Integration of distributed solar power generation By energy storage using a battery

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Abstract- *Cheapest available energy all over the world, easy accessible even on the land, roofs water surface etc. so in order to integrate number of solar power generating units optimized at different place that is distributed solar power generation. as solar photovoltaic power generation becomes more ordinary. So modification of the solar resources posses a great challenge of those person who would create and implement the next generation of smart grid. Generally grid connected solar power generation is a distributed resources whose output can be changed in large amount, resulting in many things for a distributed system operator installed a large amount of photovoltaic devices. Also batteries are utilized to provide a central power source through solar power is generated at different places through the different generating sources. But the power supplied the load is through the central power source.ie generally batteries and inverter circuitry. so this paper highlights the needs, importance, advantages of using the battery as a energy storage and also provides ancillary services like reactive power compensation of voltage deeps and swells and ramp response . Load can absorb the reactive power so that battery can used to inject the reactive power i.e. leveling the output voltage ,by increasing the ramp rate*

Index terms-—Battery energy storage systems, photovoltaic, renewable, smart grid, solar.

I. INTRODUCTION

Conventional energy sources i.e limited a source which is responsible for global warming; environmental balance and, habitat .So solution of This above problem is use of solar power with the help of PV (photovoltaic panel). Now Question arises what is photovoltaic panel. Photovoltaic panels convert the sunlight directly into electricity. In a photovoltaic panel numbers of solar cells are present. A photovoltaic cell is a special purpose semiconductor diode that converts visible light into DC current. Some pv cells also convert ultra violet (UV) radiation into DC electricity. Large sets of PV cells can be connected together to form solar modules, arrays, or panels. The use of PV cells and batteries for the generation of usable electrical energy is known as photovoltaics. One of the major advantages of photovoltaics is the fact that it is non-Polluting, requiring only real estate (and a reasonably sunny climate) in order to function. In country like Indian solar energy is available around 300days, 10 to 12 hours daily but, some kind of energy present irregular or intermittent. solar radiation are not available during night,so it is needed to provide some storage means to store the energy which is generated in in bulk radiation period and utilized it, in the period when solar radiation is not present there, and again various distributed energy sources are integrated in order to utilized natural present energy (green energy) i.e wind energy ,solar energy, wind energy, tidal energy, geothermal energy. So it is needed to connect them to a common storage device and it generally done by utilizing battery energy storage for the storing the energy.

II. SOLAR PHOTOVOLTICS INTEGRATION

Demanding levels of solar PV generation on distribution circuits can be smoothly managed by the distribution system operator. However, both the DSO and the customers of electric retail serviceman soon feel the undesirable impact on the grid as PV penetration levels increase, solar PV generation is well positioned to become a significant source of electricity incoming years. As solar PV generation penetration increases, the electricity grid will increasingly be subjected to sudden change in generation and power flow at various points on the system. A BESS can assist with orderly integration of solar PV generation by managing or mitigating the less desirable effects from high solar PV generation penetration. As the cloud passes over the solar collector. which is directly affect on the power output of solar generation system .when cloud moves away from the collector ,the output reaches to its previous level.[6] the main things is that, the rate of change of output from solar generation plant can be quite rapid as solar PV system have no inertia in the form of rotating mass. .If the surface area of the solar PV system is relatively small compared to the cloud that is passing over it, the power output of the system will be reduced significantly.

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III. BATTERY ENERGY STORAGE SYSTEM

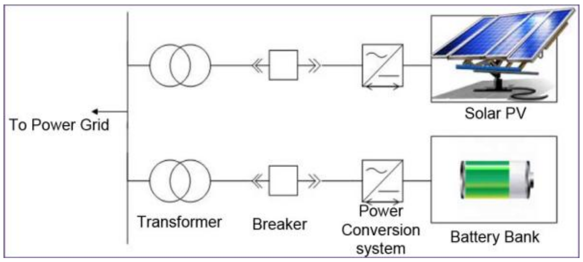

Fig-1 one-line diagram of a BESS in parallel with a Solar PV facility connected to the grid on a common bus.

A. Battery Energy Storage Basics

A typical grid-scale BESS consists of a battery bank, protective circuit breakers/relays, a power electronics device for AC-DC power conversion, and a transformer. Fig-1 one-line diagram of a BESS in parallel with a Solar PV facility connected to the grid on a common bus. Also one point to be note that a Bess is typically connected to the grid in parallel with the source. The battery bank consists of many batteries connected in a combination series-parallel configuration to provide the desired power and energy capabilities for the application. Units are typically described with two numbers, the nameplate power given in MW, and the maximum storage time given in MWh. Whevever sun light is falling on the PV panel this sun light is converted into DC with the help of power conversion system, breaker ,and transformer. when grid requirement is less than solar panel capacity under such a condition extra converted energy store into battery bank. But the grid requirement more than the PV panel capacity the extra energy boost by the battery bank. Most BESS control systems can be operated via automatic generation control (AGC) signals much like a conventional utility generation asset, or it can be operated in a solar-coupled mode where real and reactive power commands for the converter will be generated many times per second based on real-time PV output and power system data. In the case of the XP-DPR, three-phase measurements from potential and current transducers (PTs and CTs) are taken in real-time on an FPGA device, and once digitized these signals become the input for proprietary real-time control algorithms operating at kHz speeds. Various control algorithms have been used for PV applications, providing control of ramp rates, frequency support, voltage/reactive power support, and services designed to optimize the financial returns of the PV installation, including peak-shifting and leveling.

B. Electric storage Technologies

A number of electric storage technologies have been developed which serve various electric applications, including:

i) Batteries

ii) Flywheels

iii)Superconducting magnetic energy storage (SMES)

iv) Pumped Hydropower

1) Pumped Hydropower:

Since, 1929one of the oldest technology has been developed which is pumped hydro power has an electric storage technology.

Operation: Conventional hydros consist of two reservoirs, each of which is built at two different levels. Water present at higher level stored potential energy. This potential energy is converted into electrical energy when the water is released, from the reservoirs, to lower reservoirs. While water to flow through hydraulic turbine which generate electrical power a high as 100 MW

2. Compressed Air Energy Storage (CAES): CAES is an popular energy storage technology for bulk storage.

Operation: CAES systems store energy by compressing air within an air reservoir using a compressor powered by low cost electric energy. During charging the plant's generator operates in reverse – as a motor – to send compressed air into the reservoir. When the plant discharges, it uses the compressed air to operate the combustion turbine generator. This method is more efficient because natural gas is burned in this process as compared to a conventional turbine plant as the CAES plant uses all of its mechanical energy to generate electricity.

3. Flywheels:

Operation: A flywheel storage device consists of a flywheel that rotate at a large high velocity and an integrated electrical apparatus that can operate either as a motor to turn the flywheel and store energy or as a generator to produce electrical power on demand using the energy stored in the flywheel. The purpose of magnetic bearings and a vacuum chamber helps reduce energy losses. Flywheels have been used to improve the range, performance and energy efficiency of electric vehicles.

C) Available Types of Battery Storage

Until recently, the only battery technology that was economically feasible is the lead acid battery. Improved valve regulated lead-acid (VRLA) batteries are now emerging in utility systems. Advanced batteries (such as lithium ion and zinc/bromide) are being developed and are at different levels of size and readiness for utility operation.

1.Lead-Acid Battery- Lead acid batteries are marginally economic but they have an maintenance requirements. They also have a shorter life, energy decreases rapidly if battery is discharged below 30%. This results in the reduction of energy density amounting to increased capital costs. They are commonly installed in uninterruptible power supply (UPS) systems as well as in renewable and distributed power systems.40 MWh is a largest one installed in Chino, California

2. Valve Regulated Lead Acid Battery (VRLA) VRLAs use the same basic electrochemical technology as flooded lead-acid batteries, but these batteries are closed with a pressure regulating valve, so that they are essentially sealed. In addition, the acid electrolyte is immobilized. This eliminates the need to add water to the cells to keep the electrolyte functioning properly, or to mix the electrolyte to prevent stratification.

3.Use in UPS Systems

Battery applications are predominantly used for reserve power in uninterruptible power supply systems (UPS). Generally flooded cell batteries, sealed-cell batteries and flywheels are the number one choice for UPS today. Flywheels are useful for certain space-critical requirements but they cost much more than other batteries and are subject to bearing reliability and environmental issues due to high spin issues. Flooded cell batteries are the most reliable choice as they exhibit better mean time between failure (MTBF) levels as compared to either flywheels or valve regulated lead acid (VRLA) batteries. But flooded cell batteries are the most expensive kind either as first cost or on installed cost basis. According to one paper, more than 90% of installed UPS systems with power levels ranging up to 500 kVA or more rely on VRLA batteries.[4]

D. Ramp Rate Control- solar PV generation facilities have no inertial components, and the generated power can change very quickly when the sun become so obscured by passing cloud cover. On small power systems with high penetrations of PV generation, this can cause serious problems with power delivery, as traditional there mal units struggle to maintain the balance of power in the face of rapid changes. During solar-coupled operation, the BESS must counteract quick change sin output power to

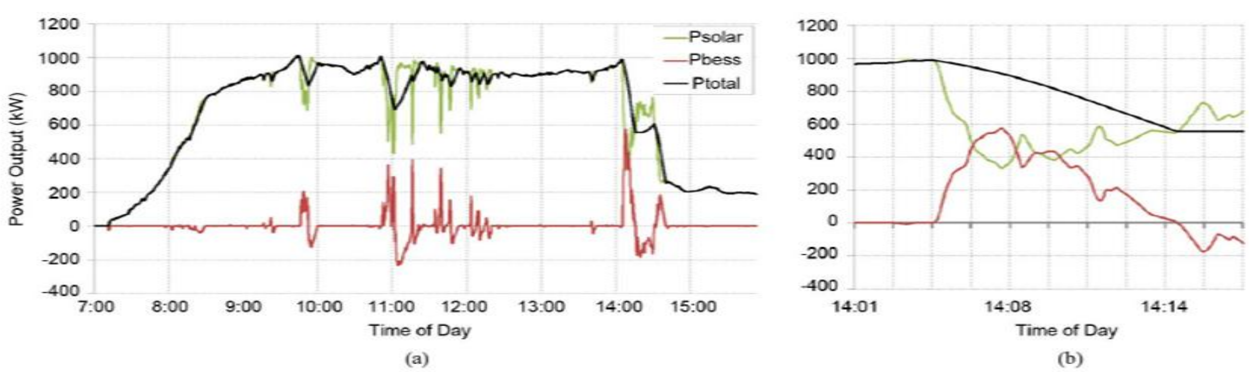

Fig.3. Ramp Rate controlto50 kW/min fora1 MW photovoltaic installation and a1.5 MW/1 MWh BESS. (a) Full day.(b) Detail of largest event.

ensure that the facility delivers ramp rates deemed acceptable to the system operator. Allowable ramp rates are typically specified by the utility in kilowatts per minute (kW/min), and are a common feature of new solar and wind power purchase a agreements between utilities and independent power producers. Note that the ramp such that the total power output to the system is within the boundaries defined by the requirement soft he utility. For more information on this algorithm. In fig 3 shows that whenever we used BESS system then main advantage is that we can obtained uniform ramp control. Means less fluaction is obtained at grid side.[2] to achieve other power system goals. The ramp rate control algorithm used in the XP-DPR continuously monitors the real power output of the solar generator, and command the unit to charge or discharge such that the total power output to the system is within the boundaries defined by the requirements of the utility. For more information on this algorithm, see [16].

E. MARKET ORIENTED OPERATION

This paper address technique and benefits, advantage and needs for battery energy storage used in distributed solar power generation. Generally we get a DC output voltage then it is controlled and regulated by a voltage regulator and charge controller, buck/boost converter to charge the battery and supplied to the ac battery circuitry and even two d.c loads through regulator

F. ADVANTAGE-

This system is easy accessible no need to operated by the technical person, easy accessiable to all common person from various feeds. These systems are capable of absorbing and delivering both real and reactive power with sub-second response times.

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