VL_SCA optimizing Control System Designing of Compensator in Hybrid solar/PV System

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ABSTRACT

Static synchronous compensator (STATCOM), as an important member of the FACT, has been widely used as the state-of the-art dynamic shunt compensator for controlling reactive power in transmission and distribution. The paper has focused on designing of a linear crow search based voltage optimization based control algorithm to achieve stability and compensation in the grid connected solar/wind hybrid energy systems. The system with the proposed controller resulted in significant improvement in the system distortion levels and improvement in the power outputs.

Key words: STATCOM, CSA, Reactive power, THD

I. INTRODUCTION

With the development in population over the world interest for the power utilization has been expanding since many years. Overconsumption off the energy and more tension on the producing stations, has come about with crumbling of climate and decrease in air quality. More attention has been drawn towards inexhaustible based energy assets, for example, wind, sun, hydro and so forth that are equipped for diminishing the weight on non sustainable power resource and making the system of generating power eco cordial.

The grid integration of these resources may lead to certain instabilities in the load side distribution. So grid reactive power compensation can improve the network power factor, stable voltage viably, diminish voltage fluctuation, improve the significant distance transmission limit and lessen power losses [1]. STATCOM which is one of the center pieces of Flexible AC Transmission framework cannot just be utilized for reactive power compensation in the power system, yet in addition improve the system stability and backing key nodes to voltage transmission system [9].

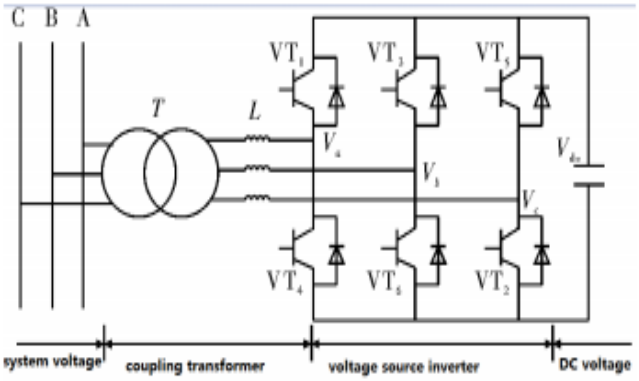

Figure 1: Basic Structure of STATCOM

II. BACKGROUND STUDY

[1] The paper presents a practical way to deal with FACTS as an approach to permit electrical architects running in the energy sectors to perceive the norms and advancement of this device. UNDERSTANDING FACTS can even improve understanding in system specifications and designing format, giving an educated view regarding the future of converters in AC transmission frameworks.

[2] This work has focused on the detailed administration and management of the renewable based energy resources which can be of mainly two types, stand alone and grid connected. It conveys a photovoltaic as an essential primary source through fuzzy and a Proton Exchange Membrane Fuel Cell (PEMFC) as an auxiliary source controlled through Proportional Integral Differential (PID) regulator. The high irregularity nature of photovoltaic is being described through the utilisation of super-capacitor and battery bank inside the proposed engineering. The ordinary strategy for the proposed system is accomplished by the utilization of dynamic force switches of the force converters. The strategy expands the utilization of accessible photovoltaic/power module/super capacitor/battery energy and diminishes weight on the power grid beneath all circumstances for 24 hours.

[3] The displaying in bond diagram of a Skystream wind turbine made with the guide out of the blades, a permanent magnet synchrounous generator (PMSG), 3-area rectifier, Boost converter and an inverter which is delegated a small scale system is introduced. Bond diagrams allows in to variant structures formed with the guide of various power domain names

[4] The proposed Hybrid Energy System (HES) incorporates sunlight based photovoltaic (PV) framework, the electrolyzer, the storage tank and the solid oxide gas cell (SOFC). The HES is utilized to feed the power to the 3ø load along with 1ø load which is synchronized to the framework with the assistance of voltage source converter (VSC). In this innovation while PV power isn't adequate to fulfill the load, at that point SOFC quality is used to satisfy the predetermined interest. An energy component regulator is proposed in which a PID regulator is utilized to change the measure of hydrogen (H2) float through the valve and applied as a fuel of SOFC. In this paper, H2 is created from electrolyzer which takes extra PV energy and water as information components

III. IMPLEMENTATION AND METHODOLOGY

The work has been focused on obtaining following key objectives:

- Designing of a Hybrid solar/wind system as well as integrating it with the grid system in MATLAB /SIMULINK environment.
- Designing of a compensating device and compare it with the basic STATCOM compensator for active power output enhancement in the system
- The compensating device control has to be designed with a linear crow optimizing algorithm to obtain a smooth voltage and current waveform.
- Reduction in the distortion level of the voltage output at the grid system is to be done by using the proposed optimizer.

The large-scale wind/solar hybrid system is connected to grid via a booster station. The system consists of wind power system and photovoltaic system. In order to improve the transient voltage stability of the large-scale wind/solar hybrid system, reactive power compensation device STATCOM is connected to grid. The compensator is being proposed for further enhancement in the output parameters like THD in voltage, THD in current and active power output.

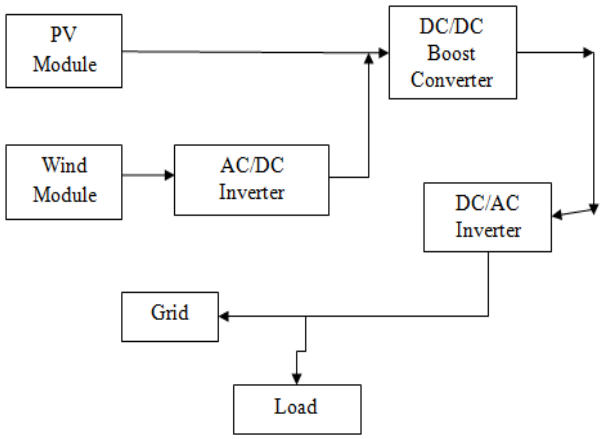

Figure 2: Hybrid energy system topology

3.1 VL-CSA algorithm

Conventional search methods have long been carried out to resolve engineering design problems. Although these techniques locate promising effects in lots of real issues, they'll fail in extra complicated design problems. In actual design issues, the range of decision variables may be very big and their effect at the goal function can be very complex. The goal feature may additionally have many local optima, while the designer is interested in the global optimum. Such issues can't be handled by way of conventional strategies that simplest locate local optima. In these instances, efficient optimization methods are wished. The paper has utilized CSA regulation and optimization at the linear optimum level.

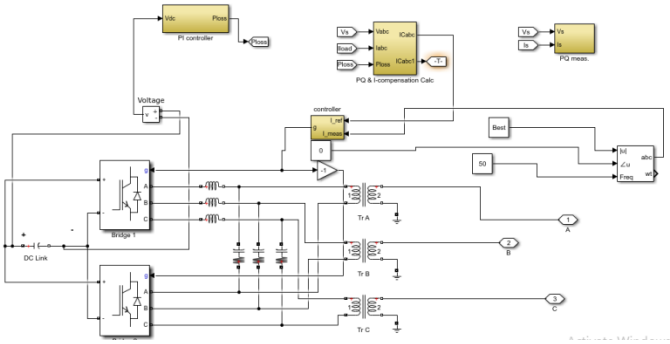

Figure 3: Compensator with proposed constrained crow search algorithm

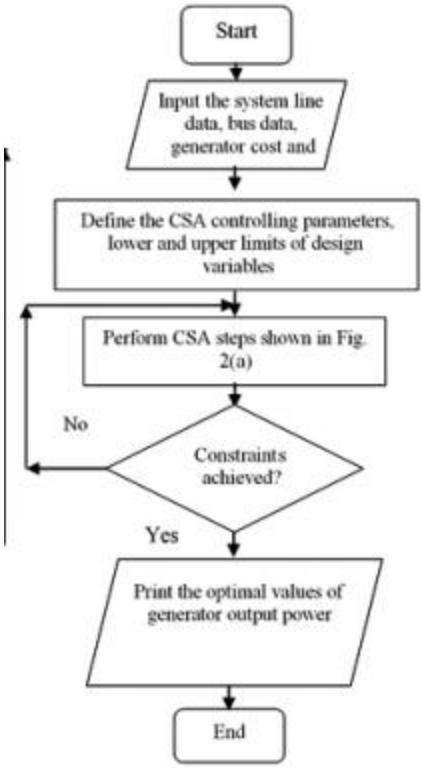

Figure 4: Designing of proposed methodology for compensation in large scale renewable energy resources

IV. RESULTS

The discussion on the solar/wind energy system has been carried out in the following two cases.

Case 1: Hybrid wind / solar energy system with STATCOM having Vdc / Vac control using PI controller.

Case 2: Hybrid wind / solar energy system with shunt compensator with voltage regulation by linear crow search optimization algorithm for big energy farm

The hybrid device is created with inputs to the sun panel being temperature and irradiation. The DC output voltage from the solar cells is combined with the output from the wind plant generation. However the wind energy machine produces 3 phase output and for this reason it is first converted to DC voltage and merged with the output

of the solar system. This mixed output is then fed to the inverter for its DC/AC conversion

4.1 Case 1: Hybrid wind / solar energy system with STATCOM having Vdc / Vac control using PI controller

The output DC voltage is converted in to AC by using inverter. This inverter is supplied pulses with fundamental controlling approach by using voltage and current regulators and producing pulses after their regulation. The output is then despatched to the transformer and then it is incorporated with the grid of 20KV voltage output. The STATCOM having Vdc / Vac manage using PI controller has been related on the load line to perform the power management.

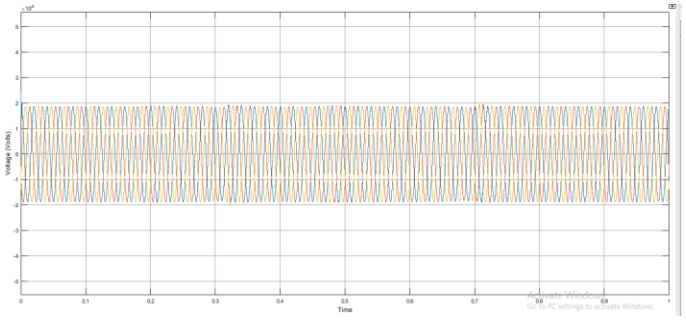

Figure 5: Voltage output from the system with STATCOM having Vdc / Vac control using PI controller.

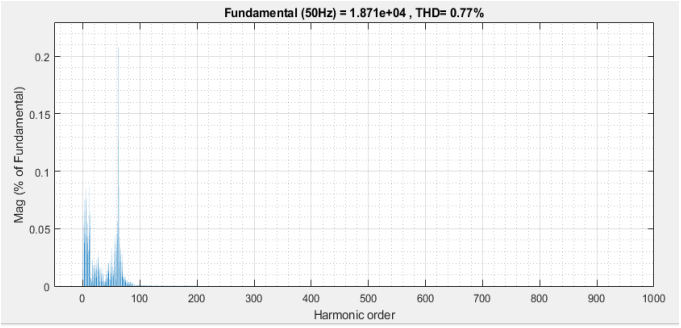

Figure 6: THD % Voltage output from the system with STATCOM having Vdc / Vac control using PI controller

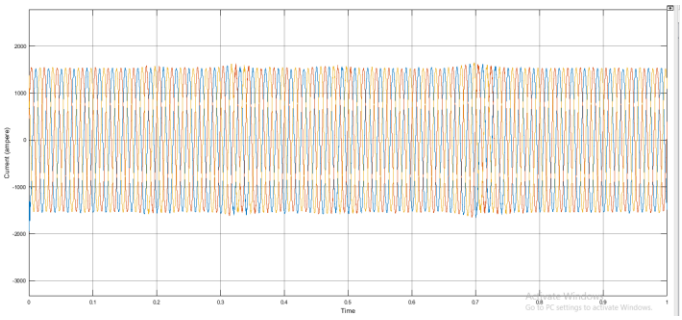

Figure 7: Current output from the system with STATCOM having Vdc / Vac control using PI controller

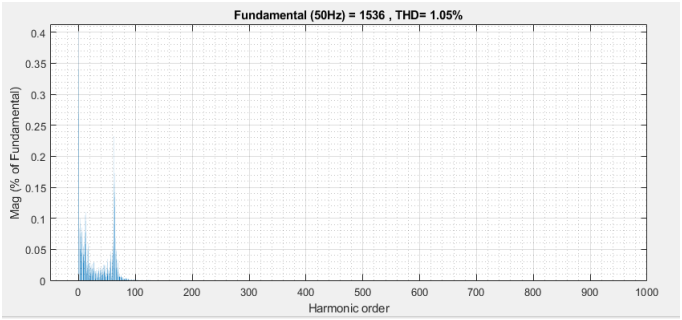

Figure 8: THD% in Current output from the system with STATCOM having Vdc / Vac control using PI controller

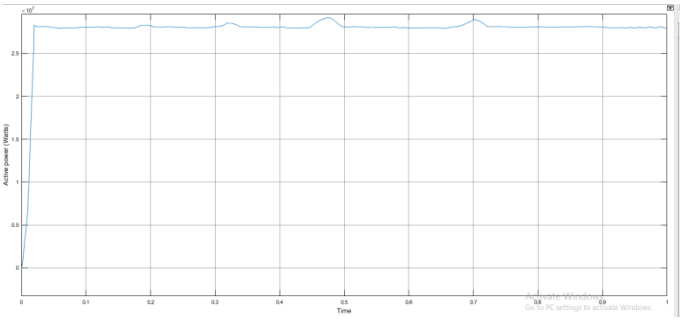

Figure 9: Active Power output from the system with STATCOM having Vdc / Vac control using PI controller

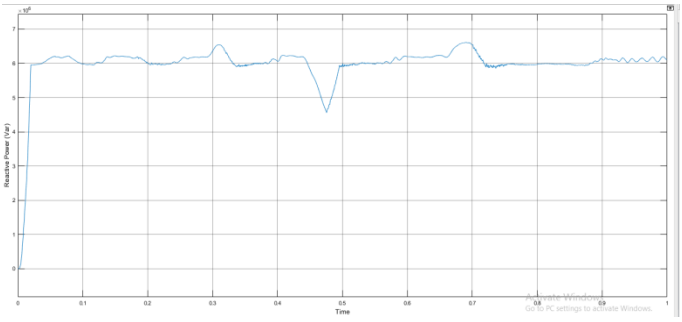

Figure 10: Reactive Power output from the system with STATCOM having Vdc / Vac control using PI controller

4.2 Case 2: Hybrid wind / solar energy system with shunt compensator with voltage regulation by linear crow search optimization algorithm for big energy farm

The inverter converts the input DC to AC after which it's far linked to the transformer for its integration with the grid. The various loads of different kinds are also linked to this system. As the active power output is improved by way of increasing the current output at the load distribution line to 1550A by the usage of linear crow seek optimization algorithm for energy farm and subsequently the loads of higher rating can also be related to this device as compared to previous model.

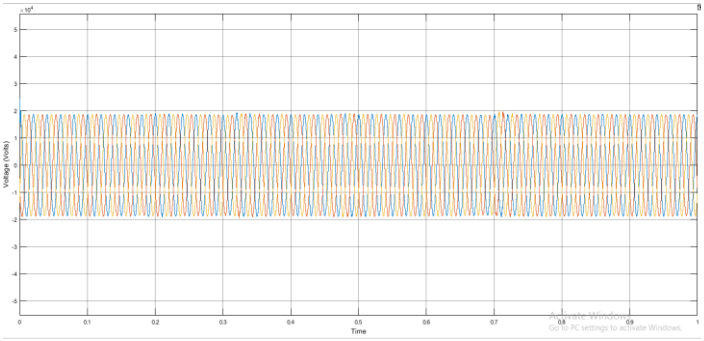

Figure 11: Voltage output from the system with Compensator having voltage regulation by linear crow search optimization (VL-CSA)

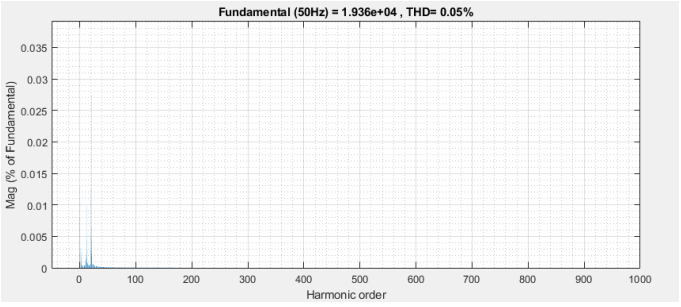

Figure 12: THD% of Voltage output from the system with Compensator having voltage regulation by linear crow search optimization (VL-CSA)

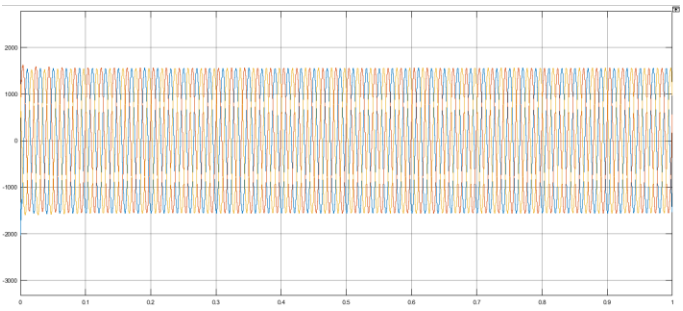

Figure 13: Current output from the system with Compensator having voltage regulation by linear crow search optimization (VL-CSA)

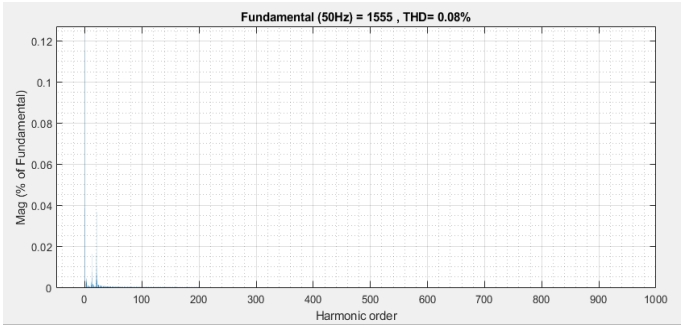

Figure 14: THD% of Current output from the system with Compensator having voltage regulation by linear crow search optimization (VL-CSA)

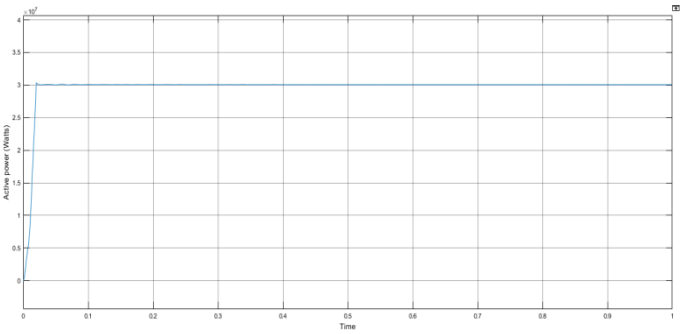

Figure 15: Active power output from the system with Compensator having voltage regulation by linear crow search optimization (VL-CSA)

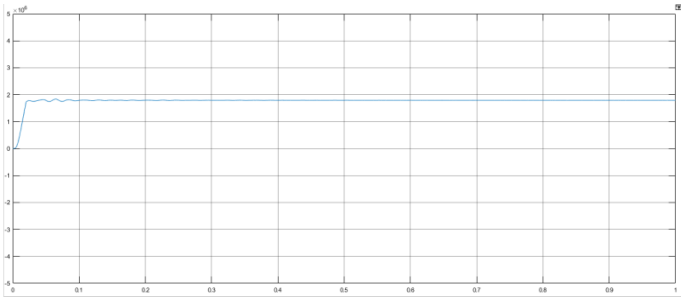

Figure 16: Reactive power output from the system with Compensator having voltage regulation by linear crow search optimization (VL-CSA)

V. VALIDATION

Parameters	System with STATCOM with Vdc / Vac control using PI controller.	Compensator having voltage regulation by linear crow search optimization (VL-CSA)
Active power output	28 MW	30.06 MW
Voltage Output	20 K V	20 KV
Current Output	1530 A	1550 A
Power Factor	0.91	0.96
THD% in voltage	0.77 %	0.05 %
THD % in current	1.05 %	0.08 %
Reactive Power output	6 MVar	2MVar

The above results show the comparative values of all the parameters. The active power output available has been enhanced from approximately 28MW at the load distribution bus in the system having STATCOM to 30.06 MW in the system which is made with the compensator driven by the **voltage regulation by linear crow search optimization (VL-CSA).**

VI. CONCLUSION

This paper presents a novel concept where a STATCOM is used innovatively as a load reactive energy compensator an interface unit among the grid and renewable electricity supply, and as an effective approach for actual power exchange among the load system, grid and renewable electricity supply. A controller unit is proposed for the shunt compensator based on Linear Crow search set of rules by which reactive energy compensation and power factor correction is done and additionally real power aid is furnished by using renewable strength.

We have designed a controller for the compensator based totally at the optimizing algorithm that's a part of artificial intelligence. Following foremost conclusions had been drawn:

- The active power output from the system has enhanced to 30.06 MW in the system having compensator regulated from the proposed controller that is VL-CSA from 28MW which is also stable as compared to the system having STATCOM.
- The Crow search algorithm is controlled in a manner such that the output voltage and current distortion has also reduced. The voltage output distortion level from the hybrid solar wind energy system was found to be 0.05% which is less than 0.77 % of the system having basic STATCOM.

- The crow search algorithm has collectively proved to be effective reducing the distortion level of current output also. The current distortion level has also come down to 0.08% using the proposed controller from the 1.05% in the solar wind hybrid system with basic STATCOM.
- The system is also integrated with the grid energy system. The line voltage being maintained to 20 KVolts. The reactive power output has also reduced. The algorithm has proven to be more effective in the compensating the reactive power as well.

The above description concludes that the hybrid system is made efficient for driving the loads having enhanced active power output at its terminal. The voltage available has been made less distorted and the THD level in current output has also came down.

VII. FUTURE SCOPE

- The modulation technique is easy and simple to be implemented; use of proper facts devices can make it more robust and easy to handle inverter.
- With the advent of more powerful artificial intelligence, the requirements for low computational complexity and memory consumption of the algorithms will drop and it might be even possible to implement more complicated and more efficient algorithms.
- The proposed controller has proved to be effective while designing the compensator. This algorithm can further work in an enhanced manner by making a hybrid AI technique for this algorithm. Therefore, it is certainly true that the area of compensator is and for a long time will remain widely opened sphere for scientific research and commercial applications

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