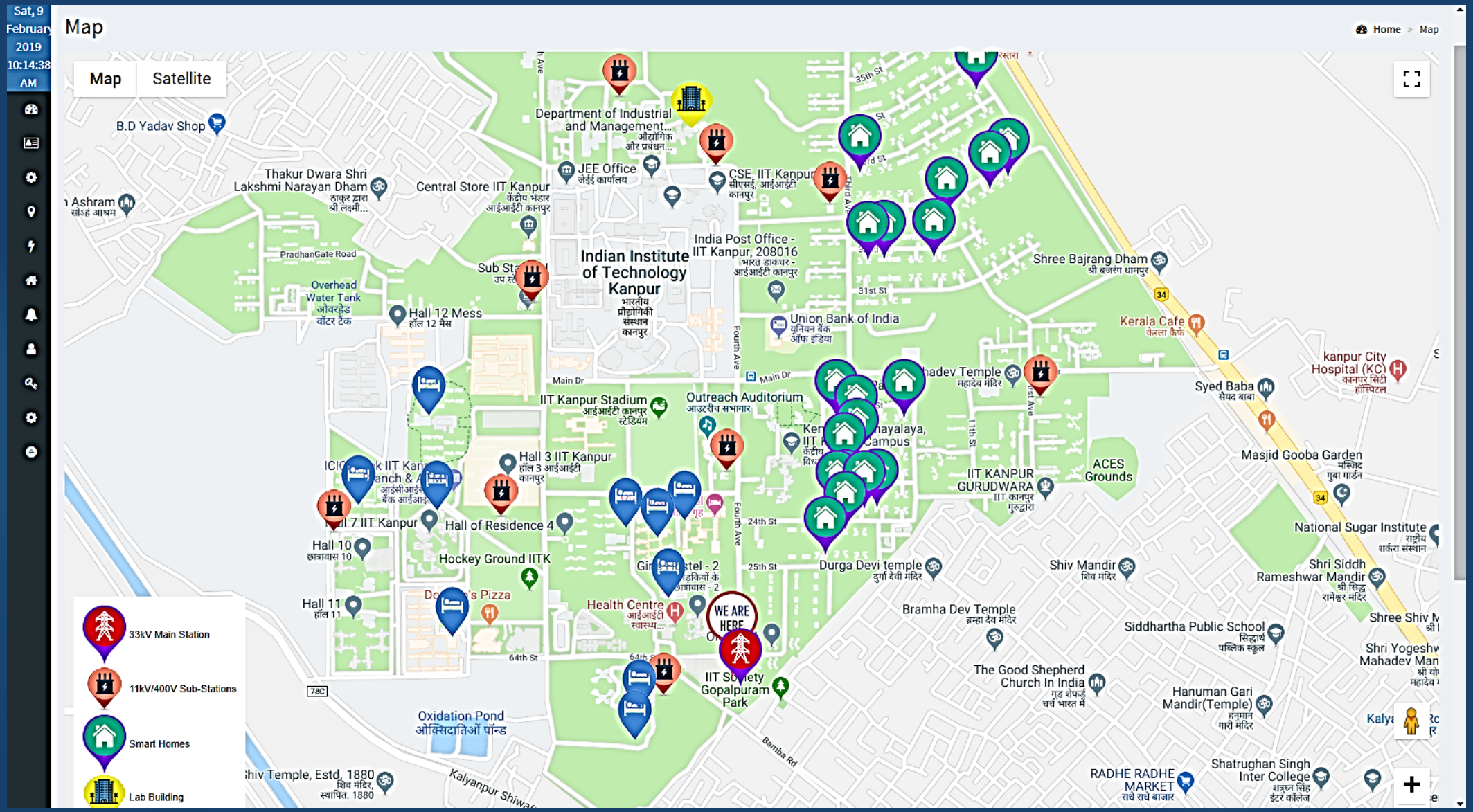
SmartCity Pilot Dashboard



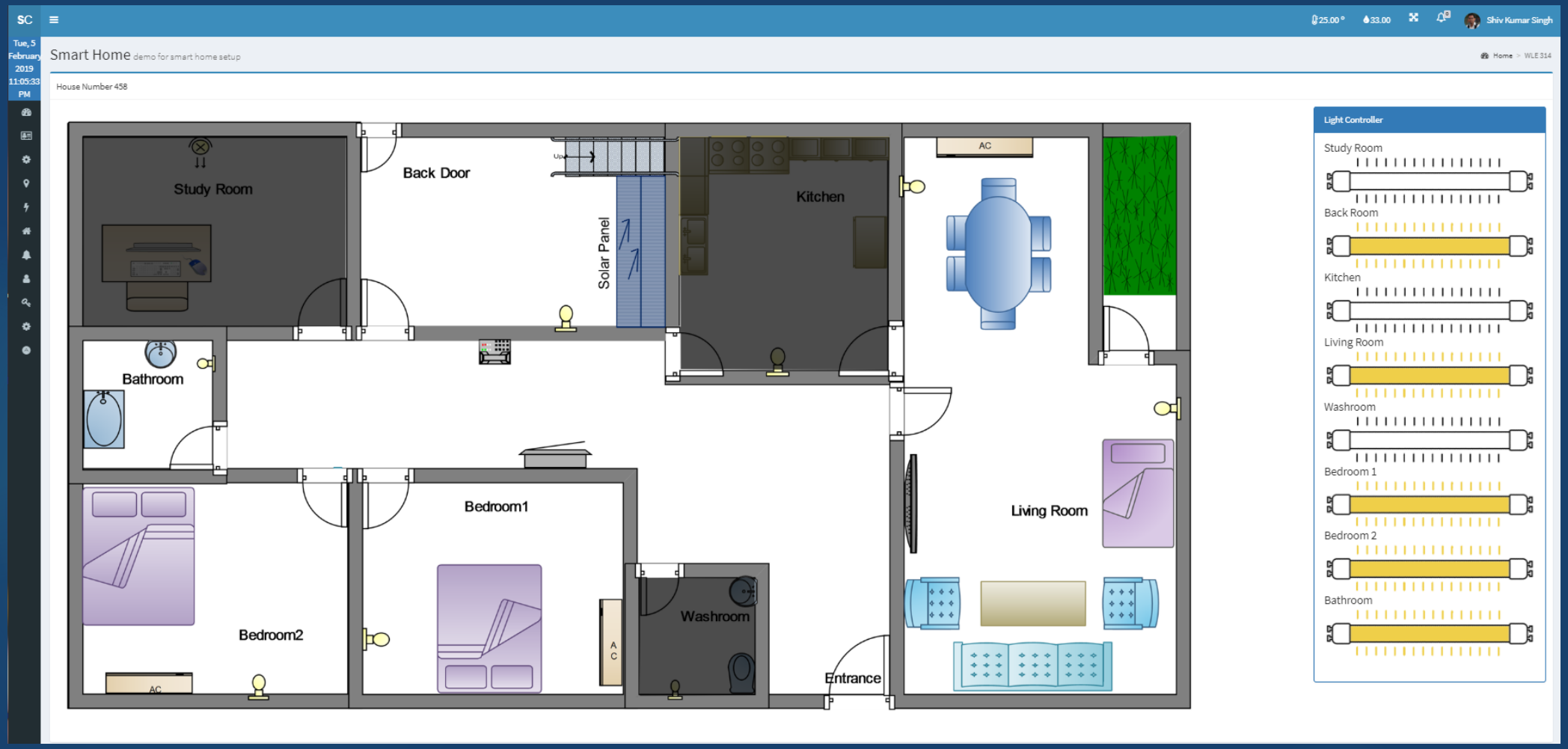
Consumer Dashboard Developed by IIT Kanpur



GIS Mapping of Installation Sites



Home Automation Solution



Thank you!