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Embedded Generation: A Step Ahead In Power Sector Reforms

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ABSTRACT:- There is increased demand of electrical energy with growing global economy and higher income. The development of economy may be hampered due the crisis of conventional fossil fuel. For this reason there is an increasing trend to interface EG with the existing distribution networks to meet growing energy demand and to offer more services to customers and the distribution networks. EG also helps to reduce the air pollution. This paper reviews the advantages, disadvantages of EG and requirements necessary for connecting EG with a distribution network.

Keywords:- EG, FACTS, distribution network, reliability, stability, power flow, power quality.

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I. INTRODUCTION

Energy security is the greatest concern all over the world. The supply of reliable energy ensures that the economic growth is not hampered but rather enabled. At present, there is a growing concern about the future of energy to fuel the growing global economy with an increasing population and higher incomes. The concerns develop from the growing scarcity of conventional fossil fuel. For example, the International Energy Agency projects India's oil consumption going up from 2.5 million barrels a day in 2002 to 5.6 million barrels a day in 2030. The countries, like India, those import substantial share of their energy needs, have higher imports bill and higher concern over energy security. Also, higher level of pollution has increased the awareness on global threat of climate change.

In the energy hierarchy, electrical energy takes higher place than other type of energy due to its convenient form, easy control, easy transmission and distribution, high transmission efficiency, greater flexibility, cheapness, cleanliness and eco–friendly. World electrical energy consumption is increasing by about 2% per year. The demand of electricity in developing countries is rising more rapidly. It is expected that the electricity demand will continue to rise in developed and under developed countries in the near future. There are many conventional sources of energy like coal, oil, gas, hydel and nuclear. Fossil fuels have been the main electrical energy sources so far. The fossil fuel sources emit large amount of greenhouse gases which is a cause of global warming. As a part of the Kyoto Protocol, many countries are taking necessary action to reduce the emission of carbon dioxide to help counter climate change. The hydel-power station having large water reservoir also produces greenhouse gases and submerge huge areas and creates different types of social and economical problems. In case of nuclear power sources there is a problem of disposal of nuclear waste materials. At the same time the cost of fossil fuel and nuclear fuel is also increasing day by day.

Increased public awareness of adverse impact on environment, escalating cost and falling down of reserve of fossil fuels and nuclear fuels have increased the demand of development and utilization of alternate sources of energy such as wind, solar, biomass, wave, tidal, geothermal, small hydel etc. These energy sources are known as renewable energy sources. Renewable energy increases national energy independence and promote lower carbon economic growth that contributes to fight against climate change. The efficient use of energy and use of renewable energy have the other advantages such as lowering the energy import bill, reducing air pollution and its associated health cost. The use of these energy sources are increasingly promoted by governmental policies that provide financial support in different forms and penalize conventional energy generation facilities that emit greenhouse gases. There is a limitation in the availability of renewable energy sources due to its intermittent behavior. The generation plants based on these sources are smaller and geographically wide spread due to its smaller energy density. However, the use of renewable sources is increasing gradually all over the world. More than half of the world's electrical energy is expected from renewable energy sources by the year 2060.

During the early years of development, power systems were developed in the form of local generation supplying local demands. It was then quite sufficient. But it was soon recognized that the energy thus produced was not sufficient and economical. This leads to the development of centrally located generating stations feeding the demands via transmission and distribution systems. The produced power is first transmitted to the load centre and from the load centre power is distributed among the consumers. But the distance from the generating station to the consumer is practically very large. It develops different types of technical problems and financial constraints. There are ways to up grade the distribution and transmission system to meet the extended demand of energy to minimize the use of fossil fuels. But the limitations in building new transmission lines are: obtaining approval to site due to environmental concern, potential health effects of electric and magnetic fields, special interest groups' concern, and the concern that property values would decline along transmission line routes. One way to improve the transmission capacity in the existing system is the application of Flexible AC Transmission Systems (FACTS). But, the greatest threat to the world in the 21^{st} century is the climate change. One main reason for the climate change is the centrally located power stations using fossil fuels. This leads to develop local generating stations using renewable energy sources. But the localized generating stations using renewable energy sources can not produce constant power due to its intermittent behavior. These problems lead to embed these localized generating stations in the distribution networks and it is termed as the Embedded Generation. It is considered as 3^{rd} generation of power sector reform. The 1^{st} generation of reform created independent power producers selling power to utilities. The 2^{nd} generation created whole sale and retail markets. The 3^{rd} generation will provide for the wide spread deployment of power generation directly at the sides of customers.

1.Terms And Definitions

The term Embedded Generation (EG) is used to mean the concept of generation embedded in the distribution network. The embedded generation is not centrally planned and centrally dispatched. These are normally smaller than 50 MW and usually connected to the distribution system. The efficiency of embedded generation is usually in the range of 40% to 55%. An Embedded Generation plant can operate during periods of high electricity prices (peak periods) and then switch off during periods of low prices.

Embedded Generation is also termed as Distribution Generation (DG). The International Energy Agency (IEA) has defined the Distributed Generation as a generating plant serving a customer on-site or providing support to a distribution network, connected to the grid at distribution level voltage. It includes small (and micro) turbines, fuel cells and photovoltaic cells. The wind power generation is not included as it produced energy in wind farm. The IEA defines another type of generation named as Dispersed Generation. It is the Distribution Generation plus wind power and other generation either connected to a distribution network or completely independent of grid.

2.Applications And Benefits Of Embedded Generation

The application of EG in the distribution network helps to reduce the transmission and distribution loss and the transmission and distribution cost. On-site production avoids transmission and distribution cost, which other wise amount to be about 30% of the cost of delivered electricity. The electricity distribution losses vary from less than 1% to 20% or more depending on the voltage and the location of the customer.

The EG also improves the reliability of the system. The demand for EG has been growing for its higher reliability. An off-cited standard for highly reliable power is 99.9999% of reliability which is equivalent to 30 seconds of outage in a year. Most of the outages are caused by the distribution system. The solution to this is the EG. Thus, the customer who is concerned with the system reliability, is encouraged to install EG for improvement of the system. The capacity of EG is the tiny share of overall electricity production. But this capacity can play an important role in meeting the share during peak demand and thus, the EG is becoming more popular as a source of emergency power. In some cases, old transmission line may not be used to meet the extended demand and replacement of old transmission line or installation of new one will be costly. Application of EG may be one of the alternative to alleviate such problems. The EG provides better service to the customers at lower cost. The EG helps in reduction of carbon dioxide, increases energy efficiency or rational use of energy, deregulation in competition policy, diversification of energy sources and national power requirement. The fuel diversity offered by the EG is considered as valuable in some country.

There is an increasing trend to interconnect EG with the existing distribution networks to meet various energy needs and to offer more services to customers and the distribution networks. These services are: stand by or back up power to improve availability and reliability of electric power, peak load shaving, combined heat and power, the ability to sell power back to utilities or other users, power quality such as reactive power compensation and voltage support and dynamic stability support etc.

1. Problems of Embedded Generation

In conventional power system, the power flow is from higher to lower voltage levels. But, due to penetration of EG, the power flow may become reversed. In this case the distribution networks no longer a passive circuit supplying load. The connected EG converts distribution network from a passive network to an active one with power flow and voltages determined by the generation and the load. The best use of the existing distribution network may be made by optimal allocation of EG. Moreover, the development of an active circuit from a passive one should be planned optimally with all relevant considerations.

Embedded generation affects the distribution network in various ways. These effects necessitate additional requirement for the existing distribution network. The EG i) can increase the fault level to a degree which makes system reinforcement necessary, ii) require adaptation of new protection practices in order to provide adequate protection for EG and associated network against any abnormal conditions including faults and islanding condition, iii) may introduce harmonics, iv) introduce stability and reliability related problems, v) may cause voltage fluctuation, vi) interfere with the control mechanism of voltage magnitude of distributions network, and vii) effect losses of distribution network.

Embedded generations also affect the whole range of existing practices in dealing with (a) the planning of future expansion and refurbishment of a distribution network and (b) the safe and efficient operation of a distribution network with EG. Thus, the main technical issues which need to be addressed while considering the connection of EG are: power flows, steady–state voltage variations and network losses, power quality, fault level contribution, transient stability, interface protection, and earthing.

II. CONCLUSION

There is an increasing trend to interface EG with the existing distribution networks to meet growing energy demand and to offer more services to customers and the distribution networks. Worldwide, more EG capacity was ordered in the year 2000 which is more than the added nuclear power. It is expected that in the next decade more than 30% of new generation will come from EG. As a result, electricity networks would operate in a much more decentralized manner.

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