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Implementation of Smart Grids In Substation

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Abstract— Substations play a major role in distributing power to the end users. In case of shortage of current production from the source area (Thermal station), Substations are unable to supply the required power to the end users, which results in severe voltage drops. To avoid this we have designed a project in which Substations will be equipped with Hybrid Power (Windmill + Solar Panel). The Battery will be completely charged with the help of this hybrid power. In case of any voltage drop in substations it will be automatically detected and informed to the Substation Head's mobile phone. Substation Head can automatically turn on the hybrid power by initiating an emergency call from his mobile, which will turn on the hybrid power , so that the voltage drop will be normalized within seconds. The necessary enabling wireless Technologies, Various mechanisms and algorithms for the optimal demand management in smart grids using these wireless technologies are also reviewed.

Index Terms— Battery, Gsm module, Microcontroller, Solar panel, Wind mill

1.INTRODUCTION

Today we already know that electric generating industries facing many problems and challenges in terms of increasing the people demands day by day. When the power demand by people side, industries face challenges like environmental Issues, security, reliability and integration of Renewable energy. In India mostly power grids are based on old vertical hierarchical infrastructure. In this structure power flows only one direction i.e. power generation to the consumer side and grid monitoring information is handled only at the operation side. Scientist and engineers believed that fundamental changes in electric power generation system and transmission or distribution system makes he grid more reliable, more secure, and efficient.

This can be enabling by the future generation electricity network smarter and controlled by advanced computing system. This can be achieved by embedding computing bi-directional information and Communication architecture with power grids. In various countries like US, European, japan , Australia and many more several countries are there who have developed smart grids as mush more better than India grids.Even 2012 India is using old technology in power generation. That is the reason our country is facing challenges in power shortage.

For example in mission 2030, USDoE smart grids R&D program having aim to archive the 20 percent reduction in the nation's peak growing of energy demand, they provide 100 percent of the availability to serve all critical load at any time. The 20 percent of the electricity capacity can be distributed from renewable source of energy.smartgrid.

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For example, the main highlight of the EU definition is that a smart grid is an electricity network that can intelligently integrate the behavior and actions of all users to ensure sustainable, economic, and secure electricity supply. The definition of US DoE states that a smart grid uses digital technology to improve reliability, security, and efficiency of the electricity system. Regardless of these different definitions, the main ingredient of the smart grid is the application of information and communication technology in power grids. Figure 1 illustrates a possible overall Smart The European SmartGrids Technology Platform has also set similar targets with an emphasis on highly interconnected distribution networks and the integration of renewable energy to meet the EU target on carbon emissions reduction by year 2020.

There are various definitions for grid architecture. It is a highly integrated and complex, yet flexible and reliable network with various centralized and distributed energy sources. As shown in Fig. 1, the power flow direction is no longer just downhill from the bulk power plants to consumers. Instead, dynamic flows can start from any generation sources and end up anywhere in the grids. The energy can be stored and released back to the grids even at household level. The integration of ICT enables not only the operation control center to make informed decisions and optimize the energy flow, but it also provides opportunities for consumers to participate in the energy demand Management to reduce the cost of their energy.

Demand management is the key to the operational efficiency and reliability of smart grid. Facilitated by the two-way information flow and various optimization mechanisms, operators benefit from real time dynamic load monitoring and control while consumers benefit from optimized use of energy. In this article, we provide comprehensive overview of demand management in smart grid with a focus on the enabling wireless Technologies. The features and enabling mechanisms in terms of consumption scheduling ,real-time response and load balancing are also discussed.

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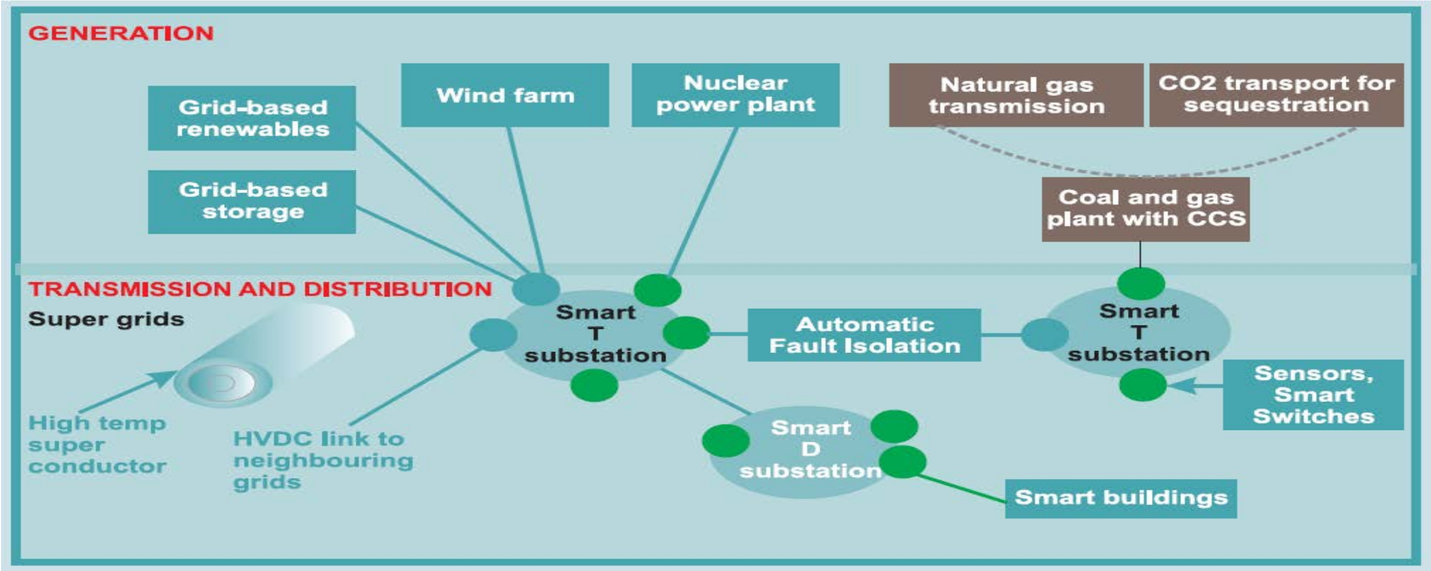

Figure-1Generating and Distribution Station

2. OVERVIEW OF SMART GRID

FEATURES

Demand management mainly consists of load monitoring, analysis and response. In conventional power grids, the two sides of the electricity demand and supply system are basically disconnected, as such demand management is performed exclusively by the utility operators using mainly the raw data based local operation monitoring and state estimation. These approaches have significant drawbacks in terms of high response time (delay) and in accuracy .The development of smart grid provides demand management with advanced features to enable many new essential functions and applications as follows:

I. Bi-Directional Coordination
II. Real-time and Online Processing
III. Pro activeness

I.Bi-Directional Coordination

Normally in smart grids demand management is to expected to be combination of centralized and distributed system monitoring center have the Major role in the basic operation system center. This operation system can also be distributed Across the whole network. Every node having some demand that can be can be able manage by the this network .so this activities can be acknowledge by the both side of supply utilities and the operator can also exchanges the data via effectively bi-directional exchanges.

Through the advantage of this full visibility of demand condition of the grids the operator can apply charges or price rates dynamically. So in both side of the directionally transmission of electricity market can participate on the demand. Through this transmission can achieve both sides of the customer's demands, while responding to the circumstances of the grid that can reduce the management price of transmission. The grid operator can potentially lead to a win situation for the utility of customer demand

II.REAL TIME AND ONLINE PROCESSING

The highly dynamic in the nature of the energy be supplied from the renewable source of energy in the electric grids having the huge impact that can be cause the or damage the possible controlled delay So it is important to handle the supply of demand of electricity in a systematic manner. But in bidirectional management of a smart grid is effective in communication as a modern communication system .now a days we are using mobile technology and internet technology to promote the exchanges or establish the information in network.

For example

If we want to detect a potential outage where both the consumer and control authorities in the impacting area can be controlled or notify immediately. The operator can early take actions before further disturbance are spread. Local area data processing and demand assessment is subject to a minor delay of seconds so that associated control can respond effectively. These activities are expected to be performed online using various user interfaces. Every participant of the activities will be responded and acknowledged transparently.

III.PROACTIVENESS

The success of the smart grid is lies in the full participation of the consumers. The smart grid should enable everyone to have access and participate in demand management. Importantly, the consumers should be given incentives for participating proactively and coordinating with the operators and other stake holders. To achieve this, an efficient and transparent exchange of information system facilitated by advanced communication architecture and attractive electricity consumption and price plans are required. Proactive participation of the demand side provides the operators not only the opportunity to respond in real time to the supply and demand, but also to predict the future demand more accurately and devise appropriate actions on the generation and supply of energy.

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Networks for managing capacity of the network and the resources can be used.

For example, Optimization techniques using distributed strategies and game theory can be developed, as discussed in the succeeding sections.

3.CHALLENGES

There are various perceived challenges spanning from policy level to technology level including social and behavioral aspects. The policy level challenges include capital investment, enforcement rules on grid operators to provide considerable incentives to consumers, standardization of electrical appliances and third party engagement of consumer raw data. The social and behavioral aspects include trust and engagement of consumers in the demand management. The technological level challenge mainly spans the integration of high quality and low delay two way communication infrastructure with the Power grids.There are various states of the art Communication technologies available,however, It is the choice of the most appropriate technology and the integration of all the components of the smart grids that will form the important challenge. To balance the supply and demand,similar techniques as used in communication.

4.WIRELESS TECHNOLOGIES

NEIGHBORHOOD AREA NETWORKS

Candidate technologies for NAN have to provide coverage radius of over a thousand meter. Reliability of communication channels between the DAP and the smart meters dictates that the spectrum used will have to be exclusive or interference free. Consequently, the most suitable candidates need to be licensed or leased wireless solutions. A comparison of the characteristics of different NAN technologies. To facilitate demand management, suitable communications technologies must be chosen to address various requirements in the different parts of the AMI.

The neighborhood area networks (NANs) and home area networks (HANs) of AMI communications infrastructure are particularly suitable for wireless deployment, largely due to the ease and low cost of adopting wireless instead of wired solutions. The backhaul network connecting the AMI headed and the data aggregation points (DAPs) can either be wireless or wired.

The AMI communication architecture is illustrated in Fig. 2. The link between the DAPs and consumers requires NANs with coverage in the range of thousands of meters. Each DAP can connect to hundreds of smart meters (SMs). As a result, a key requirement of candidate wireless solutions is coverage of wide area, which can also be achieved through mesh network architecture or relay stations. Additionally, the wireless network must be able to provide a certain level of reliability as well as low enough latency not only to satisfy demand side management (DSM) requirements but also to serve all other AMI applications. According to communication requirements from Open SG, this translates to a minimum reliability figure of 99.5 percent and a latency requirement of less than 1 second, which is a relatively relaxed figure as compared To the commercial broadband requirements.

4.1.UMTS/LTE (2G/3G Cellular)

Current cellular technologies such as UMTS and LTE also provide attractive solutions for providing NAN coverage. Relaying functionality had also been incorporated in 3GPP Release 10 (commonly known as LTE Advanced), which will allow extended coverage using relay/repeater stations.However, the utilities have to be willing to overlay DAP-SM communications over existing communication infrastructure. Although the advantage of overlaying is a lower setup cost since the existing infrastructure can be used, the utility operator will have to work with the telecommunication operators to set up the network which can be contentious due to security and privacy concerns.

4.2.IEEE 802.22

An alternative candidate to main stream broadband wireless is the IEEE 802.22wireless regional area network, which uses white spaces in the television spectrum. The IEEE 802.22 standard proposes to use cognitive radio technologies to exploit unused spectrum in the frequency spectrum allocated to television broadcast. As the spectrum used is not dedicated, the latency in data transmission could be higher as compared to other solutions mentioned earlier.

4.3.APPROACHES AND PROPOSED MECHANISMS

The success of smart grid lies in the design of flexible and robust demand management techniques underpinned by the deployment of ICT infrastructure mentioned earlier. Apart from improving the legacy load control approaches,the main contributions of recent research have been in the demand side consumption scheduling,dynamic pricing and load balancing using distributed energy resources (DER).

5.ARCHITECTURE

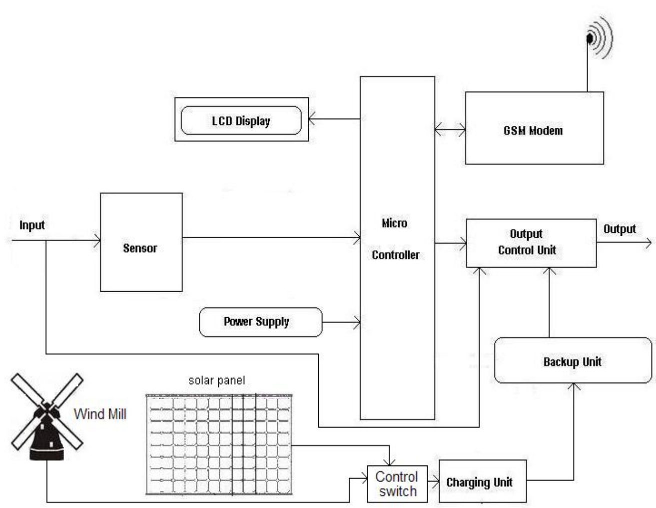

Figure-2 Block Diagram of Smart grid

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6.DESIGN

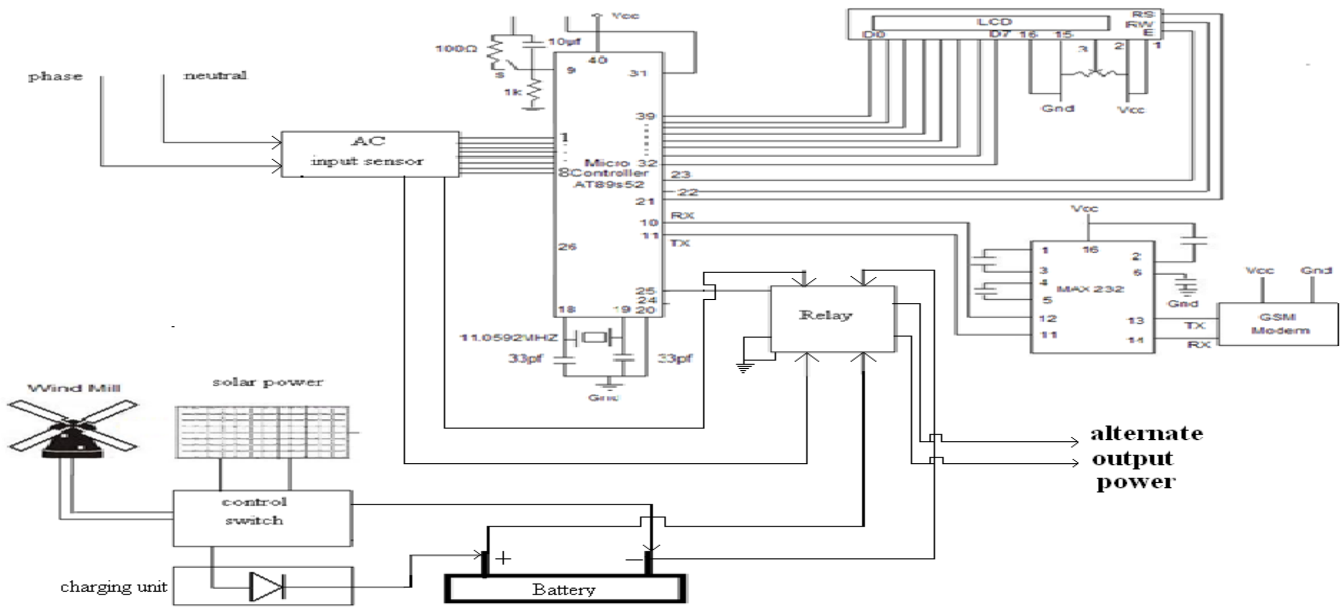

Figure 3- Design and connection between components

In this design we are using new innovation and thinking on this project. We can see in this figure 3 , microcontroller AT89S52 is a normal microprocessor which is having 15 addressing points .AC input sensor is connected to the controller and relay. Relay gets the input power from alternate power supply to control tripping of input and output. Backup unit is also connected with relay.

In backup unit we are using wind mill and solar panel which is the form of renewable source of energy. Wind mill and solar panel is connected to control switch.

Control switches work as convertor and efficiency controller. Controller unit connected with charging unit. These charging unit transfers his charges to backup unit, here special type of battery (VLRA) is used .

Whenever the microcontroller sense any voltage drop across the transmission line ,this drop will be sensed by the sensor. Then microcontroller receive the command and forwarded the command to GSM modem to make an sms to substation Incharge. when the confirmation by the other hand received by gsm modem again it is forwarded to microcontroller..Then microcontroller give command to relay for tripping the backup unit. Through the backup unit, relay transfer the power to alternate output power source .

6.1 PROTOTYPE DESIGN

Probably we developed this project as prototype demo, we controlled this by using “C” language program.

In Prototype design, both the input and output are DC

Components used in demo-

i.Transformer (12-0-12, 6-0-6)

ii.Filters –C filters 2200 mfd

iii.Relay-230/1A

iv.Variable resistor-100k

v.GSM modem-MTS MC-C2

vi.Current sensor-AT1494

vii.Baising circuit-Crystal oscillator,Reset and Set

viii.Not gate-between the microcontroller & relay

ix.Regulator 7805 IC

x.Solar panel and wind mill- 7V

xi.Embedded system-program using Keil and Ride software

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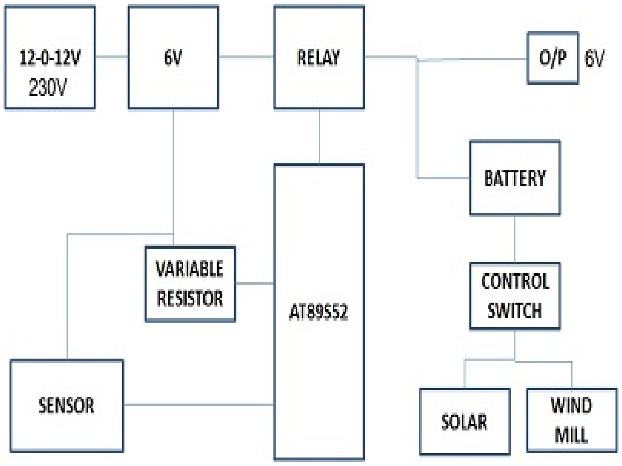

Figure 4-Prototype design of project

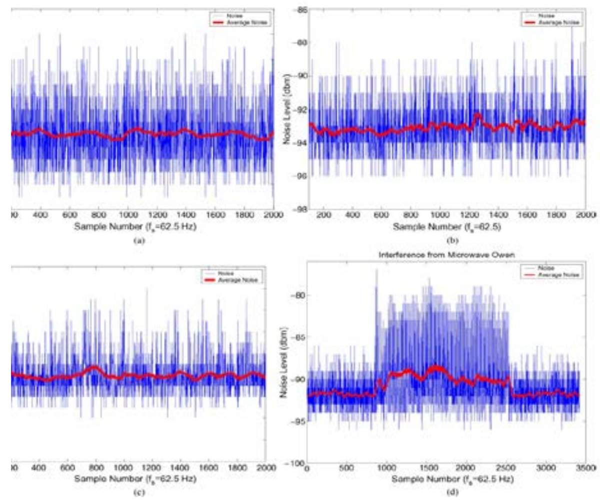

Figure5-(a) Indoor power control room (b) 500KV SubStation

(c) Under ground transformer vault (d) Noise and interference

In real time design both input and output are AC, but In Prototype design, both the input and output are DC. In real time application it depends upon

i. usage and demand across consumer side loads in substation.
ii. Higher voltage like MW or KV.

7 CONCLUSION

This is an first attempt made to integrate Hybrid Power with substations to give continuous power supply. Moving forward in the future, all the substations may follow this principle to deliver continuous power to the end customers .Through this project we highlighted that the end user who require continuous supply of power ,it will not affect them.

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