Microgrid-"A Smart Grid for Community Users"

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***Abstract*---Micro grids are modern, small-scale versions of the centralized electricity system, having specific local goals, such as reliability, carbon emission reduction, diversification of energy sources, and cost reduction, established by the community of users being served. This paper presents an intelligent micro grid that is installable in small localities and consists of sources like grid power, solar power etc. By efficient use of sources the overall cost for the users can be reduced. Smart switching at the user end as per the requirements so as to restrict the user for overloading. Local power generation and storage allow portions of the grid and critical facilities to operate independent of the larger grid, Smart switches and sensors automatically fix and even anticipate power disturbances, unlike today's system where switches have to be reset manually in case of any outage.**

I. INTRODUCTION

A microgrid is a localized grouping of electricity generation, energy storage, and loads that normally operate connected to traditional centralized grid .The connectivity between the microgrid and the centralized grid can be established or dislodged according to the requirement, hence enables the microgrid to function standalone. The loads and the generation points or sources are usually of low voltages. A connected microgrid can be controlled and monitored as a single entity.

Microgrids allow consumers to procure power in real-time at significantly lower costs, while using local generation to compensate power costs. The most significant environmental benefit of a smart micro grid is its ability to use local generation and the resulting "waste" heat to displace coal-fired generation. A local power generator can be renewable- or natural gas-fuelled. The smart micro grid can reuse the energy that is produced during electricity generation for heating buildings, hot water, sterilization, cooling etc.

Smart microgrids reliability significantly reduces costs. Smart meters that allow for the two-way exchange of pricing, usage data and electricity. Programmable smart appliances and devices that come on when the price of power reaches consumer's desired price point. User-friendly home energy control systems that allow customers to interface with the smart micro grid to automatically control every aspect of a home's power usage.

Energy efficiency improvements that help consumers use less energy and ultimately save money on monthly electricity bills. Computerized controls that constantly scan for, and even anticipate, potential instabilities to correct problems before users experience any disruption in service. One more thing is the locality can also sell the excess unutilized energy to other grids and earn revenue.

One interesting concept is vehicle to grid technology. According to which a vehicle can be used to store some energy to the smart grid after a long driving.

Microgrids can aggregate complementary distributed energy resources. Through the matching of supply and demand resources within a given microgrid, it is possible to tailor the performance of that network to provide specific operating or environmental performance characteristics. For instance, individual microgrid can be designed for interruptibility, or efficiency of generating sources and loads, or a specific level of reliability and power quality, or an

environmental emissions profile, or even to maximize economic value by selling services to the centralized grids. In this way, microgrid makes a fairly commoditized electricity system customizable to the quality needs of an individual customer.

Microgrids can ease the pressure on utilities and rates while simultaneously modernizing the grid.

II. ARCHITECTURE

The basic architecture of a microgrid system is presented in Figure 1, which shows that a microgrids system generally consists of distributed generation (DG) resource, storage systems, distribution systems, and communication and control systems

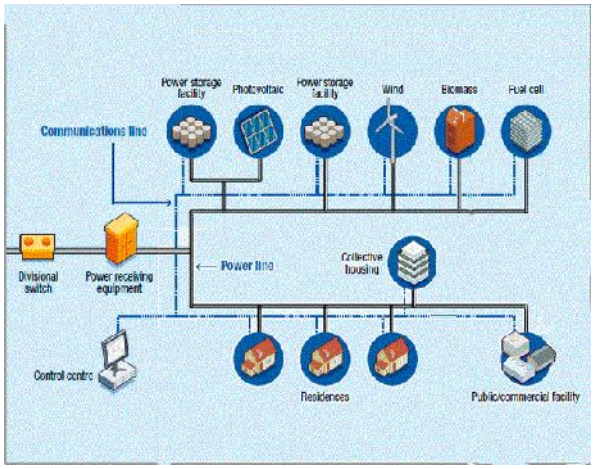

Fig.1.Microgrid Architecture.

Sources:

Distributed generation technologies applicable for microgrids may include emerging technologies such as—wind turbine, solar PV, micro-hydropower, diesel generators.

Solar PV generation involves the generation of electricity from solar energy. Due to enormous improvement in inverter technologies, PV generation is now preferred worldwide as Distributed Energy Resources (DERs). The major advantages of a PV system are

(i)The sustainable nature of solar energy,
(ii)Positive environmental impact,
(iii)Longer lifetime and noiseless operation.

Wind turbine converts wind energy into electrical energy using the wind energy conversion systems (WECSs). Wind energy has been popular for decades. Usually induction generators are used in WECSs. The main part of the wind turbine is the tower, the rotor, and the nacelle. The nacelle accommodates the mechanical transmission and the generator. Wind turbine captures the kinetic energy of wind flow through rotor blades and transfers the energy to the induction generator through the gearbox. The generator shaft is driven by the wind turbine to generate electric power. Wind turbines may have horizontal axis or vertical axis configuration. The average commercial turbine size is 300 kW. Micro-hydropower system uses the energy of flowing water to produce mechanical or electrical energy. This energy generation system depends on the topography and annual precipitation of the area.

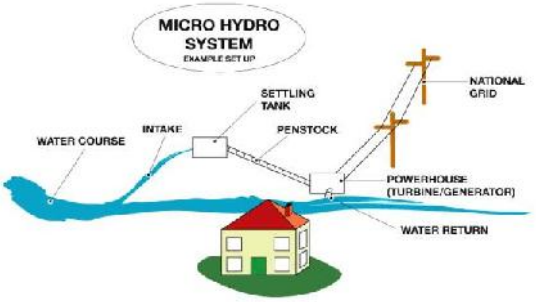

Fig.2.Micro Hydropower System.

The system suffers from large variation of water flow due to uneven rainfall and results in a variation in generation. Run-of-river system is often used in micro-hydropower systems which do not require large storage reservoir. A portion of the river water is diverted to a water-conveyance channel to rotate a turbine or a water wheel that spins a shaft. The motion of the shaft can be used for mechanical power such as pumping water or can be used to power a generator to generate electricity.

Energy Storage:

One of the main criteria of successful operation of microgrid is the inclusion of energy storage devices, which balances the short-term power and energy demand with

generation. Generally the microgrid power systems have storage through the generator inertia. When a new load comes online, it can result in a slight change in system frequency depending on its size. Storage devices are very important to balance the power following system disturbance and/or significant load changes .In the case of sudden system changes, these devices can act as an AC voltage source. Because of their physical limitations, they have limited energy storage capacity. The backup energy storage devices should be included in microgrid systems to ensure uninterrupted power supply. Suitable storage devices for microgrid system include batteries, flywheels and supercapacitors.

Control System:

The users of the community being served and the sources are connected to a centralized control system using a Local Area Network. This enables a centralized monitoring of each and every users activity and also the sources. At the user end smart meter enables monitoring the usage whereas the sources are monitored using sensors like temperature, pressure and others as per the requirement along with the smart meters. Standard usage monitoring and scheduling up to some extend are provided at the user end using LCD displays and keys to enhance the experience, and also leads to tracking the usage.

III.IMPLEMENTATION OF MICROGRID

The microgrid is implemented using 3 sources solar, wind and grid where the grid supply is used as a backup to the other sources. The control system is implemented using the Arduino open source device. Where each sources and users are monitored using smart meters, whose data like voltage, current, units consumed are retrieved by the Arduino device and are fed to a computer. The controller has a software panel by which he can control and monitor the sources.

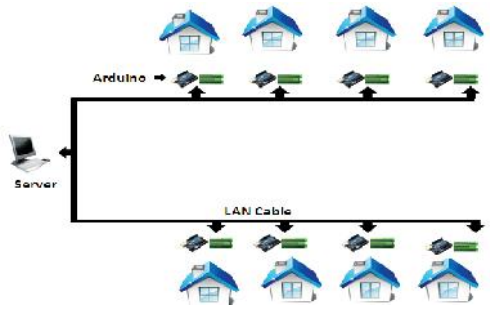

Fig.3.implemented Hardware

The software is implemented using JAVA. Statistics like variations in power, energy usage etc can be obtained from the software.

Arduino communicates with the meters using the standard RS-232 protocol with the Modbus one. Where the device acts as the master and the meters acts as slaves.

A computer collects the data from the hardware and stores in a database for future references. Controlling of user usage is also done by the computer. The computer acts as a server to the Local Area Network to which each user access as per the requirement.Fig.2 & Fig.3 are the screenshots of the developed applications.

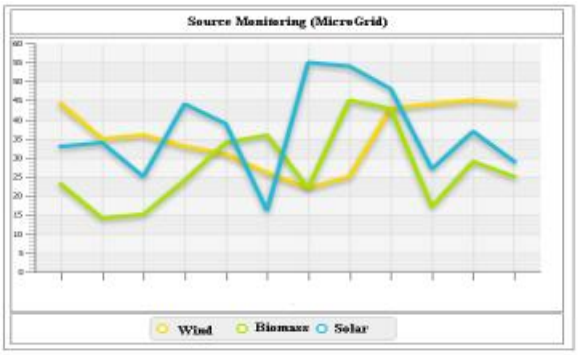

Fig.4. Source Usage Graph

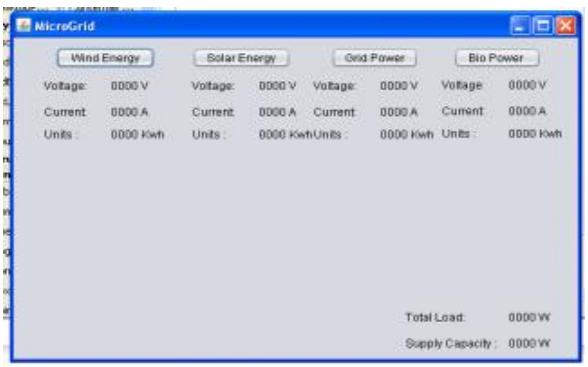

Fig.5 Contolpanel

IV. ADVANTAGES

In a microgrid system the sources and loads are situated at a close proximity so long distance transmission lines are not required unlike in the centralized grid systems. This exclusion gives prevention to the losses those occurs in the long running transmission lines and are accounted up to 20%.

One of the key advantages to the microgrid approach is that it allows local users to make smarter choices regarding their use of power, turning them empowered consumers in a flexible energy economy.

Recovered waste heat could also cool and dehumidify buildings, using thermally activated processes. This is doubly advantageous. Cooling buildings places tremendous strain on the power grid, and if a microgrid shares some of this load, it will help both the microgrid customer and everyone using the larger grid.

A major advantage of a Microgrid is its ability, during a utility grid disturbance, to separate and isolate itself from the utility seamlessly with little or no disruption to the loads within the Microgrid.

In peak load periods it prevents utility grid failure by reducing the load on the grid.

Significant environmental benefits made possible by the use of low or zero emission generators.

V. PROBLEMS &CONSTRAINTS

The set up cost for the microgrids are huge currently as the energy sources fetches large amount. But after a complete setup the grid supplies power to the customers at no cost except the maintenance as mostly renewable sources are used with the microgrids.

VI. CONCLUSION

Market-linked microgrids provide customers options that can help drive down costs and risks. The traditional electric customer is often a price-taker at the mercy of the utility's pricing structure. Customer investment in efficiency and distributed resources like solar PV provide the customer with some power, but the microgrid represents the ability to completely flip the script. The microgrid puts power in the hands of the customer and opens up choices for how to manage energy risks and optimize costs.

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