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Architectures and Overview of Hybrid Micro-Grid

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Abstract – *The distribution system is part of the electric power system that links the bulk transmission system and the individual customers. Increasing environmental concerns, consumer expectations in terms of reliability & better quality of power supply and improving the economics of distributed energy resources (DER) based on renewable, is making Micro Grid a viable proposition. Present electrical distribution system offers many technical & operational glitches for successful integration of Micro-Grid Technologies. Modern Power systems are smart, interconnected, interdependent, load sharing and phased mission systems. Microgrids are composed of distributed generators, energy storage devices, intelligent circuit breakers and local loads. In this paper, a review of the main microgrid architectures proposed in the literature has been carried out. The microgrid architectures are first classified regarding their AC or DC distribution buses. Besides, more complex microgrid architectures will be discussed. Both advantages and disadvantages of each one of the microgrid families will be discussed*

Key Words: **DER-Distributed energy resources, IOT- Internet of Things, LCD-Liquid Crystal Display ,LED-Light Emitting Diode**

1. INTRODUCTION

Renewable based microgrid is at the upfront for achieving rural electrification, especially in developing nations such as India. A microgrid is a self-sufficient and independent power system that includes one or more generating sources, an energy storage system, energy management and loads. Such a system may or may not be connected to the grid. The need for renewable-based microgrids arises to fulfill the energy requirement renewable-based microgrid arises to fulfill the energy requirement of rural, isolated regions. Grid-connected systems are mainly established in cities and have sparsely reached villages or isolated regions. In the regions where grid-connected supply is available to pay for the poor quality of supply the supply is time-limited and this hampers the social and economic growth of that region. Even in cities where the grid is stronger comparatively, load shedding and poor quality of supply make the grid unreliable. Limitations of the AC grid create a need for localized power systems or microgrids, which are not limited to a certain region, which are cost-efficient and reliable, and contribute towards sustainability rather than degradation of the environment. Renewable-based microgrids harness inexhaustible energy resources which are available in plenty and are free of cost. A microgrid can utilize DC-DC power converters having an efficiency of more than 95% and reduce the need for AC/DC converters. Centralized AC power grids face severe transmission and distribution losses. Earlier, the majority of the loads were AC, such as

induction machine and incandescent lamps Nowadays, many DC loads are used such as LED lights, Heating Ventilation and Air Conditioning (HVAC) equipment, variable-speed motor drive.

A Microgrid, a local energy network, offers integration of distributed energy resources (DER) with local elastic loads, which can operate in parallel with the grid or in an intentional island mode to provide a customized level of high reliability and resilience to grid disturbances. This advanced, integrated distribution system addresses the need for application in locations with electric supply and/or delivery constraints, in remote sites, and for the protection of critical loads and economically sensitive development. (Myles, et al. 2011).

Micro-Grid can be realized through utilizing the potential of distributed renewable energy resources where various small power systems working as independent "Micro Grids" may be established which can cater to several consumers' loads through small size distributed energy resources. In other means, Microgrids are modern, a small-scale version of centralized electricity systems which generate distributes and regulates the flow of electricity to a set of consumers at the local level itself. From a generation point of view, with the advancement of renewable generation technologies, small generating units exploiting renewable sources through Solar PV panels, wind turbines or biomass plants have already been commercialized at the distribution level. However, at most places, Micro Grids are realized through Single resources generation like Solar PV along with Battery Storage systems.

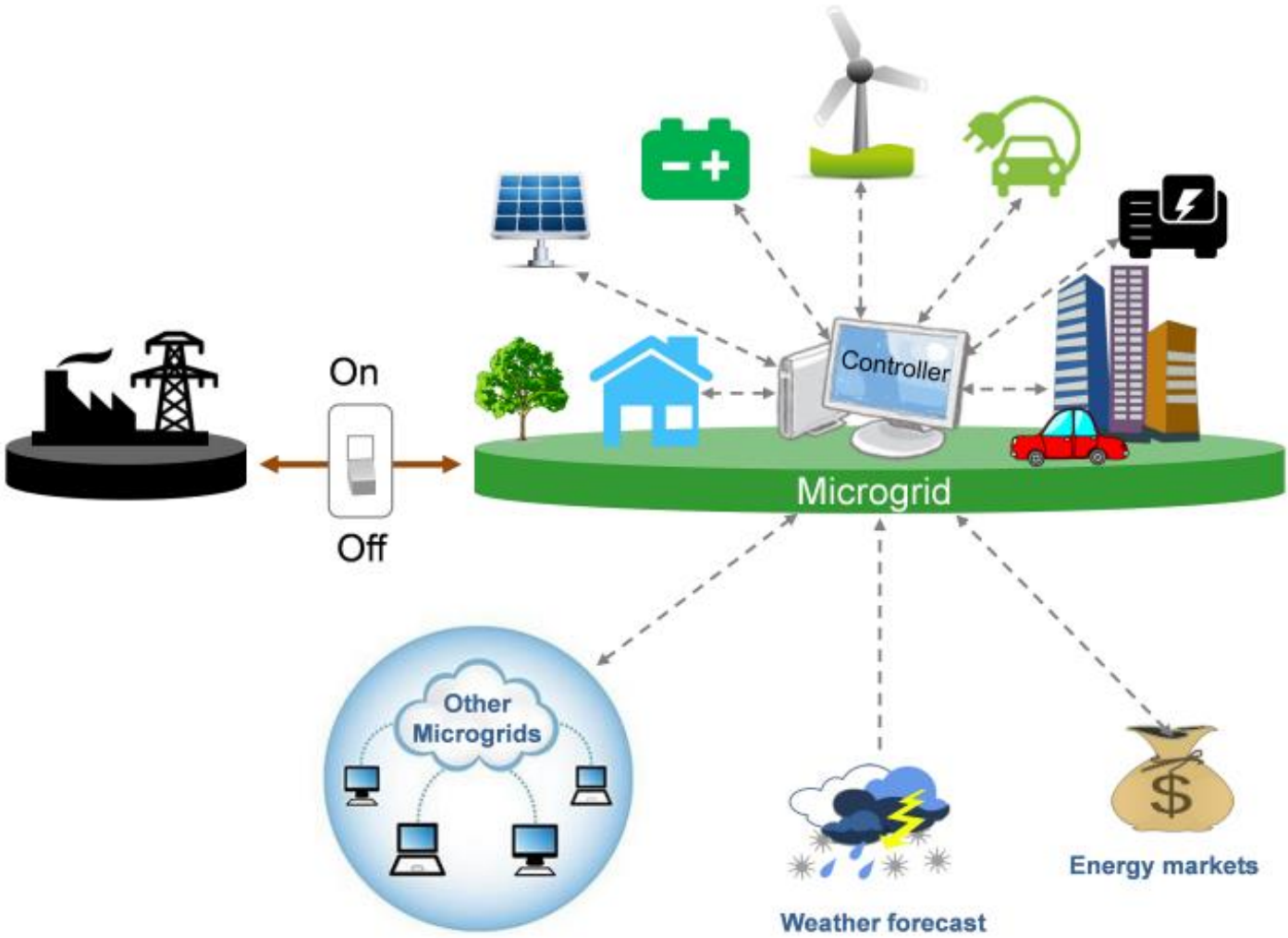

Figure1: Basic Layout of Hybrid Micro-Grid

1.1 The need for Hybrid Micro-Grid

The Effective utilization of renewable energy is a big motivation for the renovation of conventional power systems. The conventional power plants such as heat power, nuclear power, etc. are large scale and they are supposed to be responsible for wide-area transmission. Most power systems are optimized for conventional power plants. On the other hand, renewable energy sources such as solar power, wind power, etc. are usually small-scale, and their outputs are unstable. Such renewable energy sources are distributed, and the batteries are often equipped to fill in the temporal gap between generation and consumption.
The Microgrids [1] are a hopeful solution to future power systems including renewable energy sources. Especially, DC microgrid systems have big advantages in terms of their efficiency because the most renewable energy and home appliances are DC. This means that the DC microgrid systems reduce the power conversion loss between DC and AC.

To demonstrate the efficiency of the DC microgrid systems research Operating the system for the long term gives a lot of technical insight for the system operation and structural optimization. analyzed the dynamics of the resident's Such a program requires the full cooperation of the residents because such a new program imposes a non-negligible strain on the residents. Then it is impossible to perform a large-scale and long-term experiment of the DC microgrid systems with new pricing strategies.

1.2 SYSTEM MODEL ITS WORKING

DC Micro-Grid consists of DC-Line, transformer, AC and AC/apply switch controller, power-electronics, capacitors Renewable Energy sources and loads.

Transformer step-down the AC and supply parameter and then that frequency quantity gets rectified by rectifier Auto DC for DC-line bus, capacitors are connected across the rectifier, to filter out the ripples from the output of rectifier various distributed energy resources are there connected with DC bus system to feed the load in case of outrage or its associated problems. Power Electronics converters are used to enhance the output and sometimes get the desired form to time with the rest of bus system, LCD Display is used to show the variations and output of battery storage system which is used to store the energy output of renewable energy sources, so in case of a power outage, it can provide power to its loads. Traditionally homes and businesses connect to the National Grid transmission lines.

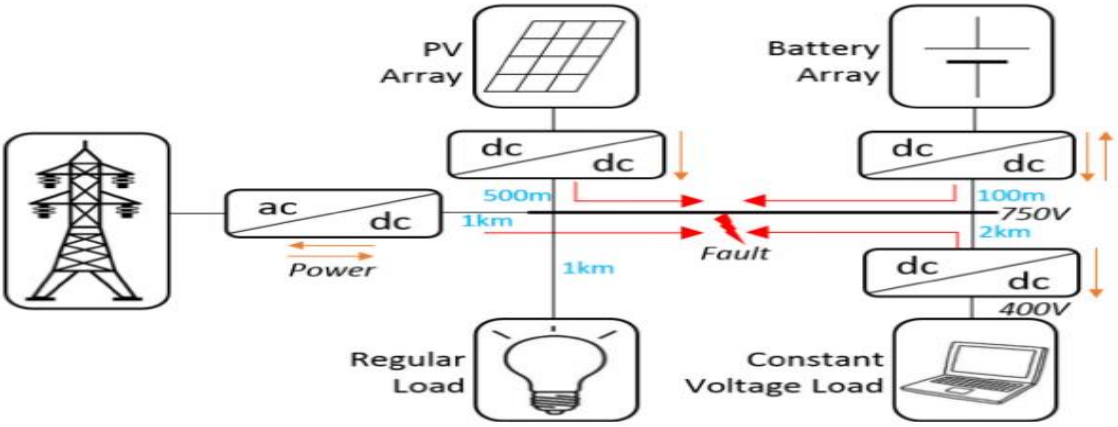

Figure2: Connection Of Hybrid Micro-Grid

Transporting our electricity from where it is generated. Think of it as a very large, interconnected web. Micro-grids generally operate while connected to the grid, but importantly, they can break off and operate on their own using local energy generation in times of crisis like storms, power outages, or for other reasons (e.g., repairs further up the line).

Micro-grid powered by :

- ❖ Distributed generators.
- ❖ Batteries.
- ❖ Renewable resources like solar panels and wind turbines.

A microgrid could run indefinitely, depend on management and fuelling. Microgrids connect to the grid. This is at a point of common coupling that maintains voltage at the same level as the main grid unless there is some sort of problem on the grid or other reason to disconnect. A switch can separate the microgrid from the main grid automatically or manually, and it then functions as an island.

Microgrids not only allow you to optimize the power source but also the power use. For example, a microgrid could deal with an energy shortage not by cutting off all power. Whilst electively disconnecting supplies to certain uses. For instance, the system might prioritize vital communications and healthcare-related energy expenditures. Cutting power to superfluous uses or appliances such as fridges and freezers. Of course, which can get by with the odd short-term power outage.

Another huge advantage to local power production is the optimization of heat energy. Large power plants tend to create a great deal of unused heat. Between 60 and 80 percent of a typical power plant's energy consumption never becomes electricity. Microgrid works in two ways one is when the consumer gets electricity directly from the main grid and the second way is an off-grid mode when consumers get electricity from the stored energy in the storage battery, the energy stored in the battery is

the mixture of wind energy, solar energy and direct ac mains supply. in the time of outage and power disruption due to natural calamities like
thunderstorm microgrid is the ray of hope to provide a continuous supply of electricity for a definite period.

2. HYBRID MICRO-GRID ARCHITECTURES

According to the micro-grid design principles proposed in literature, there are three hybrid AC/DC micro-grid architectures:

AC MICRO-GRID

AC microgrid is currently the main form, and radiation type is the basic structure. According to the application of microgrid, load type and capacity size, the AC microgrid is divided into three categories: system-level microgrid, commercial and industrial microgrid, as well as the rural micro grid. Figure 3 shows an AC microgrid structure

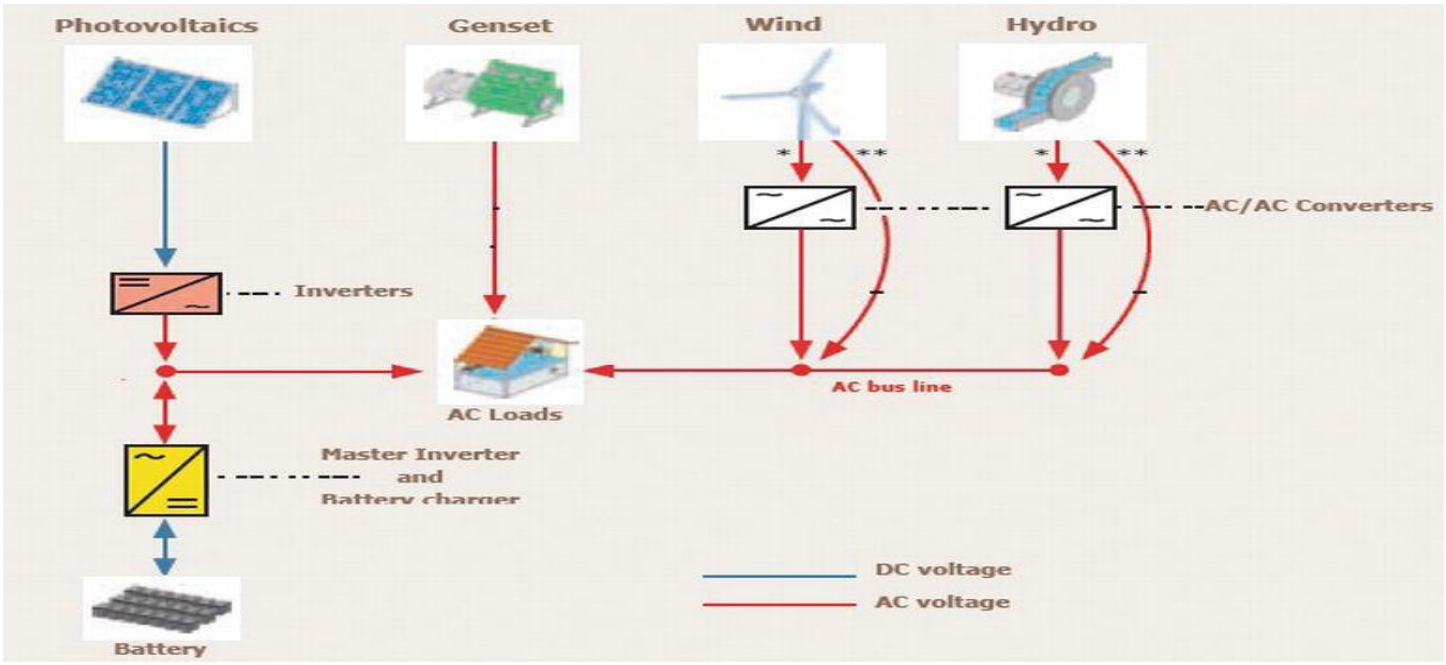

Figure3 : AC Micro-grid Layout

DC MICRO-GRID

Recently the number of DC loads has been increased and the urban distribution grid has been developed. Besides, the DC microgrid does not exist the problems which AC microgrid has, such as voltage, frequency and synchronization problem. As a result, DC microgrid has been developed rapidly. According to the different quality requirements for electricity, there have been several typical DC grid structures in recent years, such as ring-type, radiation type, feeder type, etc. Figure 4 shows a DC microgrid structure.

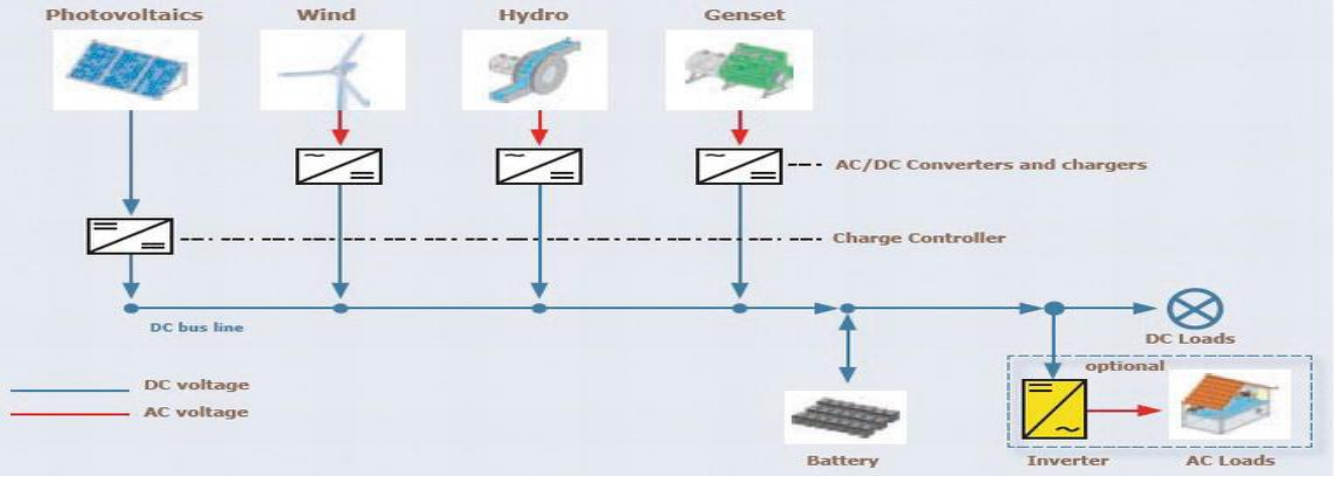

Figure 4: DC Micro-Grid Layout

AC-DC Micro-Grid Architecture

The distributed generation and AC/DC loads can access the DC bus through the power electronic converter, and then the AC microgrid can be connected with the large systems through the transformers. A new AC-DC hybrid microgrid structure is the ideal choice. Using the AC-DC hybrid micro-grid, the power supply will meet the reliability, economic and flexibility requirements

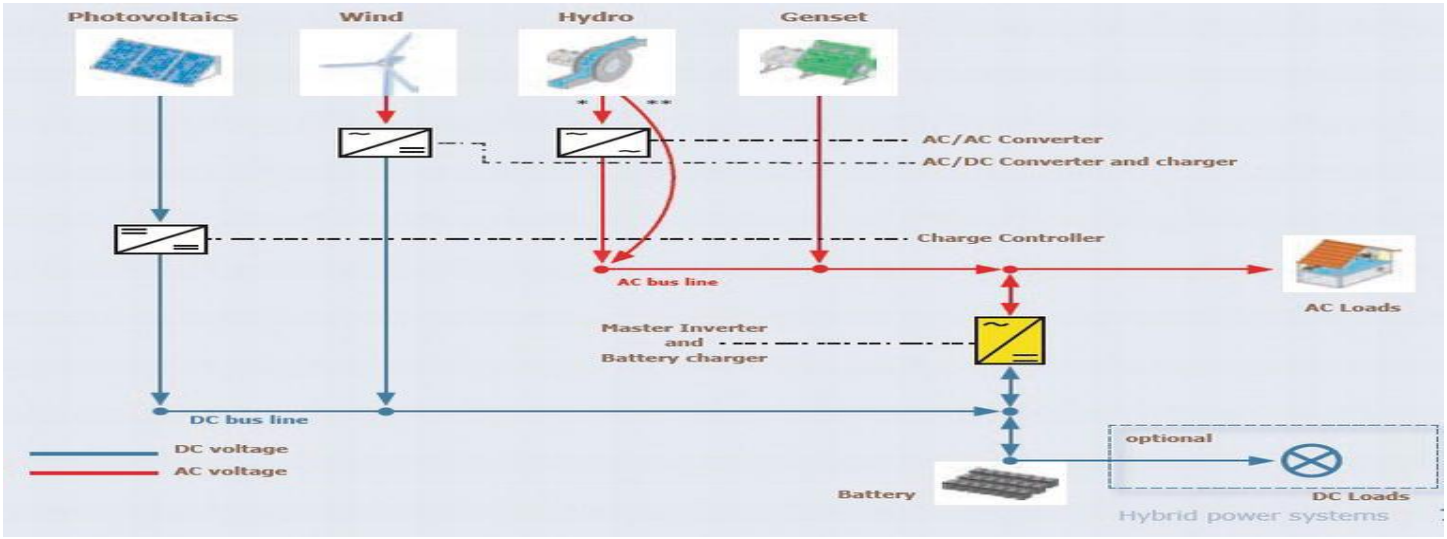

Figure 5: AC-DC Micro Grid Layout

2.1 ADVANTAGES OF MICRO-GRID

Financial Benefits - Microgrids offer many financial benefits. Take solar panels as an example. While they take from seven to twenty years to pay for themselves, depending on state tax breaks or discounts, they can save you thousands of dollars each year once paid off. Solar panels add value to your home and can be more economically stable than energy produced from fossil fuels, which has a notorious unstable pricing.

Reliability – Microgrids are also popular due to their reliability. When electricity has to traverse long distances before arriving at your home, the possibility of a storm, fire, or flood knocking out your power is a constant threat. Locally generated energy does not have to travel far, so a microgrid can provide you power even when extreme weather knocks out most power lines. If

your microgrid has diversified and produces energy from multiple sources, such as solar and fuel cells, that adds yet another level of security. If the fuel cell malfunctions, you draw from solar. If the sun is not shining, you draw from the fuel cells.

Faster Construction - Microgrids are smaller and can therefore be installed more quickly than traditional power plants, even in remote areas without a pre-existing power grid. This makes microgrids a faster solution when dealing with rapidly expanding populations. Another pro for microgrids at the moment is that there are government incentives out there. Green initiatives offer tax breaks and subsidies for companies and residences considering implementing sources renewable energy generation. These incentives can make a huge difference in the cost of implementing a microgrid and will not be around forever

2.2 CHALLANGES OF MICROGRID

Resistance from Utilities - As the number of distributed generation options expands, microgrids are becoming more complicated. Before, there may have been a few backup generators hooked onto the main grid that kicked on in the case of an outage. But power mostly flowed in one direction–from the utility to its customers. This complexity can be managed due to IT advancements and the Internet of Things(IOT), but a tool or command center capable of automatically managing various energy sources and storage vessels is essential for more complex microgrids.

Regulations - Microgrids also come with a lot of regulatory issues, which may be more difficult to comply with than people expect, as the laws are struggling to catch up to the technology. One large area to keep in mind is cyber security. Regulations regarding cybersecurity and customers' personal information is still relatively lax, but a global movement is underway that is forever changing that. On May 25, 2018, the General Data and Protection Regulation was implemented throughout the EU and the UK, implementing a massive overhaul in the way companies must protect employee data.

A New Concept - While microgrids are technically not an invention, they are being used today in ways they never have been before. They are powering towns and communities, providing energy security to hospitals and businesses, and increasing the resilience of our power grid against Mother Nature. The innovation and progress are astounding. However, as with all new things, the fact that this has never been done before means many companies are fumbling their way in the dark. There are not a lot of trained experts in microgrids and smart grids yet, through that trend will change over the coming decade.

2.3 Future Scope

1. To evaluate the practicality of the proposed (i) Wind-Diesel and (ii) PV-Wind- Diesel hybrid systems in isolated and grid-connected modes, several pragmatic issues such as control and grid integration aspects can be taken into consideration for the microgrid and energy storage schemes.

2. In hybrid systems, depending upon the type of application, design and feasibility many different strategies other than cycle charging and load following, can be performed for enhancing the system performance by implementing it on hardware. However, the structure of the algorithm includes multiple optimization processes; practical application of this scheme may demand high computational integrity. Hence, the hardware implementation of proposed hybrid configurations is a challenging task. Conversely, many other hybrid configurations with different micro sources like fuel cells, Biofuel and microturbines have been introduced in the field of hybrid power systems. They can provide good results with various combinations in real-time applications using these energy sources. Hence, there is a scope to implement the suggested hybrid power system configurations in real-time applications.

3. The energy storage algorithm developed for battery and flywheel discrimination between implementation and application can be tested and modified if required for grid-connected modes and hybrid AC/DC systems. Moreover, the proposed scheme has considered batteries for DC load requirements and flywheels for AC/DC load requirements. It would be interesting to make experiments or simulations on larger networks that include small hydro, fuel cell and microturbines along with the pumped hydro storage, magnetic storage elements and hydrogen storage and to find possible optimization configuration to implement the proposed scheme.

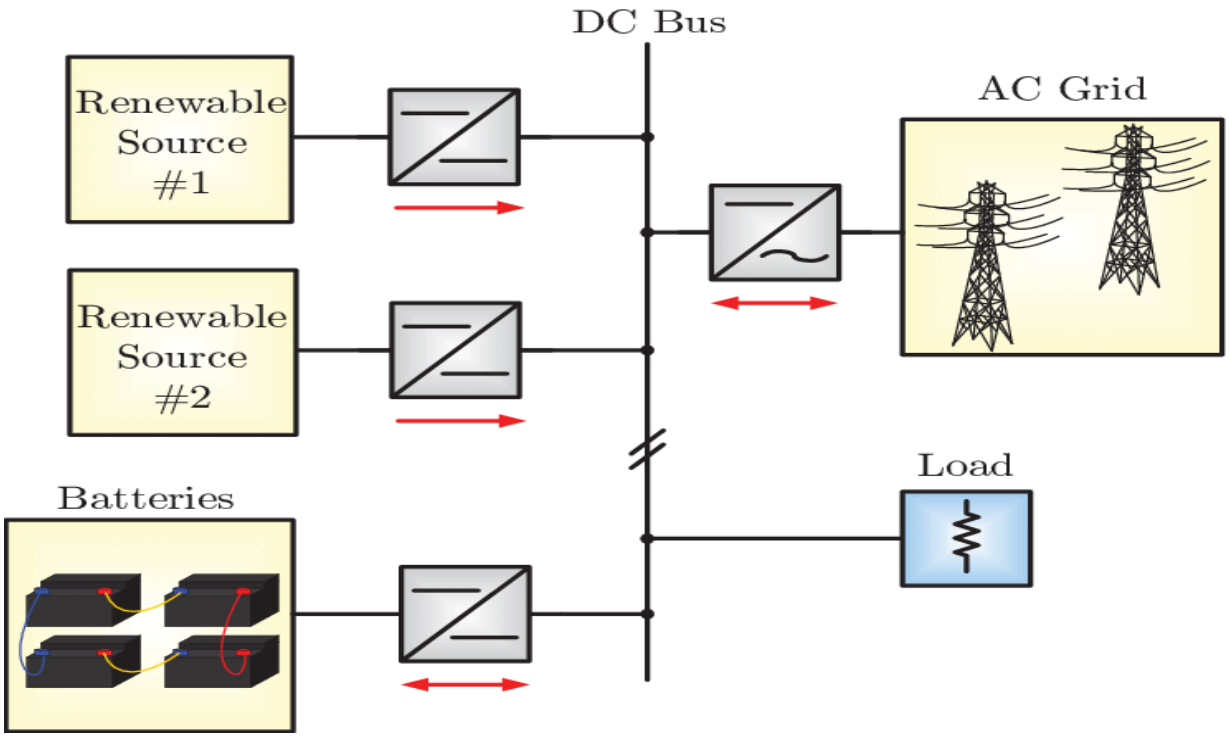

Figure 6 : Storage and Exchange of Energies

3. CONCLUSIONS

A microgrid is an extension of the main grid providing on-site generation capable of fulfilling its local load demand. A microgrid architecture requires to be added to the main grid to increase reliability, improve power quality, avoid the use of depleting fossil fuels, improve technical performance and reduce greenhouse gas emissions. The microgrid can be connected in an islanded or isolated or autonomous and grid-connected modes. Depending on the requirement these renewable energy sources are connected in the main grid or operate separately. Because of these reasons, operation, control and grid integration of renewable resources is a task of fundamental importance in the modern power system. Microgrid operating modes and dispatch strategies must be studied. Furthermore, as renewable energy sources are intermittent, energy storage schemes are required to store the energy and retrieve the energy at times required.

Thus, it is desirable to develop reliable microgrid operation and effective energy storage algorithms which would enhance the performance of hybrid power systems.

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