SMART METERING SYSTEM FOR ELECTRICAL POWER DISTRIBUTION

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ABSTRACT

The term Smart grid refers to a reworking of electricity infrastructures as well as to exchange the generated power. Smart grid is a advanced generation of power grid. In Smart grid the electricity distribution and electricity management upgraded by using two way digital communication technologies. I also presents the smart metering concept i.e. reverse metering or net metering which reduces the expenses on electricity. The smart grid can improved the quality of service, power control and efficiency. A smart grid can also improve the reliability of power and quality to eliminate the electricity blackout through a communication infrastructure. A smart grid supplies electricity between generators to consumer by using two way digital technologies. It helps to controls intelligent home appliances at consumer's house or any residence to reduce the cost, save electricity and increase the transparency. By using solar energy grid integration system (SEGIS) concept we can achieve the high penetration of photovoltaic systems in to utility grid. To maximize the benefits of residential and commercial solar energy systems the advanced, integrated controllers/inverters will be used. The objective of proposed system is to minimize the use of electricity power generated by MSEB which is non-renewable energy source as well as requires high cost to obtain. In other hand we suggest the system for the use of solar grid energy which is renewable energy source and easily available with low cost.

Keyword: *- Smart grid, SEGIS, Electricity distribution, Net metering.*

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1. INTRODUCTION

The Smart grid is the integration of traditional electrical power grid with the most recent telecommunication and information technologies. In smart grid electricity is generated, transported, distributed, and consumed by integrating advanced sensing, communications, and control in the day-to-day operation of the grid in modernized way. The smart grid can improved the quality of service, power control and efficiency. A smart grid can also improve the reliability of power and quality to eliminate the electricity blackout through a communication infrastructure. In this paper we have studied the various types of smart grid communications protocols. A smart grid supplies electricity between generators to consumer by using two way digital technologies. It helps to controls intelligent home appliances at consumer's house or any residence to reduce the cost, save electricity and increase the transparency. By using solar energy grid integration system (SEGIS) concept we can achieve the high penetration of photovoltaic systems in to utility grid. To maximize the benefits of residential and commercial solar energy systems the advanced, integrated controllers/invertors will be used. A smart grid is needed to be a modernization of the legacy electricity network. It helps to monitoring, protecting as well as optimizing automatically to operation of the interconnected elements. [2]-[4]. Many industries around the world is now started to install renewable energy sources such as solar and wind energy at its consumption sites. Also, residential consumers are also now a day's started to install smart home appliances and renewable energy resources in their homes to generate and utilization of electrical power efficiently [7] [8]. Many techniques that to be adopted by smart grid has already been used in other home applications and commercial applications, such as wireless networks in telecommunications. In general, sensing and measurement, improved interfaces, advanced components, decision support standards and groups, and integrated communications are the five key areas of smart grid communication technologies.

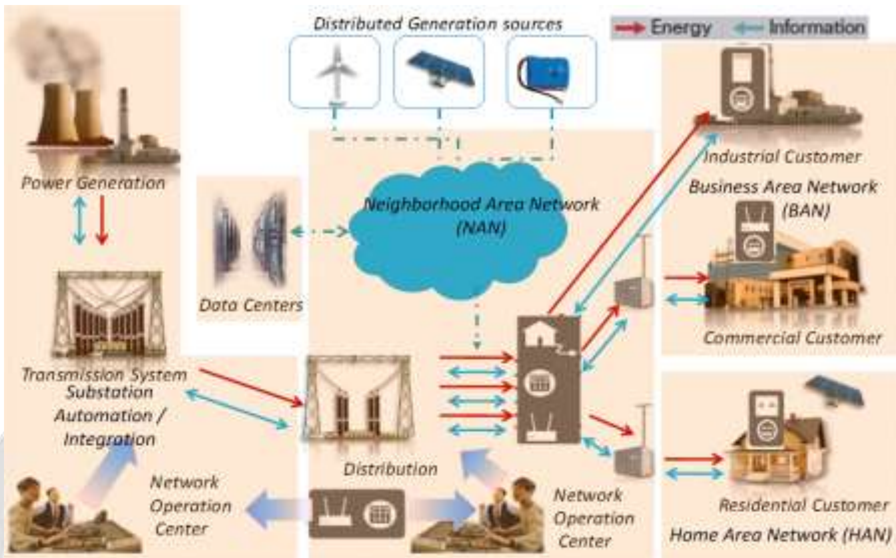


Fig-1: Smart Grid Communication Infrastructures [4]

Fig-1 shows a general overview for smart grid communication infrastructures. It contains business area networks (BANs), home area networks (HANs), neighborhood area networks (NANs), data centers, and substation automation integration systems [7]. Smart grids distribute electricity between power generators and end users (industrial, commercial, residential consumers, etc) using bi-directional digital communication technology to control intelligent appliances at consumers' side saving energy consumption which automatically reducing the expense. It will improve the system reliability and operation transparency. By using communication infrastructure, the smart metering can provide the realtime energy consumption as a feedback and correspond to the demand to/from utilities. Network operation center can show those customer power usage data and the on-line market pricing from data centers to optimize the electricity generation, distribution according to the energy consumption. It can offer sustainable operations to both utilities and customers [5]. It can also increase the efficiency of legacy power generation, transmission and distribution systems and penetrate the usage of clean renewable energy by introducing modern communication systems into smart grids.

1.1 SMART GRID COMMUNICATION PROTOCOLS

Smart grid communications are based on two basic technologies these are wireless and wired networks technologies. These networks can be classified on the basis of their functionality within the smart grid. These classifications, as mentioned in the literature, are: home area network (HAN), neighborhood area network (NAN), access network, backhaul network, core and external networks [5]. Many smart grid objects such as home appliances, smart meters, actuators, switches, reclosers, capacitors bank, integrated electronic devices (IEDs), transformer, relays, access points, concentrators, routers, printers, scanners, computers, cameras, field testing devices, and other devices are connected by these networks. All these appliances and devices are geographically distributed and inter connected through networks in the grid, from housing units to substations and up to command centers. Each device can access and exchange data through different communication protocols.

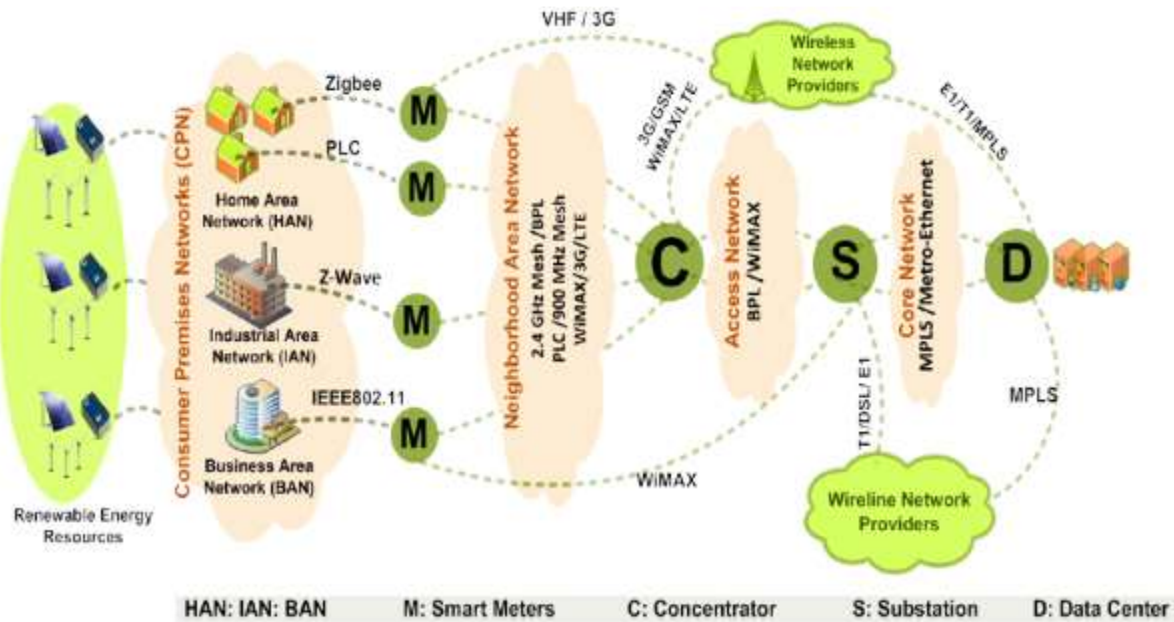


Fig-2: Smart grid communications protocols [7] [8].

Fig-2 shows the smart grid communications protocols layers [5] [6]. It contains HAN, IAN, BAN in consumer premises network(CPN).

2. SMART GRID, WIRELESS WIDE AREA SOLUTIONS AND INTERNET DATA CENTERS

Fig-3 illustrates the power flow in the grid and implementation of wireless communications and data centers in connection with the smart grid. In this Electricity is transported from supplier to the consumers over the transmission and distribution system. In addition to this consumers can become power generators and sell the power according to the novel distributed generation practices of the smart grid [1]. In the smart grid, all of the appliances are connected through modern communications devices. In the figure, data collected from various sensors and meters. The collected data fed into the utility headquarters and automatically stored in cloud data centers.

2.1 Energy-Efficient Communications And smart Grid

Energy-efficiency is an integral part of networks. It consists of battery-run nodes such as sensor nodes or mobile phones. As a result, a amount of academic as well as various efforts have been put into reducing the energy consumption of core and access network equipment. Price-following demand management of smart grid can be employed by the communications infrastructure to reduce electricity bills where this can be also extended to emission-following load management of the equipment. Smart grid-driven approaches affects the way through which energy-efficient communication technologies are implemented, on the other side smart grid involves dense communications and it is affected from energy-efficiency techniques. This section shows the works that study the mutual effects of smart grid and energy-efficient communications. We have grouped these studies as wireless, wire line and optical networks. For each type of networks, we focus on the appropriate smart grid domain. Energy-efficiency of battery-run, hand-held devices and Wireless Sensor Networks (WSNs) are more than the scope of this survey since their energy-efficiency aims at increasing the lifetime of the network or the device with their limited battery power.

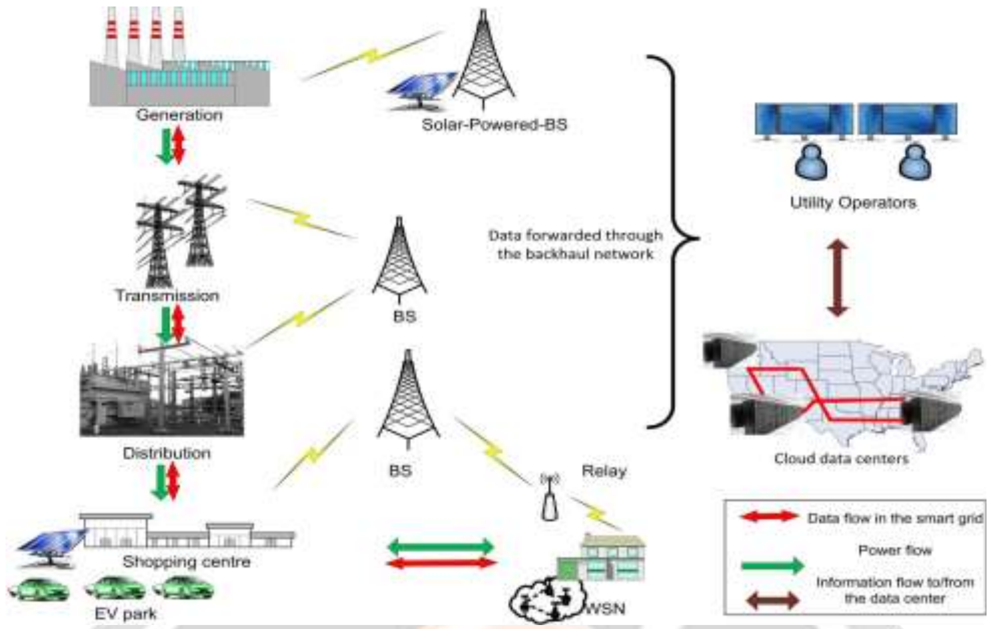


Fig-3: Smart grid, wireless wide area solutions and Internet data centers.

The smart grid can be divided into three domains on the basis of communication coverage and functionality *viz*. Smart Grid Home Area Network (SG-HAN), Smart Grid Neighborhood Area Network (SG-NAN) and Smart Grid Wide Area Network (SG-WAN). Smart Grid Home Area Network (SG-HAN) is a single residential unit with smart appliances, storage, an energy display, power consumption control tools, solar panels, small-scale wind turbines, electric vehicles and a smart meter. A SG-NAN refers to group of houses fed by the same transformer. Advanced Metering Infrastructure (AMI) collects smart grid data from the SG-NAN and aggregates the meter data before they are sent to SG-WAN which connect SG-NANs to the utility operator. From the utility perspective, besides metering, equipment in the field needs to be monitored and controlled. Hence the equipment in the field is managed by a separate network which is called as Smart Grid Field Area Network (SG-FAN). The geographical scale of a SG-FAN is similar to SG-NAN therefore similar communication technologies are applicable for both. These network domains can be implemented using a variety of communication technologies. BW and latency requirements for different smart grid applications are different which is given in Table 1.

Table-1: Smart Grid applications BW and latency requirements

Smart Grid Application	Bandwidth	Latency
Substation Automation	9.6-56 kbps	15-200 ms
Outage Management	56 kbps	2000 ms
Distribution Automation	9.6-100 kbps	100 ms-2 sec
Distributed Energy Resources	9.6-56 kbps	100 ms-2 sec
Smart Meter Reading	10-100 kbps/meter	2000 ms

	500 kbps/concentrator	
Demand Response	14-100 kbps	500 ms-min
Assets Management	56 kbps	2000 ms

3. METHODOLOGY

The basic principle of propose system is to save the electricity power and distributes such power as per our requirements for domestic as well as industrial purpose. The smart grid integrates the capacity of exchange of generated power. I also include the Reverse Metering concept that means, the MSEB electricity meter will be rotating in anticlockwise direction if our generated Grid energy is more than our output load requirement. Due to that, we provide the return electricity power supply to MSEB, which is usefull for our future requirement. We used the GSM modem to give the input i.e. our output equipments are controlled by SMS trough controller via GSM modem. The system updates i.e. how much solar power generated (Grid energy), power requirement of output equipments, how much power used at output load and how much power save or backup i.e. given to MSEB are display on LCD display and also send to mobile via SMS. For that we need to send the SMS to system “SYSTEM RESPONSE/R”. Then we get the reply immediately. The design of the given system is carried out by as per following specifications of battery and solar plate.

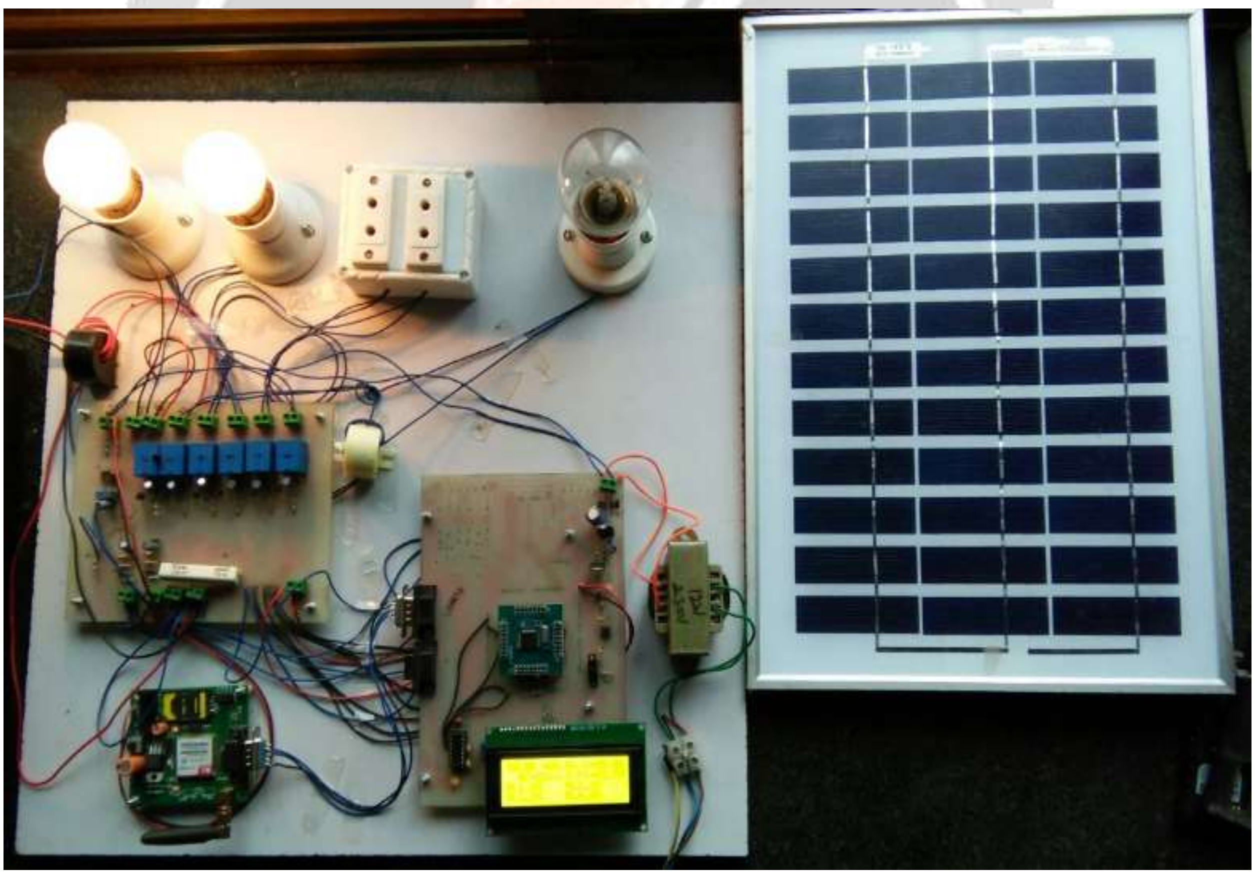


Fig-4: Experimental Setup

3.1 Calculations

- **Aim:** To design system of 100W load
- **Given:**
  - Output Load: 100W
  - Load Backup Time: 10 HR
  - Battery Input: 12V

- **To find battery specification:**
  - Battery backup = Output Load *Load backup
  - Battery Backup = 100*10 = 1000
  - Current = Battery Backup / Input = 1000 / 12 = 83A
  - i.e. Battery = 12V, 83A.

- **To calculate Solar Plate Specification:**
  - Current of system = 83A
  - Battery to be charged in Hour: 7 Hrs
  - To find current of Solar Plate = Current of system / 7
    i.e. 83 / 7 = 12A
  - Power = Current* Voltage
  - P = 12*12 = 144W
    i.e. Solar Specification: 144W, 12A, 12V

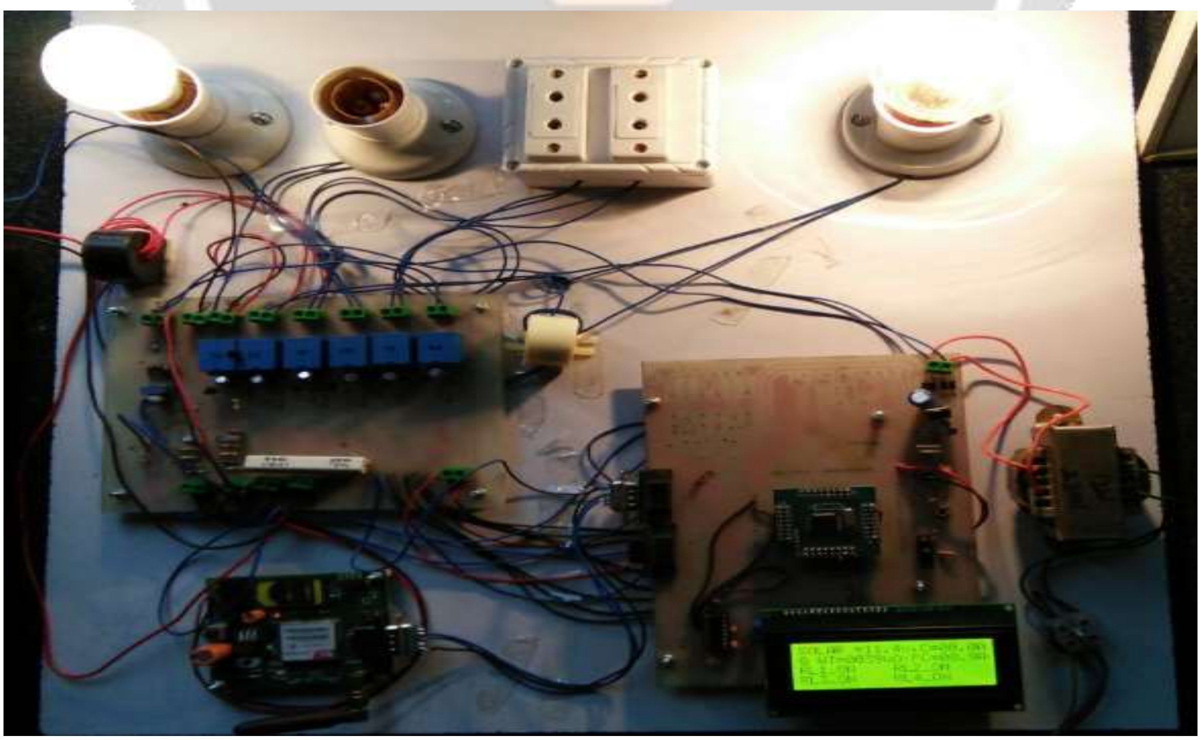
3.2 Results & Observations

Table-2: Table showing the results & observations

Solar Power	Equip- 1 (25W)	Equip- 2 (25W)	Equip- 3 (25W)	Equip- 4 (25W)	Grid Power	Meter Billing
100W	ON	ON	ON	ON	00W	STOP
100W	OFF	OFF	ON	ON	50W	REVERSE
100W	OFF	OFF	OFF	ON	75W	REVERSE
100W	OFF	OFF	OFF	OFF	100W	REVERSE
Not Avail-Able	ON	ON	ON/OFF	ON/OFF	00W	FORWARD

Observation for case 1

Observation for case 2



4. CONCLUSIONS

In the proposed system, I have presented the background for smart grid communication infrastructures. I show that a smart grid built on the technologies of sensing, communications, and control technologies offer a very promising future for utilities and users. By using Smart grid technology the electricity may available in low cost as well as exchange of power takes place. We review several industrial trials and summarized the basic requirements of communication infrastructures in smart grid paradigm. Efficiency, reliability and security of interconnected devices and systems are critical to enabling smart grid communication infrastructures. Interoperability must be achieved while avoiding being isolated into noncompetitive technical solutions and the need for wholesale replac e of existing power communication systems. It reduces high cost expenses. Based on the above survey, I want to focus on the smart metering or net metering concept which results the management and saving of power to make it more efficient and secure.

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