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A NEW SMART GRID DEVICE FOR EFFICIENT ACTIVE AND REACTIVE POWER CONTROL IN HYBRID POWER SYSTEM

L.SHANGAVI*
PG Scholar, Department of EEE,
Adhiyamaan College of Engineering,
Hosur - 635109, Tamilnadu, India.
shangaviloganathan@gmail.com

Dr.T.VIVEKANANDASIBAL**
Associate Professor, Department of EEE,
Adhiyamaan College of Engineering,
Hosur - 635109, Tamilnadu, India.
tviveksibal@yahoo.com

Abstract

This paper proposes a voltage and reactive coordinative control strategy with Distributed Generator (DG) in a distribution power system. The proposed method reduces the real losses and voltage fluctuations and improve receiving power factor. The proposed method minimizes the real power losses and improves the voltage profile using squared deviations of bus voltages. Coordinated voltage and reactive power control methods that adjust optimal control values of capacitor banks, OLTC, and the AVR of DGs by using a Voltage Sensitivity Factor (VSF) and Dynamic Programming (DP) with Branch-and-Bound (B&B) method. Effectiveness of the proposed method by using operational cost of real power losses and Voltage Deviation Factor as evaluation index for a whole day in a power system with Distributed Generators.

Keywords-Coordinated reactive power control, Voltage sensitivity factor, Voltage regulation, Loss minimization, OLTC transformer, Distributed generator.

I. INTRODUCTION

Modern power systems are often affected by an inadequate reactive power supply and a reduction of voltage stability margin. Those could be negative effects on voltage profiles, active and reactive power losses. The operator can improve this situation by reallocating reactive power generations in the system, by adjusting transformer taps, by changing generator voltages, and by switching VAR sources. The system losses can also possibly be minimized.

II.OPTIMAL DISPATCH SCHEDULE OF DISTRIBUTED GENERATOR

At each location where DG may be connected. This formulations subtly different to traditional OPF as here the functions have negative coefficients to indicate that development of DG results in a negative cost or, in other words, a benefit. As such, DG with larger coefficients will be favored, which allows locational preferences to be expressed, although it is generally assumed that these are the same for all new DG in order to avoid biasing the analysis.

A. Voltage Control Properties

The rated power factor of each DG is assumed to be 0.9 lagging. The distributed and centralized voltage control strategies allow relaxation from this value within the range of 0.9 lagging and 0.9 leading. With distributed voltage control, the power factor is allowed to vary once the generator voltage reaches.

B. Control strategy

A voltage and reactive power control strategy involves coordination among all shunt capacitors, the OLTC, and the DG in the distribution system to minimize active power losses and to improve the voltage profile according to the load demand and DG output power based on a time series. Conventionally, voltages at the primary bus of a substation change slightly over a day and are therefore assumed to have a constant value.

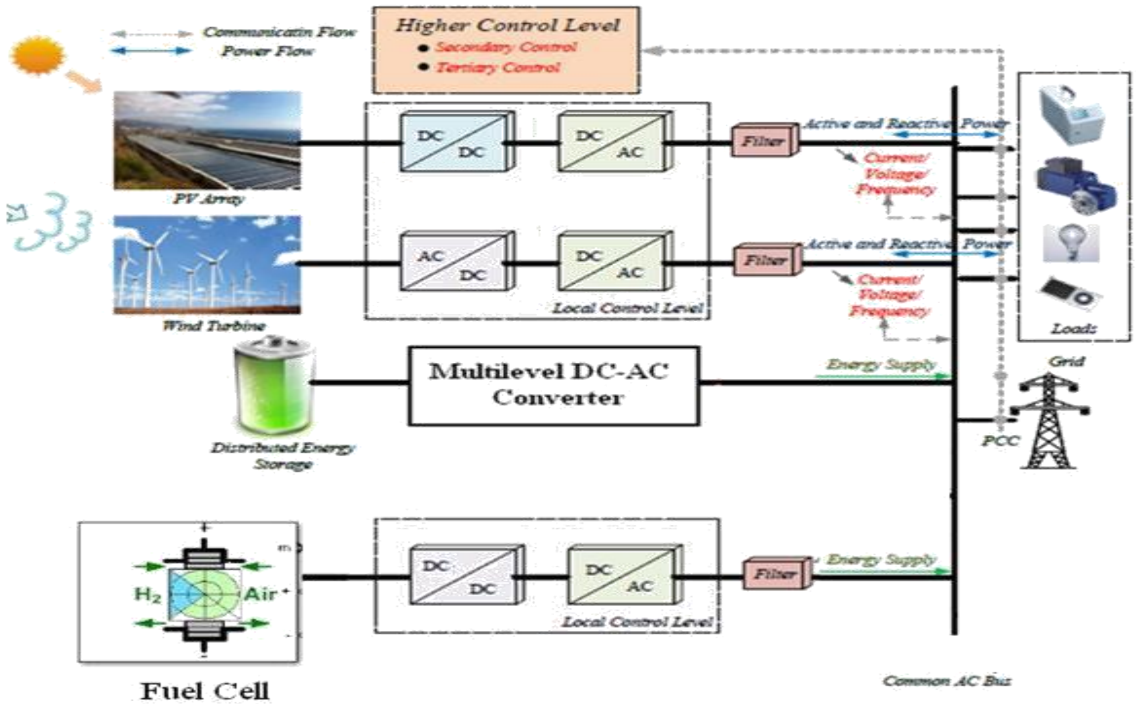


Fig.1. Proposed block diagram

III. LOAD AND GENERATION PROFILE BASED ON TIME SERIES

In a day, assuming the network is scanned every hour, for twenty-four hours operation, the network is scanned for 24 times. We assume the following as shown in Figure.4.2 .First, load level varies from 40% to 100% for heavy load condition which is 86.33MW. Second DG output power varies from 45% to 80% for the rated capacity which is 50MW.

IV. POWER FACTOR CONTROL MODE (PFC)

In power factor control mode, the P/Q ratio of a generator is kept constant, with the reactive power following the variation of real power. Traditionally, in order to ensure the availability of DG unit's full real power output, the power factor of DG remains (near) uniform. The generator bus will serve as a PQ bus. Voltage Control Mode (VC). In voltage control mode, Automatic Voltage Regulator (AVR) of generator ensures voltage constant by changing excitation.

When the output of DGs increases, AVR needs to regulate the field current of generator to keep voltage constant. Under this situation, the reactive power output will be decreased or be absorbed. This control strategy is relatively complex to deal with. The generator bus will serve as a PV bus. However, the reactive power after modified by equations may exceed limits. In this case, the PV bus should be converted to a PQ bus.

V.CONTROLLABLE ELEMENTS IN VOLTAGE CONTROL SYSTEM

Controllable elements participating in ADS voltage control OLTC, secondary capacitor in substation C, line capacitor C1 and DG units. The operation of the tap changer is limited to its tapping limits and capacity. The action times of OLTC and C are limited. There are several modes of voltage control with DG involved: Power Factor Control (PFC), Voltage Control (VC), Power Factor-Voltage Control (PFC-VC) and Generation Curtailment. PFC depends on a certain limit of generation connected to the system. VC is disruptive to the network devices such as OLTCs. PFC-VC method combines the behavior of the generator's operation in two modes namely, PFC and VC.

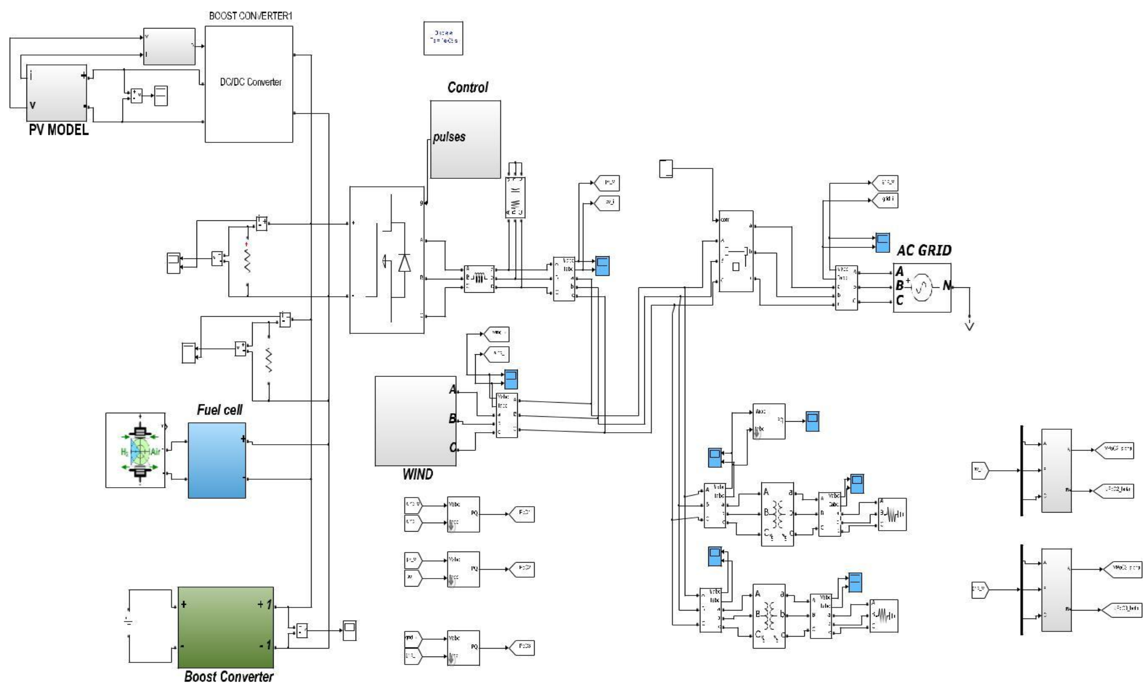


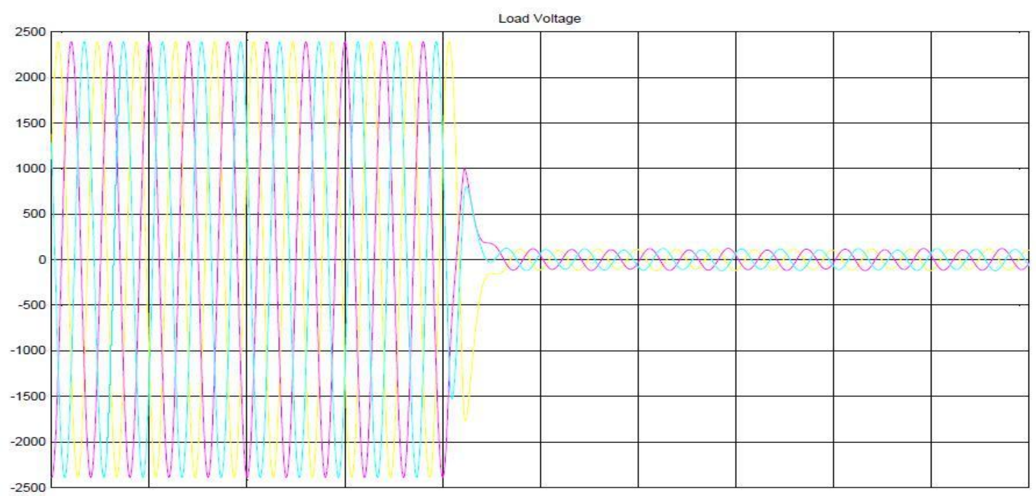
Fig.2. Proposed simulation

VI. REACTIVE POWER FROM DG

DG unit connected to electrical grid through power electronic converter can be set to inject reactive power by changing its operating power factor or increasing its reactive current output. Its maximum reactive power that can be supplied is given by How much reactive power can be supplied by a particular DG unit depends on its active power set point. If the DG active power is set close to its rated apparent power rating, capacitive or inductive reactive power range that can be supplied is small.

Reactive supply capability of DG can be increased by reducing its active power generation. If active power set point is reduced, more reactive supply is guaranteed. In this case, active power output has to be curtailed which is not favorable to the economic point of view because active power from DG is expected to be cheaper than transported active power from upstream.

WITHOUT RENEWABLE SOURCE



WITH RENEWABLE SOURCE

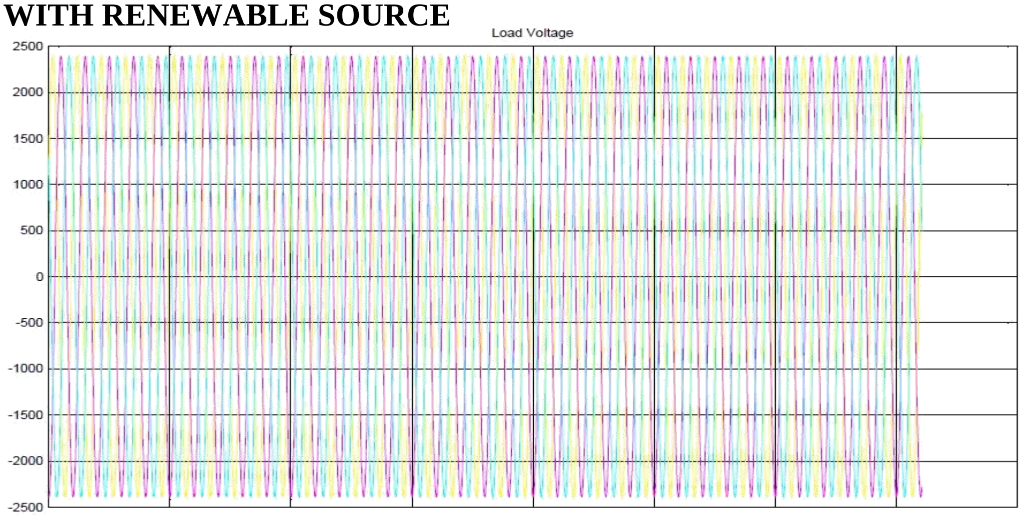


Fig.3.simulation result

VII. CONCLUSION

The control variables include switched or fixed shunt capacitor bank, tap position of On-load Tap Changer and voltage set point of distributed generator. Optimal dispatch schedules are obtained by using Voltage Sensitivity Factor and Dynamic Programming with Branch and-Bound method. To avoid the computational burden, voltage deviation matrix based sensitivity factor are applied and the searching space is reduced with flexible size.

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