Improved Power Tracking Performance with IC MPPT for A PV Solar Farm as Statcom

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Abstract:
In recent years, the energy crisis and environmental problems such as air pollution and global warming effective driving research towards the development of the nonconventional energy. In order to protect the environment and face the power demand the people always find new green energies such as wind energy, water energy, solar energy etc. Among them, the solar energy is now widely used, and it is a clean, maintenance-free, safe, and pollution free, so it is one of good green energy sources. But, there are still some problems because the sunlight intensity and temperature level of solar cells change anytime Solar Farms are absolutely idle in the night and even during daytime operate below capacity in early mornings and late afternoons. Thus, the entire expensive asset of solar farms remains highly unutilized. This paper presents novel technologies for utilization of PV solar farm inverter in nighttime for providing multiple benefits to power systems, as well as accomplishing the same objectives during the daytime from the inverter capacity left after production of real power. The new technology transforms a solar farm inverter functionally into a dynamic reactive power compensator known as STATCOM, and termed PVSTATCOM.

Keywords: STATCOM (Static Compensator), Cascaded Multi level Inverters, Fuzzy.

I. INTRODUCTION

This paper proposes novel voltage control, together with auxiliary damping control, for a grid-connected PV solar farm inverter to act as a STATCOM both during night and day for increasing transient stability and consequently the power transmission limit. This technology of utilizing a PV solar farm as a STATCOM is called “PV-STATCOM.” It utilizes the entire solar farm inverter capacity in the night and the remainder inverter capacity after real power generation during the day, both of which remain unused in conventional solar farm operation. Similar STATCOM control functionality can also be implemented in inverter-based wind turbine generators during no-wind or partial wind scenarios for improving the transient stability of the system. Studies are performed for two variants of a single-machine infinite bus (SMIB) system. One SMIB system uses only a single PV solar farm as PV-STATCOM connected at the midpoint whereas the other system uses a combination of a PV-STATCOM and another PV-STATCOM or an inverter-based wind distributed generator (DG) with similar STATCOM functionality. Three-phase fault studies are conducted using the electromagnetic transient software EMTDC/PSCAD, and the improvement in the stable power transmission limit is investigated for different combinations of STATCOM controllers on the solar and wind farm inverters, both during night and day. The night time usage of a photovoltaic (PV) star farm (when it’s ordinarily dormant) for acting voltage management, thereby improving system performance, power transmission capacity and increasing grid property of neighboring wind farms. The utilisation of this hybrid system in rising power transmission and transients reduction in collaboration with the most outlet chase technique helps in achieving stability in terribly less time. MPPT technique utilised here is progressive electrical phenomenon methodology to maximize the output power to the system no matter temperature and radiance that determines the optimum operational current. Also the system remains balanced with higher potency (less transmission losses) and power quality. This paper presents a utilisation of the PV star farm electrical converter as a STATCOM—a FACTS device for voltage management and power issue correction, both throughout for voltage management and power issue correction has been developed that provides voltage regulation and load compensation within the nights utilising the whole capability of the present star systems electrical converter. During daytime additionally, the solar system is created to control as a STATCOM victimisation its remaining electrical converter capability (left once what's required for real power generation).

II. STATCOM OVERVIEW

The STATCOM is shunt-connected reactive- power compensation device that is capable of generating and or absorbing reactive power and in which the output can be varied...
to control the specific parameters of an electric power system [2]. It is in general a solid-state switching converter capable of generating or absorbing independently controllable real and reactive power at its output terminals when it is fed from an energy source or energy-storage device at its input terminals [6] as shown in fig.4. Specifically, the STATCOM considered as a voltage source converter that, from a given input of dc voltage produces a set of 3-phase ac-output voltages, each in phase with and coupled to the corresponding ac system voltage through a relatively small reactance (which is provided by either an interface reactor or the leakage inductance of a coupling transformer).

![Figure.2. Single Line STATCOM Power Circuit](image)

The AC terminals of the VSC are connected to the Point of Common Coupling (PCC) through an inductance, which could be a filter inductance or the leakage inductance of the coupling transformer. The PV solar DG is modeled as an equivalent voltage-source inverter along with a controlled current source as the dc source as the dc source which follows the characteristics of PV panels [11]. The wind DG is likewise modeled as an equivalent voltage-source inverter. In the solar DG, dc power is provided by the solar panels, whereas in the full-converter-based wind DG, dc power comes out of a controlled ac–dc rectifier connected to the PMSG wind turbines, depicted as “wind Turbine-Generator-Rectifier (T-G-R).” The dc power produced by each DG is fed into the dc bus of the corresponding inverter, as illustrated in maximum power point tracking (MPPT) algorithm based on an incremental conductance algorithm [12] is used to operate the solar DGs at its maximum power point all of the time and is integrated with the inverter controller.

![Figure.3. Circuit Diagram of STATCOM](image)

III. PRINCIPLE OF STATCOM

A STATCOM is a controlled reactive source, which includes a Voltage Source Converter and a DC link capacitor connected in shunt, capable of generating and/or absorbing reactive power. The operating principles of STATCOM are based on the exact equivalence of the conventional rotating synchronous compensator.

![Figure.4. single Line diagram of (a) study system I with a single solar farm (DG) and (b) Study system II with a solar wind farm (DG).](image)

IV. SIMULATION WORK

<table>
<thead>
<tr>
<th>Simulation description</th>
<th>Gen. Bus</th>
<th>PCC/Middle Bus(s)</th>
<th>Inf. Bus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Night time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional Operation of solar DG</td>
<td>731</td>
<td>1.010</td>
<td>0</td>
</tr>
<tr>
<td>solar DG with damping controller</td>
<td>850</td>
<td>1.000</td>
<td>-0.20</td>
</tr>
<tr>
<td>Day time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional Operation of solar DG</td>
<td>719</td>
<td>1.008</td>
<td>91.0</td>
</tr>
<tr>
<td>solar DG with damping controller</td>
<td>851</td>
<td>1.000</td>
<td>91.0</td>
</tr>
</tbody>
</table>
Sub System of diagram:

V. CONTROLLER

VI. GENERATING PULSES FROM PV MODULE

PV System:

Subsystem of controller
VII. WAVE FORMS:

Maximum nighttime power transfer (731 MW) from the generator when solar DG remains idle. (b) Voltage at the generator terminal.

Maximum nighttime power transfer (850 MW) from the generator with solar DG using the damping controller. (b) Voltages at the generator terminal and DG PCC.

Maximum daytime power transfer (719 MW) from the generator with solar DG generating 91-MW real power.

Maximum daytime power transfer (861 MW) from the generator with solar DG generating 91-MW real power and using the damping controller.
Maximum nighttime power transfer (899 MW) from the generator while the solar DG uses a damping controller with voltage control and (b) voltages at the generator terminal and solar DG PCC (1.01 p.u.).

Maximum nighttime power transfer from the generator with both DGs using the damping controller but with no real power generation.

Maximum daytime power transfer from the generator while both DGs generate 95 MW, each using a damping controller.
VIII. CONCLUSION

Solar farms are idle during nights. A novel patent-pending control paradigm of PV solar farms is presented where they can operate during the night as a STATCOM with full inverter capacity and during the day with inverter capacity remaining after real power generation, for providing significant improvements in the power transfer limits of transmission systems. Hence solar plant is used as STATCOM during dark periods to improve voltage regulation and power factor. Due to improvement in power factor load current reduces, Simulated distribution system’s results validate these points. Hence the power quality and electrical performance of the distribution system is improved.

IX. REFERENCES:


