Campus-level Implementation of Smart Distribution System: A Case Study

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INTRODUCTION

- A smart city prototype has been built within the campus of Indian Institute of Technology Kanpur (IITK). The pilot project is jointly funded by the Ministry of Power (MoP), Government of India, and IITK.
- The main objective of the project is to identify the key challenges in implementing smart grid functionalities in the Indian context, and find innovative solutions to the challenges. The prototype will act as a test bed for smart-city related research, development, and training activities for industries, research institutes, and academicians in India.

Major components of the project:

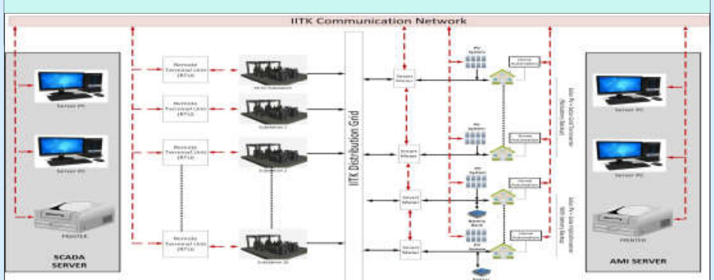
SCADA: All 33 kV, 11kV, and 440V feeders of IITK are monitored and controlled via SCADA.

Advanced Metering Infrastructure (AMI): Single phase smart meters are installed in 20 residences, and three phase smart meters are installed in 7 student hostels. AMI integrates these smart meters with the help of dedicated ICT infrastructure. Meter Data Acquisition System(MDAS) and Meter Data Management System(MDMS) are in place to collect, process, analyse, visualize, and take further actions based on the meter data.

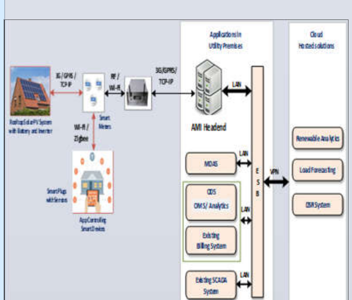
RES integration: Solar PV panels of capacity 5 kWp are installed on the rooftops of 20 houses, for feeding the local load, the surplus is fed to the Grid. Out of these houses, four houses have hybrid inverters with battery storage of 24 kWh installed, so that a part of the excess solar energy can be stored in the battery, which can be used at night to feed the loads, when solar is not available. Remaining houses have grid-tied inverters without battery storage.

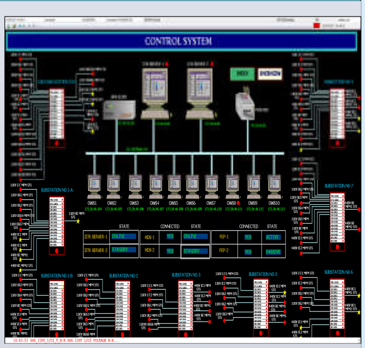
Home automation system (HAS): ZigBee, Z-wave, and Wi-Fi enabled devices and smart plugs are installed inside these 20 houses. Essential loads, such as lights and fans, and non-essential loads, such as air conditioners and geysers, are monitored and controlled through mobile apps and a system integration software present at the central control centre, allowing the consumers to actively participate in Demand Response(DR).

System Integration(SI) Software: At the control centre, the software for receiving and storing all the data from SCADA, smart meters, solar PV inverters, and smart home devices are installed on servers. The operator can run various monitoring and control applications with the help of this integrated platform.



Advance Metering Infrastructure(AMI) — SCADA SYSTEM

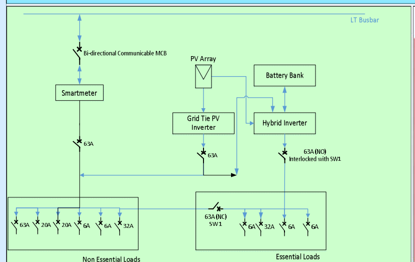


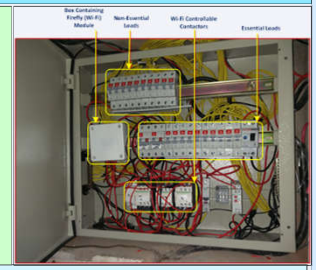


Key Performance Indicators

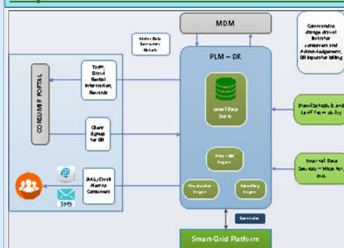
- Implementing network reconfiguration.
- A distribution system state estimation algorithm usable by typical Indian utilities.
- Improvement in the overall power quality.
- Reduction in the duration of outages by implementing fast restoration techniques.
- Implementing demand response algorithms.
- Savings on electricity bills for households with renewable solar PV and battery storage.
- Improvement in overall customer DR participation, and satisfaction.
- The design of hybrid solar inverter suitable for the Indian condition.
- Methodologies for improved operation and control of distribution systems.

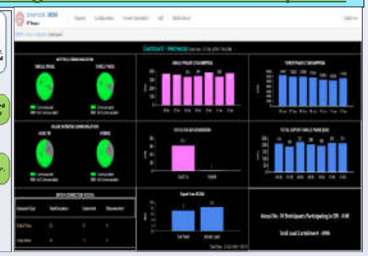
Customization of Distribution Boards of Houses



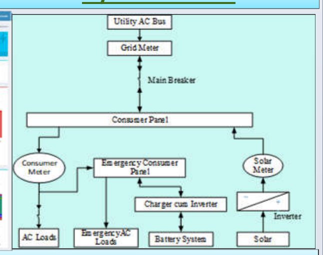


Implementation of Peak Load Management and Demand Response

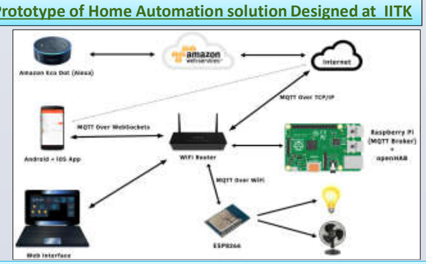




Consumer Portal — Hybrid Inverter



Home Automation — Prototype of Home Automation solution Designed at IITK



Conclusion

- Transition to smart distribution grid involves collective efforts from all stakeholders, along with a supportive regulatory and market framework.
- Interoperability of hardware and software components needs to be ensured by the utilities and vendors.
- Smart grid technologies and systems are provided by many industrial vendors who do not have requisite work expertise.
- For implementing demand response and home automation, consumer awareness drive is essential for highlighting its benefits.
- The increased amounts of data collected from smart grids helps in improving the overall operational efficiency and the increased automation improves the control of various parts of the system, enabling faster response to changes in load demand.

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