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IMPLEMENTATION OF DC GRID IN POWER DISTRIBUTION SYSTEM

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ABSTRACT: Various statistics indicate that many parts of India, especially rural and island regions, have either limited or no access to electricity. It is very expensive and difficult of installation of transmission line in these areas because of their geographical location. This problem lead to the uses of renewable energy sources to supply power to these remote areas. Most of these renewable energy source produce electricity in the form of DC. In today scenario most of people use invertor in house to store electricity in a battery which will reused during cut off hour. While electricity generation of renewable source is in the form of DC and transmission of this supply is in the form of AC. And a wide variety of daily utility devices such as cell phone chargers, laptops, laptop chargers, electric vehicle etc. operate on DC electricity. So to supply power from generation unit to the consumer multiple time of conversion from AC to DC and vice versa take place. Because of this conversion losses occur which will affect the overall efficiency of power grid. So in this paper a proposed model of distribution system is discussed to overcome present problem.

KEYWORDS: Renewable Energy, DC Grid, Nano Grid, Micro Grid, Smart Grid, Mini Grid, AC Grid.

I. INTRODUCTION

World Energy Outlook 2015 reports that approximately 17 per cent of the world's total population needs access to electricity at home. As announced by the International Energy Agency, India has more than 237 million people in this group. According to CEEW (Council for Energy, Environment and Water), more than 50 per cent of houses in West Bengal, Bihar, Madhya Pradesh, Uttar Pradesh, Jharkhand, despite being grid-connected, Orissa has a lack of electricity. Regardless of the efforts used over the years to electrify rural areas[1], many households in five of these six states have no supply of more than 8 h or no supply at all and are routinely subject to blackouts. Most of these house used kerosene fuel for lighting[2]. Which give poor lighting. It also sends out dangerous fumes, may cause fire hazards.

In the energy production market, fossil fuels and conventional energy generation methods are rapidly losing interest, as policymakers around the world are emphasizing the consequences of global warming and climate change. The world is moving towards green energy to meet ever-increasing demand for energy[3]. The abundance of solar radiation and the falling prices of photovoltaic components make it easier to sustain and scalable, making the generation of solar PV more common among renewable energy sources[4]. Although the sun shines well in most parts of the country for up to 10 to 12 hours a day for most of the year. The enormous effect of distributed solar power has not been extensively exploited. For areas that receive sunshine more than 1,400 average peak hours per year, the electricity shortage gap can be bridged by the use of solar energy. The Government of India has become aware of these facts and is rising the use of renewable energy sources, specifically solar energy, by meeting the demand-supply gap across the nation. This initiative has facilitated studies and developments on low voltage DC solutions, as they are ideal for residential applications and can be easily integrated with renewable energy sources and storage systems. Increased demand for the integration of renewable energy resources brings DC back to the energy distribution system because, in such situations, it is easy to integrate renewable sources into the grid. As a result, several forms of research have been performed on dc distribution systems and their possible use in residential applications.

And most of the renewable energy source produce electricity in the form of DC. It will convert in AC for transferring to end user. But most of the device work on DC current again it will convert in DC to supply power to these devices. Because of these multiple conversion efficiency of power system will decrease. So here an

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overview of present model and proposed model and type of DC grid[5] is discussed to solve the problem of conversion losses and to increase the efficiency of renewable energy source so that increase electricity demand can be fulfil by using the best method of supply.

II. PRESENT MODEL OF ELECTRICITY DISTRIBUTION SYSTEM

In present scenario electrical distribution system is very complicated. From the source station to the load supply it takes multiple time of conversion of DC to AC or vice versa to supply the power to the consumer. This increase the losses and reduce the efficiency of distribution system. Today in the energy production market, fossil fuels and conventional energy generation methods are rapidly losing interest, as policymakers around the world are emphasizing the consequences of global warming and climate change. The world is moving towards green energy to meet ever-increasing demand for energy. And most of the renewable energy source like solar, water and wind generate electricity in the form of DC power[6]. For transmission of this power to the end user this DC power convert in the form of AC and then transmitted to the end user. After reaching at domestic level. It will again converted into DC and stored in battery because most of the people used invertor in their houses to supply power during cut off hour. So to store this AC power into battery it will again converted in DC power and stored in battery. During cut off hour this stored DC power is used. Because in house distribution of power in through AC wiring so o transfer this power to the load it will again converted into AC and supply directly to AC load. But in today world most of the device work on DC supply like cell phone, laptop, LED bulb etc. So transfer this Ac power to these DC load it will again converted into DC form. Fig. 1 show these conversion during transmission of electric supply from source station to end user.

So in this model multiple time of conversion has seen. This will increase the conversion loss in each time. And as everyone know that demand of electric supply is increasing rapidly and energy sources are limited. So to overcome this problem this paper proposed a model with the help of which multiple conversion are minimize and efficiency is increased.

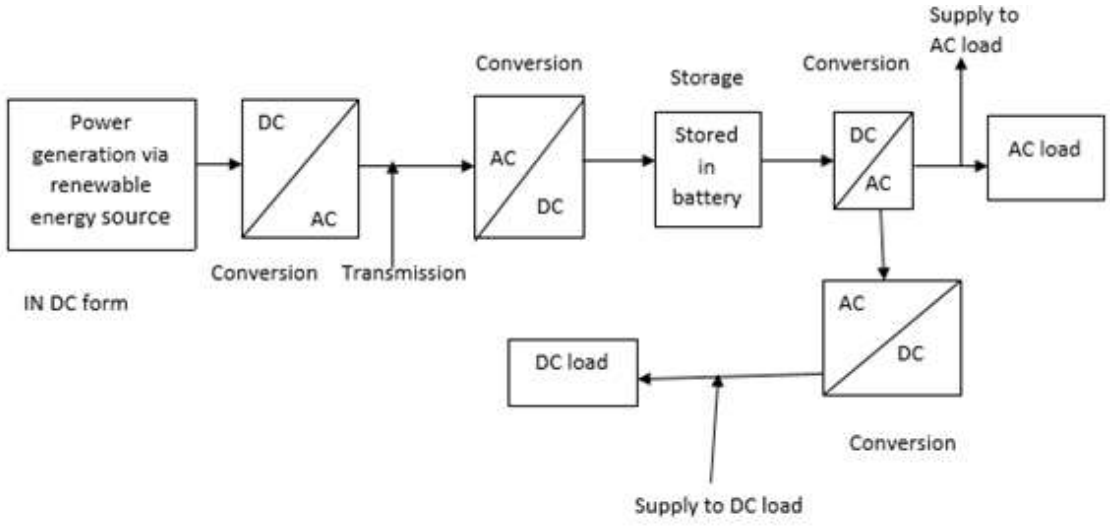

Fig. 1: Present Model of Distribution System

III. PROPOSED MODEL OF DISTRIBUTION SYSTEM

To solve the above problem here a model of electricity distribution system is proposed. Which will help to reduce multiple conversion during power supply and increase the efficiency. As everyone know that most of the renewable energy sources generate electricity in the form of DC. And in today world most of the device like mobile phone, tablet, laptop, LED bulb work on DC supply. DC product are more convenient with high efficiency compare to AC product. Fig. 2 show the proposed model of electrical distribution system. Here the generated Dc power is directly send to the receiving end without conversion via DC transmitting line. And stored in battery in the form of DC power. And for transferring this power to AC load it will converted into AC. Here only one conversion will take place. And for DC load this will directly send to these load. For stepping up or stepping down the power different kind of chopper is used. Which will convert DC to DC with varying

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voltage level[7]. Second benefit of DC grid is that DC power flow on the surface of the wire so resistivity of wire is very less. This will increase the efficiency of power station.

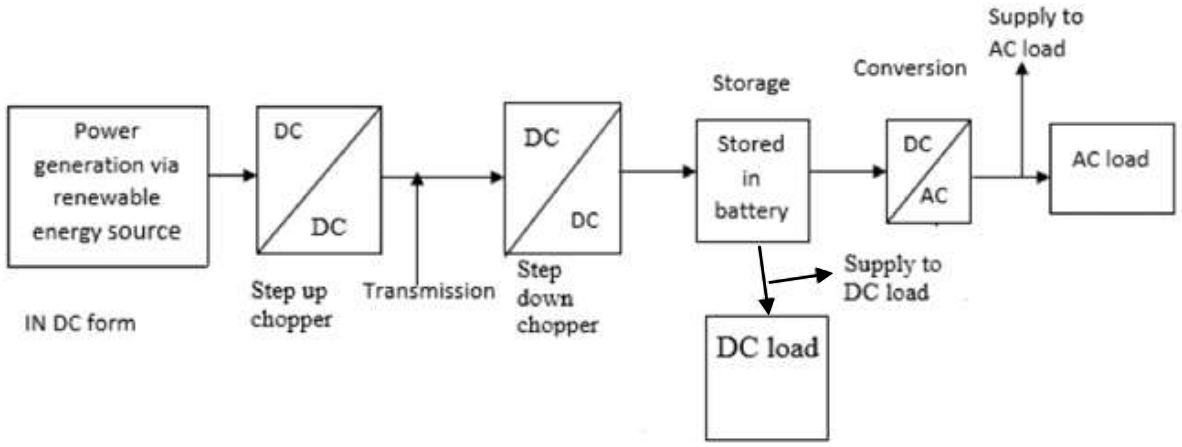

Fig. 2: Proposed Model of Distribution System

IV. ADVANTAGE OF DC GRID OVER AC GRID

The benefits of the DC-grid system in distribution system could be explained in two respects. One is the stability of power and the quality dimension, and the other is the economic and environmental aspect as set out below.

1. Stability of power and the quality dimension

In the AC-grid system, both voltage and frequency must be monitored and controlled in order to maintain the reliability of the power supply. Nonetheless, there are no reactive power interactions in the DC-grid system, and then the network regulation is voltage-oriented only. The DC-grid therefore has the benefits of preserving the reliability of electricity over the AC-grid. Therefore, the synchronization of generators is easier than the AC-grid[8]. In the AC-grid system, it is necessary to consider the voltage, frequency, phase angle during synchronization of more than two generators. Nevertheless, only the voltage is a crucial factor in the DC-grid system.

In terms of the power output of the AC-grid, the main problem is the harmonic distortion. In order to solve this problem, the harmonic filters were additionally mounted. In terms of the power output of the AC-grid, the main problem is the harmonic distortion. In order to solve this problem, the harmonic filters were additionally installed in the past, and then the phase-shifting transformer was widely introduced. Which increase the cost of the system. Nevertheless, it is not appropriate to transfer the AC to a constant voltage in the DC-grid system and thus the rectifier component in the DC grid system could be removed. To sum up, the DC-grid system has the following advantages in terms of power stability and quality compared to the AC-grid system.

1. Free from reactive power (increased power stability).
2. Free from frequency (easy power synchronization).
3. DC power distribution (reducing harmonic distortions and increasing power quality).

2. Economic and Environmental Aspect

In the AC-grid system, the generator and the prim-mover set will operate at a fixed frequency of 50 or 60 Hz. Nevertheless, the actual fuel oil consumption of the generator and the prime-mover set varies depending on its load and is configured to optimize about 75–85 percent of the load factor. When running at low load, the actual fuel oil consumption is increased. Nevertheless, in the DC-grid system, generator and prime-mover sets will work with variable frequencies, so that there is a broader operating window with high fuel efficiency. It is estimated that the DC-grid system will reduce fuel consumption and pollution by up to around 20%.

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3. Other advantage

It is also easier to transfer electricity in DC form through transmission line compare to AC because current flow on the surface of Wire in DC form while in Ac form it will flow inside the wire. So power losses are increase because of resistivity of conductor in AC grid as compare to DC grid.

V. TYPES OF DC GRID

1. Smart-grid:

Smart grid[9] are two-way flow of power and info in distribution grid. Implementation of Smart-grid will reduce the penetration of renewable energy sources as shown in fig. 3.

Fig. 3: Smart-Grid

A smart grid is an integrated power demand control network, built on modern technologies and designed to promote convergence by those concerned, in a safe, efficient, and economic manner. Consumers as well as providers have resources for handling, tracking and addressing energy challenges in the Smart Grid environment. The energy transfer from the public sector to the customer is a two-way debate. Smart grids generate more electricity to satisfy growing demand, increase stability and power supply consistency, boost energy performance and incorporate carbon-free energy sources into power grids.

2. Micro-grid

Micro-grid[10] are building block of a smart grid. It can supply a power of several hundred KW to a few MW. This system reduces energy dissipation as described in fig. 4. A micro power network with a community of loads, distribution and multiple DGs is a micro grid identified in the United States by CERTS (Consortium for Electrical Reliability Solution). This will meet the power efficiency and power supply reliability specifications. It supplies the 46 local regions with both heat and electricity.

The network comprises of a variety of distributed energy facilities, such as solar panels, wind turbines, micro turbines and various hard drives for electricity, such as flywheels, tanks, super condensers, etc.

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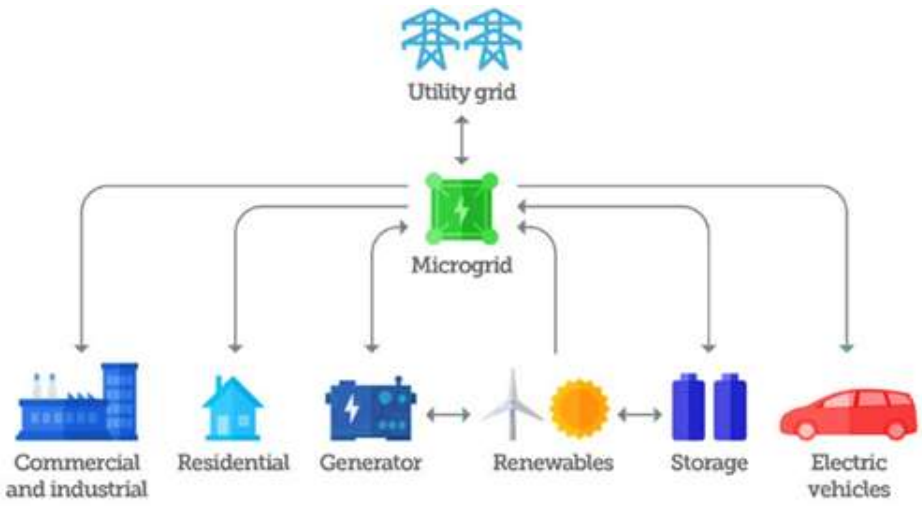

Fig. 4: Micro-Grid

3. Nano-Grid

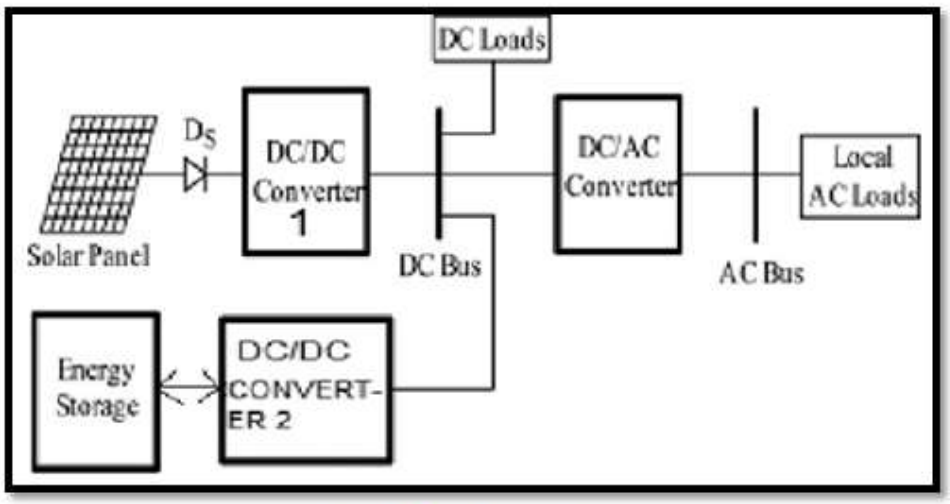

Fig. 5: DC Nano Grid

Nano-Grid are building cells of a micro-grid. DC Nano grid[11] operate in a peer to peer fashion. It can generate HV-DC (at 1kv or so) for distribution as depicted in Fig. 5. A nanogrid is a single voltage, durability and control area. It has at least one load and at least one portal toward the outside (power sunk, which may be a storage).

Collection of energy may be present or not. Electricity outlets do not shape part of the nanogrid, but instead even a single nanogrid is associated by a connection. "Gateways" establish interfaces with certain control institutions. No technical dimensions of systems are introduced through Nanogrids only. The device, loads, storage (optional), and gateways are constituents of a nanogrid.

VI. CONCLUSION

This paper proposed a model of implementation of DC-grid in Power supply distribution system. This grid is capable of highlighting the advantages of a DC grid arrangement over traditional AC grids, with the ultimate advantage of reducing multiple conversion from DC to AC or vice versa during the transmission and distribution of supply from source end to the consumer end. By increasing the uses of renewable sources for electricity production and transfer this power in the form of DC will solve the problem of increasing demand of electricity. Implementation of DC grid also solve the problem of supplying electricity to isolate location by installing mini grid or Nano grid in these place and supply power directly to the load in form of DC. It is easier

to supply power in the form of direct current compare to alternative current. By using DC grid implementation 20 to 25% of power can be saved. It will also reduce the tariff of electricity.

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