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Study and Challenges in Integrating the Renewable Energy Technology

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ABSTRACT

Different types of renewable energy sources Integration utility grid depends on the scale of power generation. The power generations are connected to transmission systems whereas small-scale distributed power generation is connected to distribution systems. There are many challenges in the integration of both types of systems directly. The interconnections of the grid have played a main role in the electric power systems. The main benefits of interconnection are usually derived from synchronous AC operation. The alternative energy source to assist the main power stations in future is expected from renewable energy sources based on distributed generation. The Distributed power generation capacity has experienced tremendous growth in the past decade due to its environmental benefits, technological advantages, and government incentives. This paper presents some issues and challenges encountered during grid integration of different renewable energy sources with some possible solutions.

Keywords- *Grid-connection, Integration, Renewable energy, solar energy, wind energy*

I. INTRODUCTION

The demand for renewable energy increased greatly just after the first big oil crisis in the late seventies. At this time, economic issues were the main factors, hence the interest in such processes decreased when oil prices fell. The current resurgence of interest in the use of renewable energy is driven by the need to reduce the high environmental impact of fossil-based energy systems. Harvesting energy on a large scale is undoubtedly one of the main challenges of our time. Although in most power-generating systems, the main source of energy (the fuel) can be manipulated, this is not true for solar and wind energies. The main problems with these energy sources are cost and availability: wind and solar power are not always available where and when needed. Unlike conventional sources of electric power, these renewable sources are not dispatchable—the power output cannot be controlled. Daily and seasonal effects and limited predictability result in an intermittent generation. [4]

The output of solar energy during the day and the year are highly predictable and variable, due to the movement of the sun is very well understood. An additional, less predictable source of variability, however, is the presence of clouds that can pass over solar power plants and limit generation for short periods of time. Cloud cover can result in very rapid changes in the output of individual PV systems, but the impacts on the electric grid are minimized when solar projects are spread out geographically so that they are not impacted by clouds at the same time. In this way, the variability from a large number of systems is smoothed out. For large photovoltaic (PV) plants, cloud cover typically affects only a portion of the project at a given time while the clouds travel through the system. Compared to solar, wind energy is less predictable, but still subject to daily and seasonal weather patterns. Often wind energy is more available in the winter or at nighttime when the wind blows stronger.

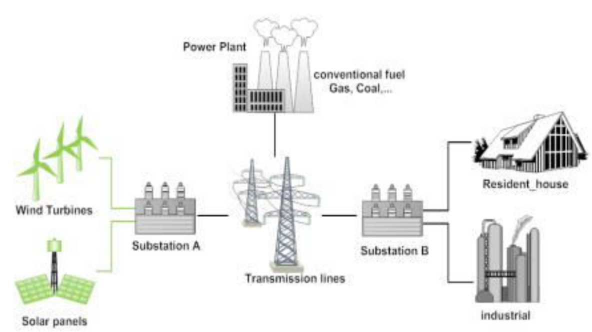

Figure1: The general structure of integrating renewable energy into AC Grid [6]

The generation of electricity from renewable energy sources includes technologies such as hydropower, wind power, solar power, tidal and wave power, geothermal power, and power from renewable biomass.

Wind and solar power are the focus of this report, for two reasons. First, they are among the renewable generation types –wind, solar, and wave – that are subject to natural variability in their energy sources. This variability creates distinct challenges for integration into the larger power system, namely non dispatch ability. Secondly wind and solar are relatively mature for use in large capacities and in wide areas, and so have a significant impact on the power grid that is likely to increase over time.

1.1 Climate Change

The climate change becomes an important issue the whole world is currently facing, the ever-increasing price of petroleum products and the reduction in the cost of renewable energy power systems, opportunities for renewable energy systems to address electricity generation seems to be increasing. The electricity grid to accommodate a higher percentage of renewable energy would need large quantities of conventional backup power and huge energy storage. These would be necessary to compensate for natural variations in the amount of power generated depends on the time of day, season and another factor such as the amount of sunlight or wind at any given time. Since today's electricity grid cannot handle this variability, the cost of adopting the renewable energy sources is much more expensive. [5]

Due to climate change most of green energy sources rely on uncontrolled recourses. On other words, producing power from renewable energy comes from nature resources such as sunshine, wind, or ocean waves. This kind of sources leads us to know that power generation from renewable is intermittent and inconstant. As a result, it is a challenge mission to share power from renewable energy technologies into the grid. [6] Most of the renewable energy technologies depend on weather and environmental factors. The accuracy is usually obtained in case of load forecast in power system distribution, and it results in high quality of operation due to the constant producing of power and it is to ensure the future load demand.

1.2 Output Power Variation

The speed fluctuations of the generator are changing the output power. The fluctuation speed could appear in hour-to-hour, minutes to minutes, or even second to seconds. Generally slow change, power output may be expected, but on another hand, high speed of variations is another challenge that might face the renewable energy grid integration in the large-scale case. The different level of generating power from renewable energy technologies is another difficulty of renewable energy grid integration. Some variation in power output is not going to have a concerning effect, but when the magnitude of fluctuations in power output is large, special requirements have to be considerable.

1.3 Power Quality

In many countries where renewable energy generation is growing rapidly, electricity networks are facing new challenges in terms of network stability and power quality. High penetration levels of renewable energy generation increase risks of serious network failures. In many countries the penetration rate of renewable energy generation is high, it has been reported that the costs of network reinforcements have risen considerably. The main possible development is for current passive distribution networks to evolve into actively managed networks. This means that the network must be treated not as a power supply system but as a transport system that provides a connection between points of supply and consumption. In this case, bi-directional flows of electricity are possible, local control areas which enable local network areas to act as independent islands are used, and system services become specified attributes of a connection. The renewable energy technologies pose a different technical challenge. High penetration rates of intermittent distributed generation pose a serious technical constraint, which requires some form of backup power or energy storage. The high share of wind power in the different country is being backed-up with a large capacity from the electricity pool. To some extent, combined heat and power (CHP) plants have also provided backup capacity. There is a revival of interest in energy storage as a technical option for intermittent energy generation. The current particular interest is in the production and storage of hydrogen from electricity at an off-peak period and during the times where there is a surplus of renewable energy. [7] Wind and solar generation both experience a) intermittency, b) a combination of uncontrolled variability and partial unpredictability, and c) dependency on resources that are location dependent [8]. These vital aspects along with some other aspects posing challenges for generation authorities and grid operators during the course of integrating wind and solar generation with the conventional grid. This fluctuation in power output results in the need for additional energy to balance supply and demand on the grid on a real-time basis, as well as auxiliary services such as frequency regulation and voltage management. Variability in the context of wind and solar resources refers to the fact that their output is not constant. It is distinct from unpredictability, which we discuss in the following section. Even if operators could predict the output of wind and solar plants perfectly, that output would still be variable, and pose specific challenges to the grid operator. On the seconds to minutes time scale, grid operators must deal with fluctuations in frequency and voltage on the transmission system that, if left unchecked, would damage the operating system associated. To do so, operators may require injecting power (active or reactive) into the grid not for sale to consumers, but in order to balance the actual and forecasted generation of power, which is necessary to maintain frequency and voltage profile in the grid.

1.4 Location dependence

The amount of wind and solar resources are based in specific locations and, unlike coal, gas, oil or uranium cannot be transported to a generation site that is grid-optimal. Generation must be collocated with the resource itself, and often these locations are far from the load centers where the power is ultimately be used. New transmission capacity is often required to connect wind and solar resources to the rest of the grid. Transmission costs are especially important for offshore wind resources, and such lines often necessitate the use of special technologies not found in land-based transmission lines. Because the availability of wind and sunlight are both temporally and spatially beyond human control, integrating wind and solar generation resources into the conventional electricity grid involves managing other controllable operations that may affect many other parts of the grid, including conventional generation. These operations and activities occur along a multitude of time scales, from seconds to years, and include a) new dispatch strategies for rampable generation resources, b) load management) provision of auxiliary services for frequency and voltage control) expansion of transmission capacity, e) utilization of higher capacity energy storage technologies, and e) linking of grid operator dispatch planning with weather and resource forecasting. The essential insight to an integration of variable RE is that its variability imposes the need for greater flexibility on the rest of the grid. Discussion of variable generation operation alone is insufficient to describe the full impact of high penetrations of RE on power system operation. Thus this paper explores RE integration from both a generation plant operator and a grid system operators perspective, so as to identify the full range of operations involved. Far removed from the day-to-day management of the grid is its long-term planning – specifically the siting and utilization of new transmission lines. Here RE generation plays a significant role and introduces new challenges. Because wind and solar resources are often located in remote locations, far from load centers, developing sufficient transmission facility to move RE to markets is vital in the process of integrated grid operation. Transmission planning processes are subjected to high variations,/ and tend to be influenced by regional politics. For example, a transmission line may provide capacity for energy produced in one country or state, passed through another territory, and consumed in yet another. These disparities in generation capacity, transmission location and load size between locations can make the development of transmission for RE contentious and complex, particularly with respect to cost allocation. Because new transmission lines built for RE generation resources will carry primarily renewably generated, variable and partially unpredictable electricity where technical needs arise regarding the transmission technology to be used. On the other hand, distributed energy resources provide for an alternative vision of the future grid, where energy is generated and used locally on a micro-grid, avoiding the cost of line losses and the high capital cost of transmission lines. In such a scheme, the electricity grid could be conceptualized as a collection of independent micro-grids with significantly reduced long-distance energy transmission needs.

1.5 Power System Planning and Risk Management

Maintaining the balance between generation supply and real-time customer demand becomes more difficult with variable generation resources without large-scale, economical energy storage capacity and demand-responsive loads. Existing conventional planning methods, tools, metrics and standards for resource adequacy need to be developed for an operating environment with variable generation, energy storage, demand- responsive loads, renewable energy standards, and GHG emission policies. Research is needed to understand and respond to the implications of emerging smart grid and customer-owned technologies on grid reliability. New planning and risk management tools must be developed to support decision-making in an electric system with much more uncertainty than that experienced here before.

1.6 Distribution and Transmission Planning

The electric power grid is becoming an increasingly automated network and is expected to have evolved functionality, higher efficiency, better programmability, and more flexibility. Specifications are needed for the communication networks that are interconnected to the electric grid for sensing, monitoring, and control. Increased penetration of renewables could result in low use of transmission lines unless large scale storage is available [1].Distributed energy resources, storage, and demand-responsive load at the distribution level make line loading much more uncertain. Planners have to be able to determine the network topology best suited for this new integrated operating environment, and the effects on system performance and reliability of having a large number of spatially distributed generation sources. New network topologies need to be designed to outperform traditional networks with lower transmission losses, and lower susceptibility to performance and reliability problems under contingencies. The new topologies must enable vastly increased levels of renewable generation while considering legacy systems and incorporating emerging technologies in HVDC, FACTS, distributed electronic power-flow controllers, and power conversion devices for interfacing renewable resources. Protection systems must be designed to accommodate the new operating conditions. Advances in computational methods will allow network topologies to be co-optimized as a part of resource dispatch hence and network designs must not be designed as static assets and allow for dynamic reconfiguration driven by technical and economic objectives. Finally, new customer use and storage technologies pose distribution planning challenges due to increased uncertainties about line and transformer loading.

1.7 Interface between the Grid and RE resources

Basic power quality requirements must be met as regards harmonics, voltage, frequency, etc. for interconnecting any equipment to the grid [1]. Renewable energy generators with their associated power electronics generate harmonics and have electrical characteristics under voltage and frequency deviations that may make it difficult to meet power quality requirements. Large-scale wind farms and large-scale PV systems present a series of technical challenges arising mostly from the expanding application of power electronic devices at high power ratings. The connection of renewables at the distribution levels also requires significant modification of the distribution system design to accommodate bidirectional power flow. Facilitating the integration of distributed energy resources requires innovations in micro grid and energy management systems that transparently provide control and regulation.

1.8 Partial unpredictability

Partial unpredictability, also called uncertainty, is distinct from variability. The variability of wind and solar generation is ever-present, a result of reliance on the ever-changing wind and sun, and affects the system at the moment-to-moment time scale as a cloud passes over a PV plant or the wind drops. Partial unpredictability, on the other hand, refers to our inability to predict with exactness whether the wind and sun will be generally available for energy production an hour or a day from now. This hour-to-day uncertainty is significant because grid operators manage the great majority of energy on the grid through “unit commitment”, the process of scheduling generation in advance, generally hours to a full day ahead of time, in order to meet the expected load.

II. CONCLUSION

The renewable energy is non- polluting and environmentally friendly source of energy. To provide a clean environment in future we must reduce CO_2. The one method is to reduce it by using it in other system and convert it to another form. In the microgrid, the preferred system is the decentralizing system. By decentralizing the microgrid the system efficiency would be increased and hence reduce the amount of electrical energy lost in a transmission system. The transmission lines may be reduced by increasing the efficiency of the power system and this will be more economically beneficiary to reduce the number of power lines that will need to be installed in the future to fulfill the demand.

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