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Improved Efficiency of Large Capacity Renewable Energy - Integration with Grid

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--ABSTRACT---
Renewable energy is predicted to be the future of energy around the globe. The Renewable energy sources include energy from wind, sun, hydro, tidal, geothermal and energy from renewable bio mass, but wind and solar power takes an important place in the production of energy from the Renewable energy sources. These sources are subjected to natural variability and it creates distinct challenges for their integration into the large power system. De-carbonization, energy security and expanding energy access are the major driving forces towards Renewable energy sources. But there are certain difficulties that are faced when a large capacity of Renewable energy is being integrated to the grid, Non-controllable variability**,** Partial unpredictability**,** Location dependency**,** transmission technology seems to be major concerns when they are being integrated with the grid. We are providing solution for these above listed problems to obtain maximum efficiency from the Renewable energy sources.

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I. INTRODUCTION

The non-renewable energy sources are in the verge of their extinction and its damage to the environment has increased the awareness on Renewable energy sources. Almost in a decade Renewable energy has grown considerably and proving to play a major role in the production of energy in the coming years. There are certain difficulties that are faced in the present environment which is making the integration of large capacity Renewable energy in the grid. Solution for some of the problems faced being offered in this paper that might improve the integration of large capacity Renewable energy into the grid. This eco-friendly energy source is not predictable as it entirely depends on nature but minor adjustments made in the power plant of Renewable energy sources can play a vital role in the integration process and will surely lead to a system that can satisfy the required demand. Thus maximum energy and efficiency can be Renewable energy sources around the globe. Climatic conditions will be varying around the place and the efficiency cannot be maximum with the present technology be followed but our paper deals with these drawbacks and most certainly will improve the efficiency of the Renewable energy sources.

II. DRIVING FORCES OF RENEWABLE ENERGY SOURCES

Renewable energy is a growing component of electricity grid due to its contribution in (i) Energy system de-carbonization (ii) Expansion of energy access to the new consumers in the developing world (iii) Energy security in a long term. These factors have been so important in the increased usage of renewable energy.

2.1. De-carbonization

The importance of addressing global climatic change, a worldwide environmental phenomenon which will affect all the people on the planet earth. UN recently said that “warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level and most of the global average warming over the past 50 years is very likely due to anthropogenic greenhouse gas increases and it is likely that there is a discernible human-induced warming averaged over each continent excluding Antarctica. The emission of carbon dioxide related to 70% of the total greenhouse gas emitted and production of electricity will cause half of the total carbon dioxide emitted in the greenhouse gases emitted. The RE will result in the reduction carbon dioxide emitted in the electricity production and it will have a greater influence in the environment protection. One of the fast developing countries, China is planning to reach 180MW by wind power plants and 20GW in solar energy by the year of 2020.

2.2. Energysecurity

Driven by the natural forces, RE has no fuel costs. The zero-fuel-cost of RE manifests itself in having three great benefits. (i) the average energy costs which will tend to decline over a period for renewable generation (ii) as variable costs are limited to operations and maintenance and do not include fuel (iii) RE assets are insulated from fluctuations in fossil fuel prices, which are historically volatile and subject to geopolitical disruptions. Coal, gas and oil-fired generation costs, in contrast, increase when the cost of the relevant fuel increases. Fig. 1 represents world electricity generation till the year 2035.

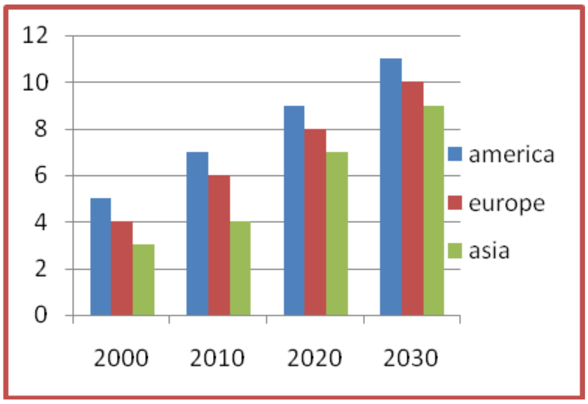

Fig. 1 World electricity generations till the year 2035

2.3. Expanding Energyaccess

Energy demand increase rapidly in each country due to the development in the technology. In that case RE source will be a great asset in the years to come to meet out the demand of every country. More energy will be required in the years to come as every individual in the world are being given access to electricity. Fig. 2 shows the required electricity demand in MW.

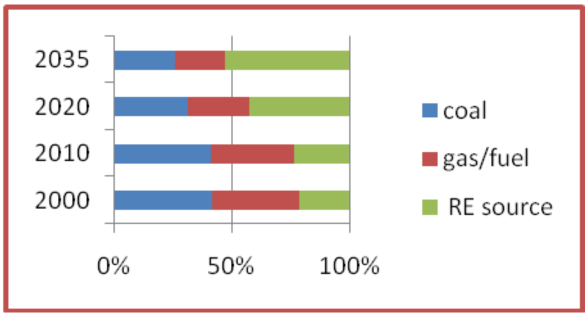

Fig. 2 Electricity demands in MW

III. WIND ENERGY

Wind turbine generators extract energy from wind and convert it into electricity via an aerodynamic rotor, which is connected by a transmission system to an electric generator today's mainstream Wind energy turbines have three blades rotating on a horizontal axis, upwind of the tower shown in Fig. 3. And vertical-axis Wind energy turbines have shown in Fig. 4.

Fig. 3 Horizontal axis wind turbine

Fig. 4 Vertical axis wind turbine

In general, a Wind energy turbines can begin to produce power in winds of about 3 m/s and reach its maximum output around 10 m/s to 13 m/s. Power output from a Wind energy turbines increases by the third power of wind speed, a 10 % increase in wind speed increases available energy by 33 %, and is directly proportional to the rotor-swept area (the area swept by the rotating blades). Power output can be controlled both by rotating the nacelle horizontally (yawing) to adapt to changes in wind direction, and rotating the blades around their long axes (pitching) to adapt to changes in wind strength. The capacity of Wind energy turbines has doubled approximately every five years, but a slowdown in this rate is likely for onshore applications due to transport, weight and installation constraints. Typical commercial Wind energy turbines at present have a capacity of 1.5 MW-3 MW; larger ones can reach 5 MW-6 MW, with a rotor diameter of up to 126 meters. Since a single Wind energy turbines has limited capacity, much less than a conventional power generator, a wind power plant. Normally consists of many Wind energy turbines connected together by overhead lines or cables. Their power output is collected and transmitted to the grid through an alternating current (AC) or direct current (DC) line, after voltage step-up at the substation in the wind power plant Fig 5.Some WPPs now have a capacity comparable to that of conventional power generators.

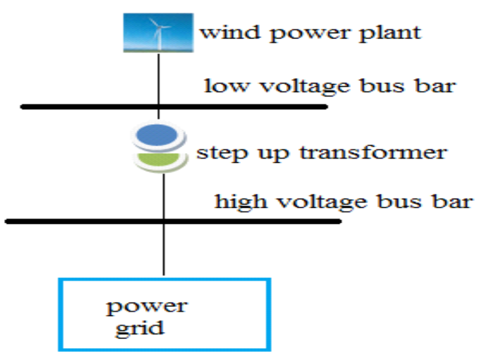

Fig. 5 Substation in the wind power plant

IV. SOLAR ENERGY

According to the materials and design, current PV power generation technologies can be classified into crystalline silicon, thin-film and concentrating PV Fig. 6 and Fig. 7.Crystalline silicon PV is currently the best established PV technology, with an energy conversion efficiency of up to 20 %. More recently, thin-film PV, which can also use non silicon semiconductor materials, is gaining attention. Although thin-film PV generally has a lower efficiency than silicon PV (around 11 %), it is less expensive and less energy-intensive to manufacture and is also more flexible for versatile applications. Concentrating PV, in which sunlight is concentrated and strengthened by a lens before it reaches the PV cells, is on the edge of entering full market deployment. Concentrating PV can reach an efficiency of up to 40 %. Other technologies, such as organic PV cells, are still in the research phase.

Fig. 6 Solar power plant

Fig. 7 Solar power plant

One of the key components of PV systems is the inverter. DC output from PV systems is changed into AC by inverters. The performance of the inverter is especially important for grid connected PV power plants, since it directly influences whether the PV power plant can meet the requirements of grid operation. Most inverters have low voltage ride through (LVRT) and flexible active and reactive power control capabilities. However, since there is no rotating component, PV systems cannot supply inertia support to the power system. Fig. 8 shows basic solar principle representation diagram.

4.1. Concentrated solar power generation

CSP generation, also known as solar thermal power generation, is much like conventional thermal power generation that converts thermal energy into electricity, but differs in how the thermal energy is obtained. CSP plants use various mirror configurations (with a sun tracking system) to reflect and concentrate direct-beam sunlight to heat the working fluid flows (such as air, water, oil or molten salt) in the receivers to a high temperature, thus converting solar energy into thermal energy. Fig. 8 shows concentrated solar power.

V. TYPES OF CONCENTRATED SOLAR POWER PLANTS:

1. **Parabolic trough systems** use long rows of parabolic mirrors to reflect and concentrate sunlight beams onto a linear receiver tube that contains the working fluids.

2. Linear Fresnel reflector systems use long rows of flat or slightly curved mirrors to concentrate the sunlight beams onto a downward-facing linear receiver tube fixed in space above the mirrors.

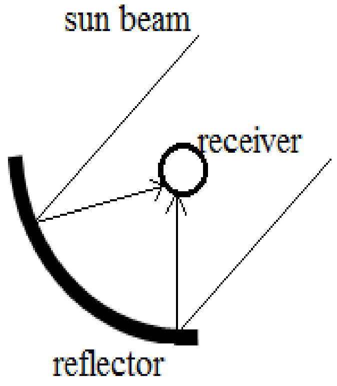

Fig. 8 Concentrated solar power

3. Solar tower systems, also known as central receiver systems, use numerous large, flat mirrors to concentrate sunlight beams onto a receiver at the top of a tower.

4. Parabolic dish systems, also known as dish/engine systems, concentrate sunlight beams onto the focal point of a single dish, where the receiver and an engine/ generator (such as a Sterling machine or a micro-turbine) are installed.

VI. NON CONTROL VARIABLITY

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 system as well as equipment on it. To do so, operators may order generators to inject 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 on the grid. These ancillary services go by a plethora of names and specific descriptions.

Typical services for an impressionistic overview include:

- **Frequency regulation**: occurs on a seconds-to-minutes basis, and is done through automatic generation control signals to generators;
- **Spinning reserves**: Generators available to provide power typically within 10 minutes.
  These reserves are used when another generator on the system goes down or deactivates unexpectedly
- **Non-spinning reserves**: these generators serve the same function as spinning reserves, but have a slower response time.
- **Voltage support**: generators used for reactive power to raise voltage when Necessary.
- **Black-start capacity**: generators available to re-start the power system in case of a cascading black-out.

High penetrations of wind and solar generation will add more variability to the energy system than grid operators have traditionally managed in the past, and thus increase demand for ancillary services and balancing energy overall. It is more difficult, and sometimes impossible, to manage such challenges at the device level, and so grid-level actions, technologies and strategies are often needed. Wind and solar resources in sufficient amounts may also complicate load following functions when large demand shifts coincide with weather events that alter power output from wind or solar resources. Grid operators located in more remote regions and serving smaller loads may have less flexibility to provide ancillary services and load following than their larger counterparts. Compounding matters, plentiful RE resources are often located in these remote locations.

VII. 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. When actual production does not match the forecast, the grid operator must balance the difference. RE generation increases the cost of this function by increasing the spread between predicted and supplied energy, a cost that is ultimately borne by consumers.

VIII. LOCATION DEPENDANCY

Far removed from the day-to-day management of the grid is its long-term planning – specifically the sitting 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 to move RE to markets is critical to their integration. Transmission planning processes are highly varied, 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, 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 out to RE generation resources will carry primarily renewably generated, variable and partially unpredictable electricity, 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 schema, the electricity grid could be conceptualized as a collection of independent micro-grids with vastly reduced long-distance energy transmission needs.

IX. CONCLUSION

Thus by these methods a large capacity RE can be integrated to the grid and hence a maximum efficiency will be obtained. RE will be an inevitable source of energy that can be even considered as the future of energy. Therefore natural forces can be used to its maximum efficiency for producing energy that can neither be created nor be destroyed.

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