Reduction in Greenhouse Gases Emission Using Distributed Energy Resources (DER) in Distribution Network

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Abstract

This article presents a study of distributed generation resources to reduce greenhouse emission in a distribution network. According to report of the International Energy Outlook (IEO), 80%of the total energy generation in 2025 would be produced from fossil fuels. This global dependence on fossil fuels is dangerous to our environment because it emits greenhouse gases. Recent research tells that with the use of distributed generation we can reduce the emission of these gases. Distributed generation consists of different renewable energy sources used in generation of electric power. In this, we reduce greenhouse gases in a micro-grid using combined heat and power processes. We will also study about other renewable energy sources which are used to reduce the emission of gases and improve environment as well as availability of supply.

***Keywords*:** Distributed generation, Distributed energy resources, Greenhouse emission, Combined heat and power.

Introduction

There are two objects in future power system that requires rethinking on the distribution system and the use of distributed energy resources. The two objects are:

- More use of renewable energy resources such as wind generation, biomass and photovoltaic system.
- Reduce pollution and greenhouse emissions and increase system efficiency.

Nowadays, distributed generation (DG) resources is an incipient power scenario for electric power generation. These are becoming more and more popular due to increase in energy demand and limitations on power delivery ability to the grid. DG is an electric power source connected directly to the distributed network or on the consumer side of the meter. A large number of researches have been conducted on distributed system, which consider various aspects such as technical, economic and environmental.

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Distributed generation consists of a wide range of prime mover technologies, such as internal combustion (IC) engines, gas turbines, micro-turbines, photovoltaic, fuel cells, and wind power. Most emerging technologies such as micro-turbines, photovoltaic, fuel cells and gas internal combustion engines with permanent magnet generator require an inverter to interface with the electrical distributed system. These emerging technologies have lower emissions and the potential to have lower cost from traditional economies of scale.

Distributed energy resources (DERs) have the advantage of increased system reliability and power quality due to the decentralization of supply. The conventional power systems such as coal fired, gas and nuclear powered plants as well as hydroelectric dams are located very far from the load center, and they are centralized whereas DER systems are modular, decentralized and more flexible that are located near the load. DERs are directly connected to medium-voltage or low-voltage distributed system. DER consists of both generation unit such as micro turbine, photovoltaic and energy storage terms like batteries, magnetic energy storage, etc.

Microgrid

Microgrid is a local network of DERs that is a subset of the distribution network. It can operate in an isolated manner or be connected. Microgrid management targets are local energy supply and demand. The major advantages of microgrids are:

a. Microgrid can provide an efficient way to integrate distributed energy resources and loads for taking full advantage of them (including CHP).
b. Microgrid can be a *grid-friendly* entity and does not give undesirable influences to the connecting dismbution grid. That means the operation policy of distribution grid does not have to be modified.
c. Microgrid can achieve a flexible way for DER to connect and disconnect as they like, which is called as *plug-and-play* feature.
d. Microgrid can independently operate without connecting to the upper distribution grid when a fault occurs (islanding mode).

Greenhouse Emission

According to the report of Indian network for climate change assessment (INCCA), the total greenhouse gas emissions from electricity generation in 2007 was 719.31 million tons CO_2 eq. This includes both grid and captive power. The CO_2 eq emissions from electricity generation were 65.4% of the total CO_2 eq emitted from the energy sector. Coal constituted about 90% of the total fuel mix used. These energy-intensive industries emitted 33.85 million tons of CO_2 eq in 2007. The solid fuels include manufacturing of coke and briquettes.

The emissions are of two types-direct emission and indirect emission. Indirect emissions are those that occur during the manufacturing of the power unit and transport of energy resources. Greenhouse gases are those that absorb and emit radiation within the thermal range. This process is the fundamental cause of greenhouse effect. It consists of a large amount of oxides of nitrogen and oxides of sulpher (NO_x and So_x) and CO_2.

The energy sector emitted 1100.06 million tons of CO_2 eq due to fossil fuel combustion in electricity generation, transport, commercial/ Institutional establishments, agriculture/ fisheries, and energy-intensive industries such as petroleum refining and manufacturing of

solid fuels, including biomass use in residential sector. Fugitive emissions from mining and extraction of coal, oil and natural gas are also accounted for in the energy sector.

Industrial activities together emitted 412.55 million tons of CO_2 eq of GHG in 2007. Industry sector emissions have been estimated from manufacturing of minerals, metals, chemicals, other specific industries, and from non-energy product use. The emissions covered in the industry sector include fossil fuel combustion-related emissions as well as the process-based emissions. The cement industry emitted 129.92 million tons of CO_2, which is 32% of the total CO_2 eq emissions from the Industry sector. The emissions cover the entire technology mix for manufacturing of cement in the country covering large, medium and white cement plants.

Today, the fundamental source of energy generation is fossil fuels. 60% of the total energy produced in India is due to coal combustion. Since coal has the highest carbon intensity among all fossil fuels, the thermal power plants are generating the highest output of CO_2. This is the main reason of greenhouse effect.

Thermal power plant is the major contributor of CO_2 and SO_2 gas emissions. It creates many health and ecological problems. For example, when SO_2 dissolves in the atmospheric moisture, the result is acid rain.

Reduction of Greenhouse Gas Emission

A distributed system that is integrated with DER is very pro-combined heat and power (CHP). An example of effective use of combined heat and power is the microgrid, which is designed to allow CHP systems to be placed anywhere. The main reason of emission is due to waste heat. We can use this waste heat through co-generation or combined heat and power and provide an integrated energy system which deliver both electricity and useful heat from an energy source.

CHP process works with microgrid in distributed generation. It produces both electricity and useful heat using distributed generation. It can convert as much as 90% of its fusil fuel into useful energy. By this approach efficiency increase as well as environment also improves, which gives more benefits to the power system.

Electricity can also be transported to long distance but for heat usually in the form of steam or hot water which cannot be easily or economically transported to long distance. So heat can be used locally; for this we use combined heat and power process. Electricity is more rapidly transported than heat. Generation of the heat close to the location of the load usually makes more sense than generation of heat far from the load.

If we use biomass as a generation source, it has neutral value for greenhouse gas emission because the amount of CO_2 emitted in atmosphere is equal to the amount of CO_2 absorbed during its growth.

Battery storage as well as fuel cells have no direct emissions; sometime the emission occurs during manufacturing process. For the production of electricity, the fuel mix stored in the batteries is taken into account as an indirect emission. In this case, fuel cells emissions also depend upon energy mix.

Photovoltaic generation produces less than 15% of the CO_2 than coal-fired power plant.

The emissions from emerging DG technologies are comparatively lower than coal power station. Combined cycle gas turbine (CCGT) and

 ISSN: 2456-1401

large hydro units have lower SO_2 and CO_2 emission than coal power station.

Combined Heat and Power

Combined heat and power (CHP), also called cogeneration, is the simultaneous production of electrical and thermal energy from a single fuel source. CHP systems are a group of distributed generation technologies capable of capturing heat that would otherwise be emitted into the atmosphere during the electric generation process and re-directing it for useful purpose.

Traditionally, generation of electricity and heat has been a mutually exclusive process. However, by generating heat and power in a process, CHP systems are more cost-effective, reduce greenhouse gas emission and provide more efficient use of natural resources. This combined cycle operation increases the efficiency level up to 60-80%.

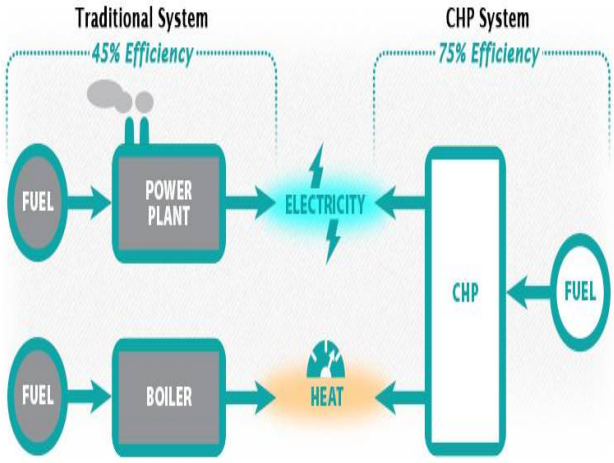

Figure 1.Traditional System and CHP System

Benefits of CHP over DER

- Reduces utility costs and improves economic competitiveness.
- Increases power reliability and self-sufficiency.
- Reduces greenhouse gas emission and other pollutants.
- Reduces demand for imported energy supplies.

Many industrial, commercial and residential customers now require a high level of quality of power due to the increase of digital systems. These customers are especially sensitive to voltages fluctuations caused by remote faults. Power quality, availability and reliability are important issues to all customers. This approach is complex and costly and is not complete if distribution and DER are not well-integrated. DER has the potential to increase system-reliability and power-quality due to the decentralization of supply. Increase in reliability levels can be obtained if DER is allowed to operate autonomously in transient conditions.

Conclusion

This article presents a study of distributed generation resources to reduce greenhouse emission in a distribution network. The study

examined the environment impact of the conventional power-generation methods. Most of the energy generation in India is produced by the combustion of fossil fuels, thus GHG emissions occur. To reduce this, we are using an emerging technology which is distributed generation; therefore, identified four areas where DG could be used to reduce this environment problem.

The areas are reduction in GHG emission, higher energy efficiencies, reduced damage to human health and conservation of resources. We have discussed that a microgrid integrated with DER working on CHP process reduces the greenhouse emission. This approach provides a good environment effect and increases the quality and quantity of supply as well as increases local reliability.

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 ISSN: 2456-1401