IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor 6.252
Volume 2, Issue 2, July 2022

Energy Management System for Smart Grid Connected with Power Grid System

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Abstract: *The rapid economic development is causing huge stresses in the existing generation, transmission and distribution systems as they are not able to keep pace with the increasing demand. Installation and incorporation of a large number of electrical power generation units with increased capacities to deal with the surging demand has an adverse impact on the environment therefore an efficient Energy Management is imperative. Smart Grid may be the answer to this expected energy crisis and management. Conventional instrumentation has proven inadequate for the purpose of managing the extensive and complex power systems. The electric grid to increase overall system efficiency and reliability. Much of the technology currently in use by the grid is outdated and in many cases unreliable. The non-linear load current harmonics may result in voltage harmonics and can create a serious PQ problem in the power system network. Active power filters (APF) are extensively used to compensate the load current harmonics and load unbalance at distribution level. This results in an additional hardware cost. However, in this paper authors have incorporated the features of APF in the, conventional inverter interfacing renewable with the grid, without any additional hardware cost.*

Keywords: Energy management system**,** Active power filters (APF), Power Quality (PQ), Distributed system

I. INTRODUCTION

Electric utilities and end users of electric power are becoming concerned about meeting the growing energy demand. 75 present of total global energy demand is supplied by the burning of fossil fuels. But increasing air pollution, global warming concerns, diminishing fossil fuels and their increasing cost have made it necessary to look towards renewable sources as a future energy solution. There has been an enormous interest in countries on renewable energy for power generation. The market liberalization and government's incentives have accelerated the renewable energy sector growth. With the depleting energy resources, enhancing energy security and energy-access, particularly in emerging economies is one of the major challenges that one has to deal with. In addition to managing the existing energy resources, generating power effectively and intelligently is an equally important agenda. Supplementing the establishment of large power plants from conventional energy sources, there is also a need to focus on distributed small scale generation of power particularly from renewable energy sources. Although Distributed Energy Resources (DERs) need additional infrastructure and investment to connect them to the grid, these technologies obviate the need for an expensive transmission system and reduce transmission and distribution (T&D) losses. A better way to realize the emerging potential of distributed generation is to take a system approach which views generation and associated loads as a subsystem or a Micro-grid [1-4]. During disturbances, the generation and corresponding loads can separate from the distribution system to isolate the Micro-grid's load from the disturbance without harming the transmission grid's integrity. Economic, technology and environmental incentives are changing the face of electricity generation and transmission. Centralized generating facilities are giving way to smaller, more distributed generation partially due to the loss of traditional economies of scale. Intelligent systems driven by microprocessors and computers need to be employed for online monitoring and control of modern large-scale power systems, in generation, transmission and distribution to overcome the complexities and drawbacks of the conventional instrumentation schemes. These intelligent systems form the basis of the smart grid. The smart grid (generation, transmission and distribution) by itself does not completely solve the problem of the existing

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demand-supply mismatch. The smart grid needs to be complemented with smart (programmable) appliances at the customer sites to efficiently re-distribute the demand to provide the benefits of lower costs for customers and operational efficiencies for suppliers. Smart Energy Management System need to integrate with smart grid & smart appliances to analyse end to end complex power system data which leads to the reduce power consumption and increase smart grid reliability and efficiency [5].

II. DISTRIBUTED GENERATION

Distributed generation, also called on-site generation, dispersed generation, embedded generation, decentralized generation, decentralized energy or distributed energy generates electricity from many small energy sources. Currently, industrial countries generate most of their electricity in large centralized facilities, such as fossil fuel (coal, gas powered) nuclear or hydropower plants. These plants have excellent economies of scale, but usually transmit electricity long distances and negatively affect the environment [6,7].For example, coal power plants are built away from cities to prevent their heavy air pollution from affecting the populace. In addition, such plants are often built near collieries to minimize the cost of transporting coal. Hydroelectric plants are by their nature limited to operating at sites with sufficient water flow. Most power plants are often considered to be too far away for their waste heat to be used for heating buildings.Today, new advances in technology and new directions in electricity regulation encourage a significant increase of distributed generation resources around the world. As shown in Fig. the currently competitive small generation units and the incentive laws to use renewable energies force electric utility companies to construct an increasing number of distributed generation units on its distribution network, instead of large central power plants. Moreover, DES can offer improved service reliability, better economics and a reduced dependence on the local utility.

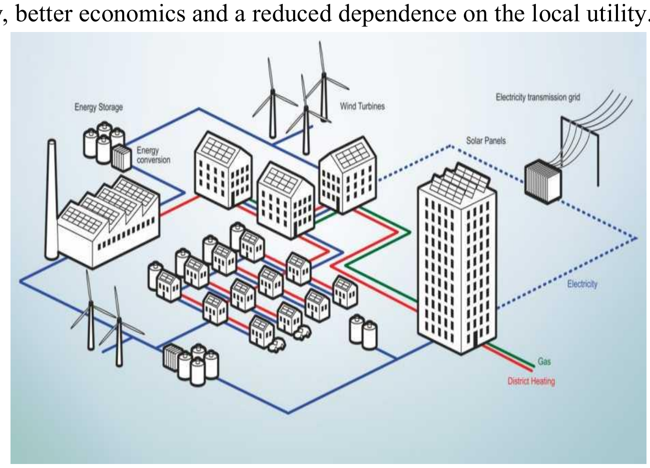

Fig 1: A large central power plant and distributed energy systems

III. POWER QUALITY

The contemporary container crane industry, like many other industry segments, is often enamoured by the bells and whistles, colourful diagnostic displays, high speed performance, and levels of automation that can be achieved [8]. Although these features and their indirectly related computer based enhancements are key issues to an efficient terminal operation, we must not forget the foundation upon which we are building. Power quality is the mortar which bonds the foundation blocks. Power quality also affects terminal operating economics, crane reliability, our environment, and initial investment in power distribution systems to support new crane installations. To quote the utility company newsletter which accompanied the last monthly issue of my home utility billing: 'Using electricity wisely is a good environmental and business practice which saves you money, reduces emissions from generating plants, and conserves our natural resources.' As we are all aware, container crane performance requirements continue to increase at an astounding rate.

3.1 Active Power Filters

Active Filters are commonly used for providing harmonic compensation to a system by controlling current harmonics in supply networks at the low to medium voltage distribution level or for reactive power or voltage control at high voltage distribution level [9]. These functions may be combined in a single circuit to achieve the various functions mentioned above or in separate active filters which can attack each aspect individually.

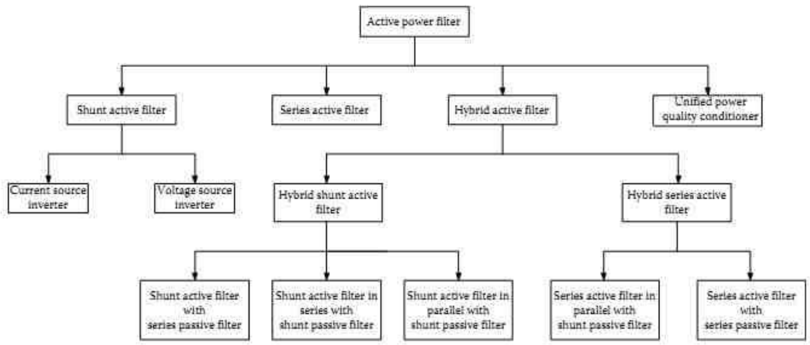

Fig 2: Subdivision of power system filters according to power circuit configurations and connections

IV. SIMULATION SETUP AND RESULT ANALYSIS

All the simulation, implementation and analysis work was done on windows ten. Since the platform provided the premise for doing everything, so it becomes essential to debate some options and additionally somewhat on however it evolved and the way is actively operating behind the scenes. The HOMER implementation of the smart grid model. PV indicates photovoltaic cells, which are connected to the DC grid and Wind and Biomass resources are connected to AC grid. The Generator on the figure is the biogas generator used as a biomass resource which runs using biogas as fuel and BWC Excel-S is the wind turbine used to generate wind energy. A bidirectional converter is used which can be used both as Homer generates output power productions and power consumptions. The electrical grid of the example represents Utility distribution system. It consists of a 120-kV transmission system equivalent supplying a 25-kV distribution substation. Several feeders are connected to the 25-kV bus of the substation. One of them supplies the power to a community that owns the PV farm and an energy storage system.

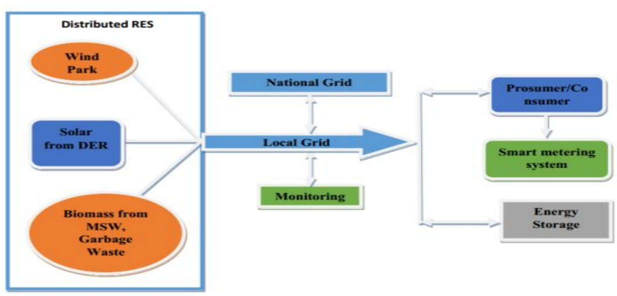

Fig 3 Developed model

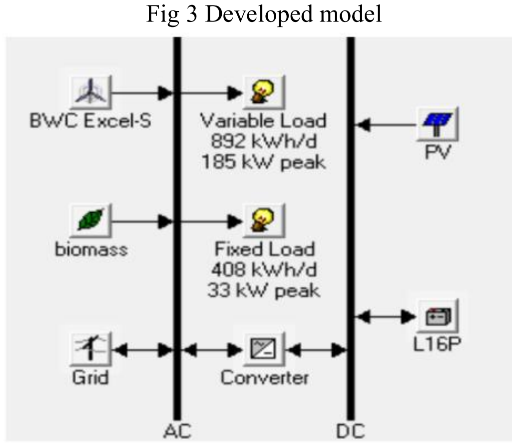

Fig 4 Distribution generation set up

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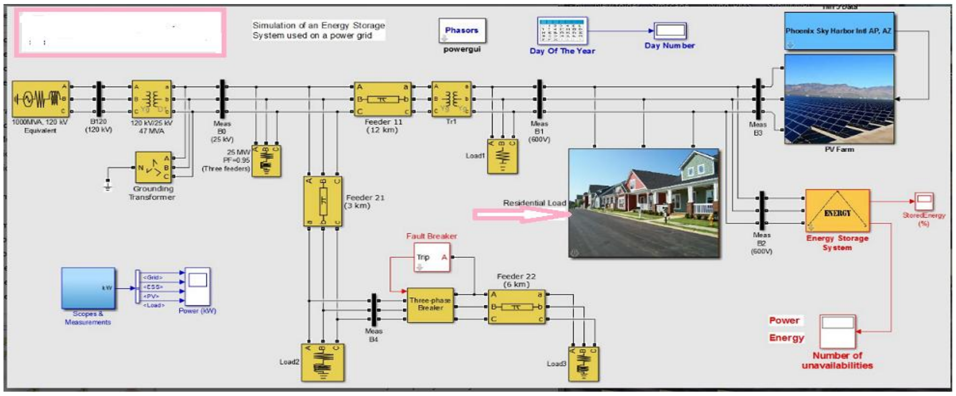

Fig 5 Distribution System

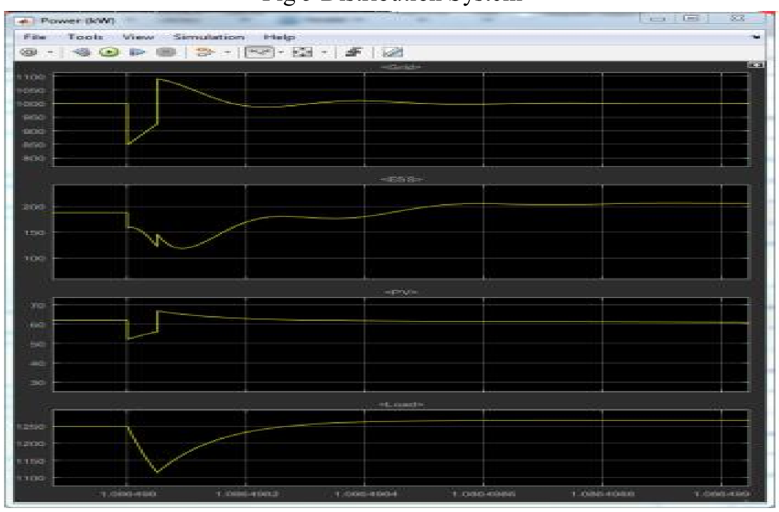

Fig.6 Power calculation

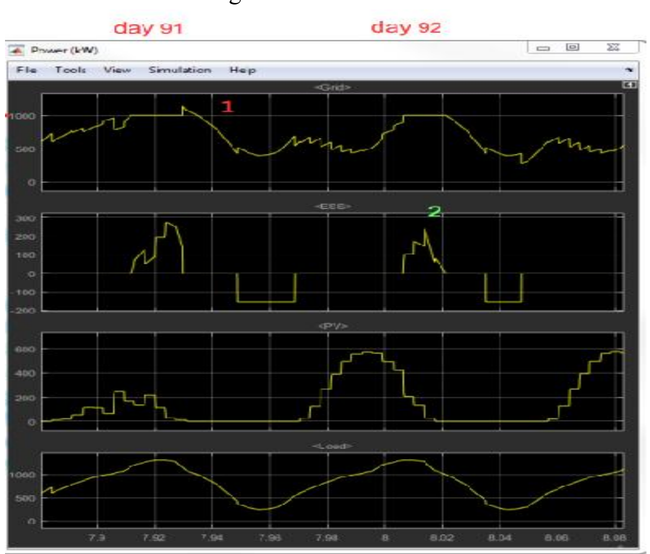

Fig.5.5Power Calculation

V. CONCLUSION

This paper presented a novel control of an existing grid interfacing inverter to improve the quality of power at PCC for a 3-phase 4-wireDGsystem. It has been shown that the grid-interfacing inverter can be effectively utilized for power conditioning without affecting its normal operation of real power transfer. When the power generated from renewable energy sources is more than the total load power demand, the grid-interfacing inverter with the proposed control approach not only fulfils the total load active and reactive power demand (with harmonic compensation) but also delivers the excess generated sinusoidal active power to the grid at unity power factor. Thus using better and advanced method in each of the above mentioned fields will surely result in a highly secure and reliable smart grid which will be capable to meet future energy demand efficiently.

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