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A Simulink Model for Emergency Power System and Electricity Market using Green Energy Technology

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ABSTRACT

The electric power system is an important infrastructure that plays the important role in the economical status of a nation. It is, therefore, very important and useful to design a green energy distributed power system .This paper presents the concept of power management strategies of a green energy distributed power system .The green energy distributed power system is one way to assure self-healing characteristics in an electric power system . This green energy aims at operating and managing individually with customer owned distributed energy sources at the time of faults. This concept is expected to make significant contribution during faults and creating power management strategies for the efficient and reliable operation of the system. In order to operationalize and test this concept , the proposed green energy distributed power system is simulated using MATLAB and power management strategy is implemented using C language.

Index Terms**:** *Green Energy Technology, Emergency Power System*

I. INTRODUCTION

Electric power system is an important infrastructure that plays the important role in the economical status of a nation. The approach towards the deregulation of electricity supply has led to profit based competition that resulted in an inefficient growth of generation and transmission. Moreover there are manmade and natural disasters that let to major disturbance in the power system.

Electric energy supplies a large percentage of our energy needs. We use energy to facilitate modern society with critical loads like lights, water pumps, life support equipment, elevators, furnaces, and mass transit etc. A lot of attention has been given to energy in recent period for several reasons including Gasoline prices are volatile and higher than we like, Prices for electricity and natural gas have increased, and Global warming has become a major issue.

The mere availability of a renewable energy resource does not mean that resource can readily be used as an energy source. To utilize a resource several factors need to be considered: the conversion system, quality of the fuel, conversion cost, transport cost as well as the size and location of the demand.

To increase reliability of electric services locally, commercial and some residential customers have increasingly installed on-site distributed energy resources despite the rapidly growing number of on-site distributed energy resources systems, there is yet no established mechanism for capturing and coordinating these on site distributed energy resources to serve critical loads at the distribution level. This paper presents the concept of power management strategies of a green energy distributed power system. The green energy distributed power system is one way to assure self-healing characteristics in an electric power system.

Grid connected distributed power system is a network of many interconnected small sub networks that can operate individually during the system fault. Each sub network will be given with enough generating capacity to secure critical loads, as well as ability to communicate internally among generation, loads and electronic control devices.

II. BACKGROUND

There are six related areas as a background for green energy distributed power system

A. Smart Grid

A smart grid is an electricity network that uses digital and other advanced technologies to monitor and manage the transport of electricity from all generation sources to meet the varying electricity. demands of end-users. Smart grids co-ordinate the needs and capabilities of all generators, grid operators, end-users and electricity market stakeholders to operate all parts of the system as efficiently as possible, minimizing costs and environmental impacts while maximizing system reliability, resilience and stability."

Smart grids can essentially be defined by their functions and their components. Environmental and economic challenges in the electricity sector transcend individual steps in the value chain. The smart grid is therefore expected to address the key challenges stakeholders in the sector are facing: mitigation of climate change, disruptions in supply of conventional energy sources, exploding global demand for electricity, wider diffusion of renewable energy sources and louder consumer demands for greater transparency.

An automated, widely distributed energy delivery network, the Smart Grid will be characterized by a two-way flow of electricity and information and will be capable of monitoring everything from power plants to customer preferences to individual appliances. It incorporates into the grid the benefits of distributed computing and communications to deliver real-time information and enable the near-instantaneous balance of supply and demand at the device level

It is one of the key technologies recommended by policy makers drafting technology roadmaps for electricity delivery in many countries, like the United States, the European Union and Japan. Subsequent studies have all promoted the micro grid concept citing the increased reliability and power quality it provides to the local grid.

B. Power Market and Demand Response

Power Market refers to the commercialization of electricity to final customers – residential and commercial loads. An automated, widely distributed energy delivery network, the Smart Grid will be characterized by a two-way flow of electricity and information and will be capable of monitoring everything from power plants to customer preferences to individual appliances. It incorporates into the grid the benefits of distributed computing and communications to deliver real-time information and enable the near-instantaneous balance of supply and demand at the device level.

This capability refers to the capacity of the user or operator to adjust the demand for electricity at a given moment, using real-time data. Demand response can take the form of active customer behavior in response to various signals, generally the price of electricity at the meter, or it can be automated through the integration of smart appliances and customer devices which respond to signals sent from the utility based on system stability and load parameters. For example, a residential hot water heater could be turned off by a utility experiencing high electricity loads on a hot day, or could be programmed by its owner to only turn on at off-peak times. Active demand management can help smooth load curves, which in turn can reduce the required reserve margins maintained by electricity generators. Some pilot projects can already claim results in this respect: the Olympic Peninsula Project, overseen by the Pacific Northwest National Laboratory on behalf of the US Department of Energy, dropped peak power usage by 15 percent. A similar project from Constellation Energy in Baltimore, Maryland, cut peak power demand by at least 22 percent—and as much as 37 percent.

C. Hardware Infrastructure

A connected hardware device installed at the generator's premise enabling real-time communication between the electricity producer and the Consumers.. And they can technically be designed to send control signals to connected devices. Depending on the system requirements, monitoring devices require more or less built-in intelligence. In a basic set-up, signals from the sensors must be converted into digital information and fed into a communications channel. But more sophisticated designs might be necessary to control thresholds or frequencies of sending data.

Smart meters at customer premises can play two roles in terms of grid management. These meters will provide communication protocols and they receive information and control signals destined for the customer and the appliances. Such signals can trigger the turning off or turning on of non-critical devices in the household and inform to the power market about the usage of renewable power. But smart meters also enable improved control over electricity consumption and billing.

D. Communications Network

Power market consists of agents and these agents provide the information about the generation of renewable energy, availability of electrical power, pricing of electrical power, data base agent and the electronic device control agents. A communication network is created between the operators of power market so as to provide the information to the consumers.

The communication network will be able to end control signals to individual units in order to respond to sudden fluctuations in demand at the level of the distribution or transmission grid. A communication between the agents of the communication network in the electricity market is developed by using C language.

E. Internet communication

The software communication system is the heart of the technology as it allows the aggregator to observe, manage and control power flows between power market and consumers. Making use of this internet communication between the power market and the loads a consumer can decide whether to purchase or not and the consumer will get the pricing details of the energy at any time. Necessary functionalities include user interfaces for visualization of the system status and sending of control messages, as well as algorithms to support decision-making. It is assumed that at least one type of communication medium must be available to facilitate communications among local generators, loads and electronic devices. Such communication means can be a wired local area network (LAN), a wireless network.

F. Physical and Cyber Security

Smart grid communications will play critical role in maintaining high levels of electric system reliability, performance and manageability. But at the same time, the grid is increasingly subject to attack, as many of the technologies being deployed to support smart grid projects (such as smart meters, sensors, and advanced communication networks) are interoperable and open. Meeting the critical need for an integrated security infrastructure will require the establishment and implementation of a security framework for managing physical and cyber security, as well as an accompanying security policy. In addition to reducing the system's vulnerability to physical or cyber attacks, a comprehensive approach to security will help utilities better manage their systems, keep costs lower, and improve the system's resilience against security disruptions and data privacy invasions.

III. GREEN ENERGY DISTRIBUTION SYSTEM

A. Distributed Energy Resources

Green energy distribution system is atypical network which consists of hardware and software communication system. Whenever there are any natural or manmade disasters occur there is a possibility of failure of existing renewable power system and it may lead to failure of power supply for a long time or it may lead to total washout of the existing generating system. So under such critical conditions we need to provide an alternate arrangement to serve the critical loads. Prior importance is given to the emergency loads like hospitals, defence loads and then to the domestic loads. To serve these loads an alternative arrangement is done at the distribution level by creating an DC grid with the help of distributed energy resources like solar energy, wind energy, DC battery etc and later on it is converted to AC and supplied to the load at the distribution load.

B. Electricity Power Market

An electrical power market is created at the distribution level which comes into activation as the existing generation is failed for any manmade or natural disasters which leads to failure of generation. The total information regarding the generation of the power, availability of the power, cost of the power, energy provider details can be known by the consumer. A communication network is created between the consumers and the loads through a wireless network or through internet access. With respect to the requirement of the energy and the type of loads a consumer can use the power. As the existing generation fails first the critical loads like hospitals, defense loads will be served then with respect to the availability of the power then the importance is given to the domestic loads.

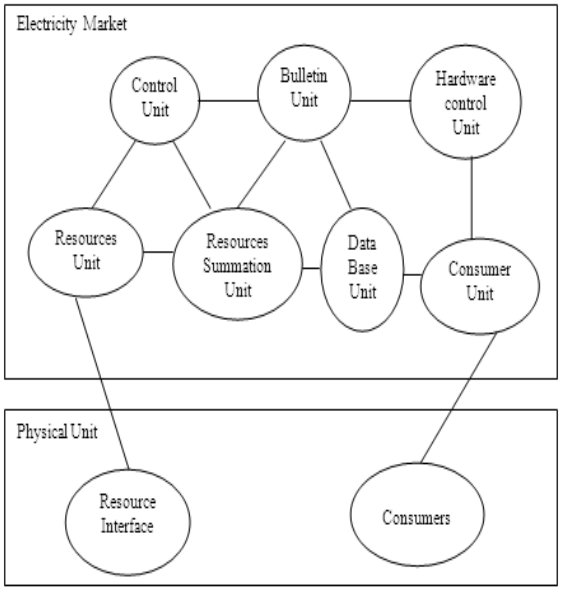

Fig.1. Electricity Market

C. Communication Network

A hardware and software communication is developed in this technology. A communication is developed between the different data providers in the electricity market .Whenever the failure of conventional energy system fails then the activation of distributed energy sources comes into activation, so the consumers can utilize the sources with their requirements. To know the information about the availability of the energy and the pricing of the energy a communication between the data providers of electricity market and the consumers is created. The communication between the hardware and the electricity market is provided with the help of wireless communication or internet.

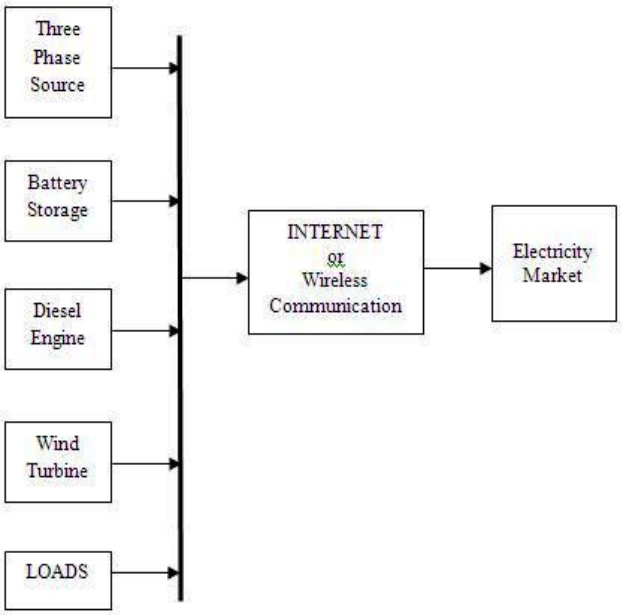

Fig 2: Communication Network

IV. SIMULINK RESULTS

In order to operational and test this idea, the proposed Green energy distributed system is being simulated and analyzed using MATLAB/Simulink Soft ware. Simulation model comprises two subsystems – hardware and software models – that interact with each other through the web services platform.

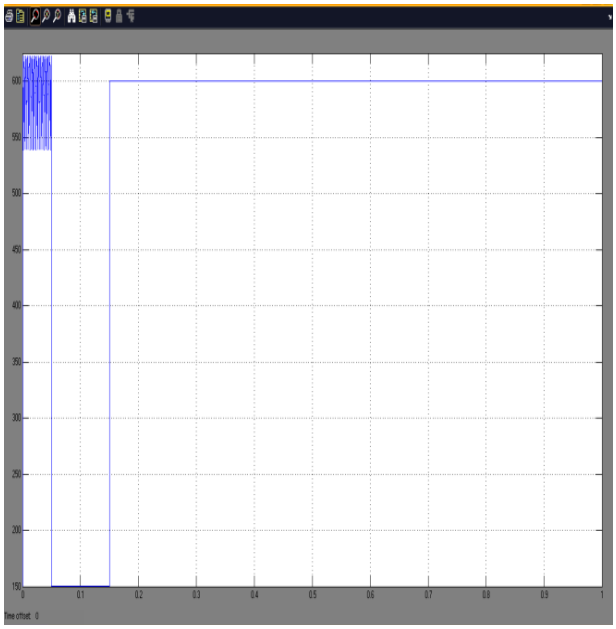

Fig.3.Voltage at Grid with Conventional and Non-Conventional

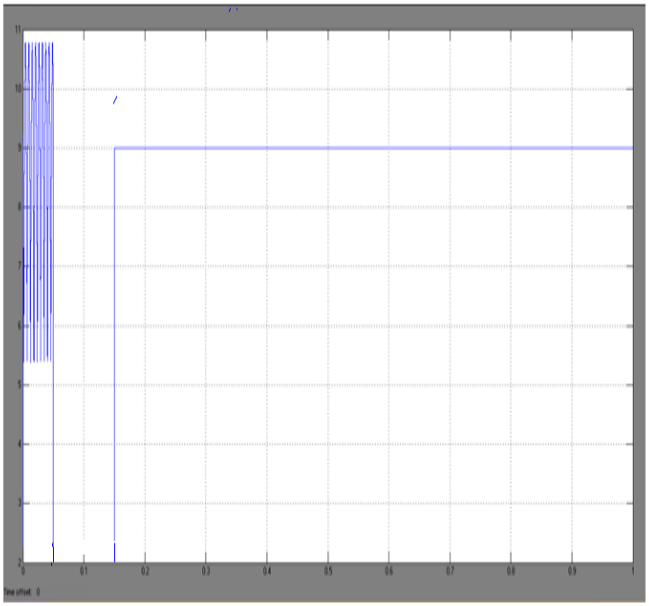

Fig.4: Current at Grid with Conventional and Non- Conventional

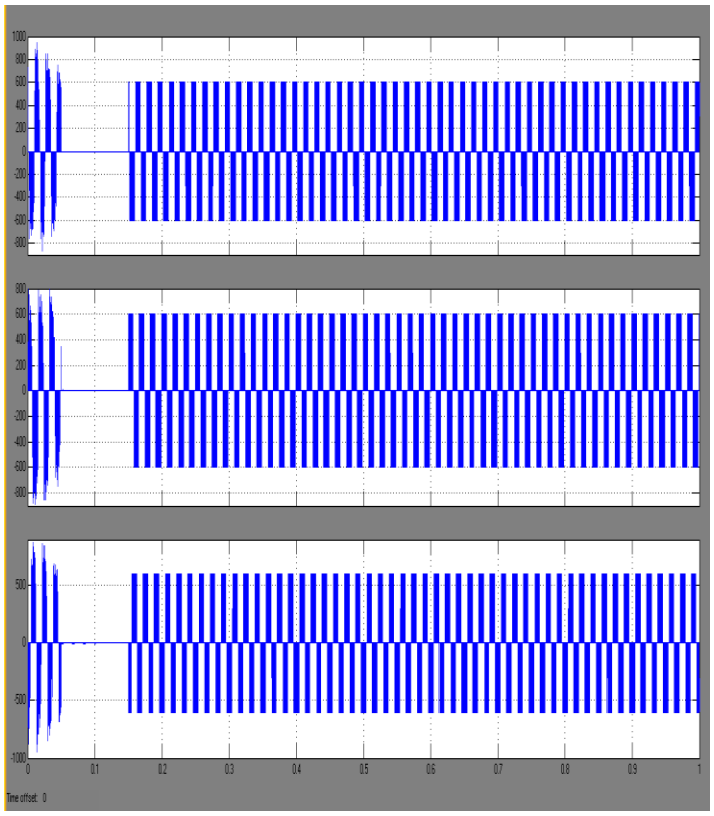

Fig.5: Voltages at Load with Conventional and Non- Conventional Sources

V. CONCLUSIONS

This paper presents the concept of emergency power system and electricity market and simulation model of this concept. This paper illustrates about the usage of electrical power under emergency condition. The development of the novel supply-driven-demand management model makes demand side management possible within the emergency power system under normal operating conditions, and allows critical loads to be served during emergency conditions. The utilization of internet services or wireless communication enables components within emergency power system enables to communicate with one another and also ensure portability and interoperability among various resource units. Usage of emergency power system includes the usage of Green energy technologies, the flexibility of customer choices in residential electricity markets and the design for more resiliencies in electric power systems.

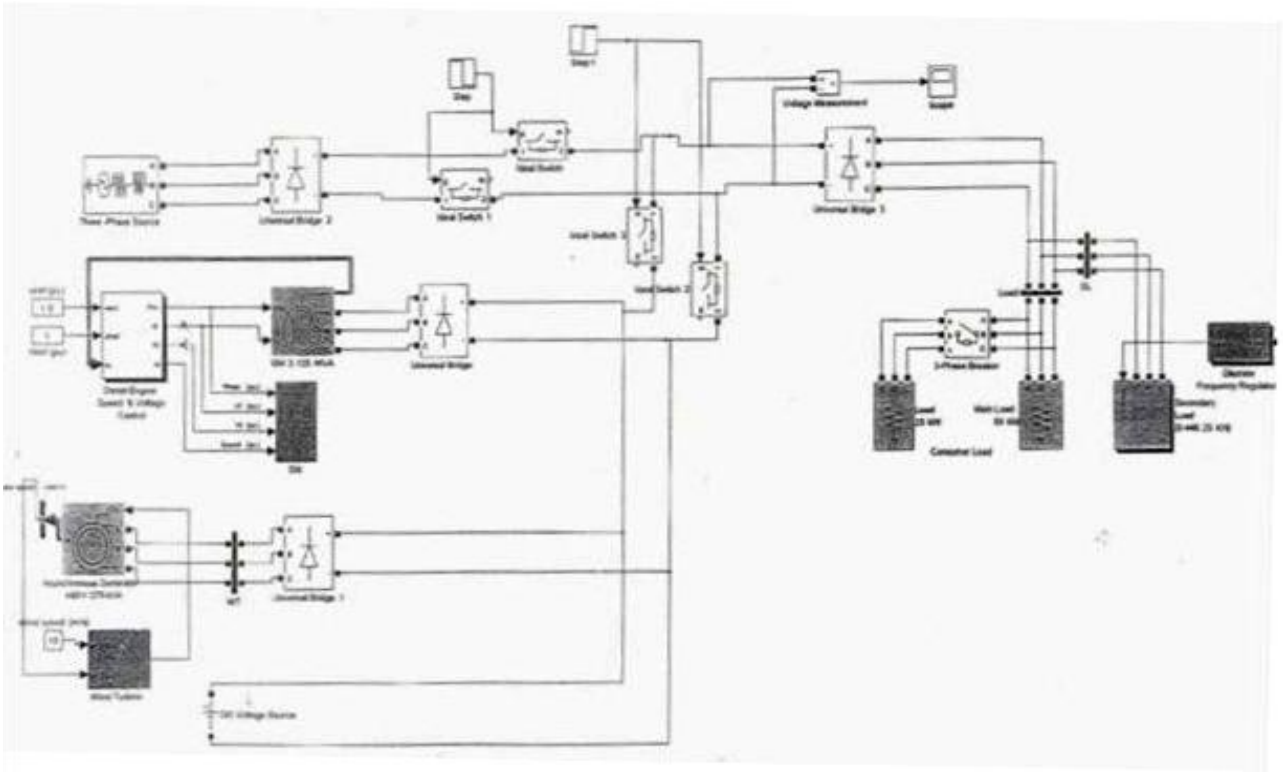

Fig.6: Simulink Model for Green Energy Distributed System

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BIOGRAPHIES

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