Technical Cost Of Operating A Photovoltaicinstallation As A Statcom At Nighttime

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Abstract

Reactive power support of photovoltaic farms has been under discussion in several countries. This kind of operation has been proposed because the photovoltaic farm converter is an expensive asset that is often used well below its power rating. This project proposes a fuzzy control methodology for estimating the reactive power support capability and the associated technical cost of operating photovoltaic installation as a STATCOM at nighttime. The technical cost is related to the need for buying active power from the grid to compensate for power losses. A precise estimation of this cost is of interest to both photovoltaic farm owners and grid operators to be able to evaluate the economic feasibility of this kind of operation. MATLAB Simulink has been used to evaluate proposed system performance.

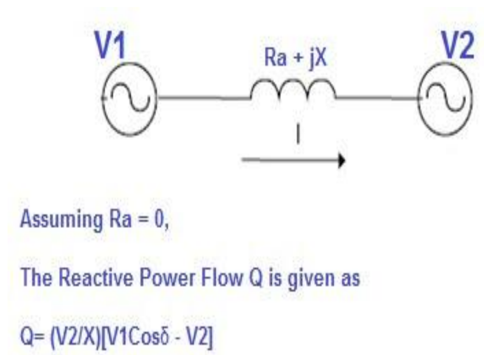
I. INTRODUCTION

STATCOM or Static Synchronous Compensator is a power electronic device using force commutated devices like IGBT, GTO etc. to control the reactive power flow through a power network and thereby increasing the stability of power network. STATCOM is a shunt device i.e. it is connected in shunt with the line. A Static Synchronous Compensator (STATCOM) is also known as a Static Synchronous Condenser (STATCON). It is a member of the Flexible AC Transmission System (FACTS) family of devices.

The terms Synchronous in STATCOM mean that it can either absorb or generate reactive power in synchronization with the demand to stabilize the voltage of the power network.

A. Working Principle of STATCOM:

To understand the working principle of STATCOM, we will first have a look at the reactive power transfer equation. Let us consider two sources V1 and V2 are connected through an impedance Z = Ra + jX as shown in figure below.



In the above reactive power flow equation, angle δ is the angle between V1 and V2. Thus if we maintain angle δ = 0 then Reactive power flow will become

Q = (V2/X)[V1-V2]

and active power flow will become

P = V1V2Sinδ / X =0

To summarize, we can say that if the angle between V1 and V2 is zero, the flow of active power becomes zero and the flow of reactive power depends on (V1 – V2). Thus for flow of reactive power there are two possibilities.

1) If the magnitude of V1 is more than V2, then reactive power will flow from source V1 to V2.
2) If the magnitude of V2 is more than V1, reactive power will flow from source V2 to V1.

This principle is used in STATCOM for reactive power control. Now we will discuss about the design of STATCOM for better correlation of working principle and design

Varma et al presented a novel control of a large-scale PV solar farm as STATCOM, termed PV-STATCOM, for alleviation of sub synchronous resonance (SSR) in a steam turbine driven synchronous generator connected to a series compensated transmission line

Hesamaldin et al presented a novel control of PV solar farm as a STATCOM (PV-STATCOM) coordinated with Power System Stabilizers (PSSs) for damping of electromechanical oscillations in a power system. A two-area power system with a 150 MW PV solar plant connected at the midpoint of the tie line is simulated in PSCAD/EMTDC software

Varma et al presented a novel control of PV solar system as a FACTS device STATCOM, termed PV-STATCOM, for power oscillation damping (POD) in transmission systems

Varma et al presents a novel concept of utilizing a photovoltaic (PV) solar farm inverter as STATCOM, called PV-STATCOM, for improving stable power transfer limits of the interconnected transmission system

Saikrishna et al designed in Hardware Technology, with Experimental setup, is application for Residential Solar Power Distribution, is a small proposed Kit for only Few watts generation

II. EXISTING SYSTEM

Luis et al aimed of this methodology is to evaluate thereactive power support capability of a PV-STATCOM in nighttimeoperation and the related technical cost for each point ofoperation. The related technical cost for providing the reactivepower support is associated with the power that must be boughtfrom the grid to supply the system losses. The PV-STATCOMand the conventions adopted in this work are shown in Figure. In this figure, vdc is the measured DC circuit voltage, Cthe DC circuit capacitor, vcabc is the converter voltage in the abcframe, rr and Lr are the resistance and the inductanceof the tie reactor, Rf ,Lf and Cf are the resistance, theinductance and the capacitance of the filter; iabc and vg abcarethe measured grid side current and voltage in the abcframe. For the control scheme, vdc ref is the DC voltage referencevalue, id ref and iq ref are the current references in the dqframe, idq and vg dq are the measured grid current and voltage in the dqframe, vcdq ref is the reference voltage generatedto the PWM in the dqframe, _ is the grid voltage phaseangle. Qref is the reactive power reference and vg d is thedcomponent of the grid voltage in the dqframe.

III. PROPOSED SYSTEM

A. FUZZY LOGIC CONTROLLER (FLC):

Fuzzy logic starts with the concept of a fuzzy set. A fuzzy set is a set without a crisp, clearly defined boundary. It can contain elements with only a partial degree of membership. To understand a fuzzy set, first consider the definition of a classical set. A classical set is a container that wholly includes or wholly excludes any given element. Fuzzy set theory first introduced by Zadeh was used to describe inexact information, but after Mamdani‘s pioneer work on its application to a steam engine control, many applications of fuzzy control in industry processes have been developed. Procyk and Mamdani described the first self organizing controller (SOC). Fuzzy logic controller is designed for the power quality improvement. The fuzzy logic controller provides the design of a non-linear model free controller and can be used for the coordinated control of RSC and GSC in the DFIG system. The Takagi-Sugeno-Kang type fuzzy logic controller may not be able to provide the smoothness over a wide range of speed of the wind. The Mamdani type fuzzy logic controller can provide a wide range for the control of the machine by utilizing both linear and non-linear rules in the consequent expression of the fuzzy rules based and is well suited to human input. Fuzzy control processes an inherent robust property. A typically fuzzy controller as shown in Fig. consists of three major parts: a fuzzification, decision making logic (fuzzy inference system), and defuzzification. The key to successful design of a fuzzy controller relies on the suitable selection of fuzzy variable and linguistic rules, obtained practical experiences and intuitive tries.

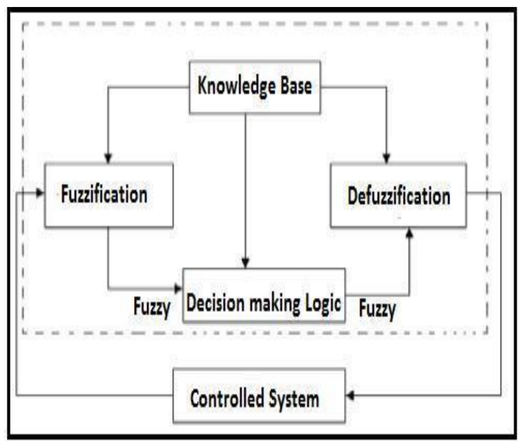


Fig The general scheme of the fuzzy controller.

RESULTS AND DISCUSSION

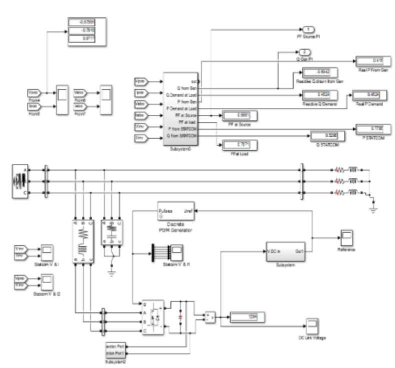


Figure STATCOM

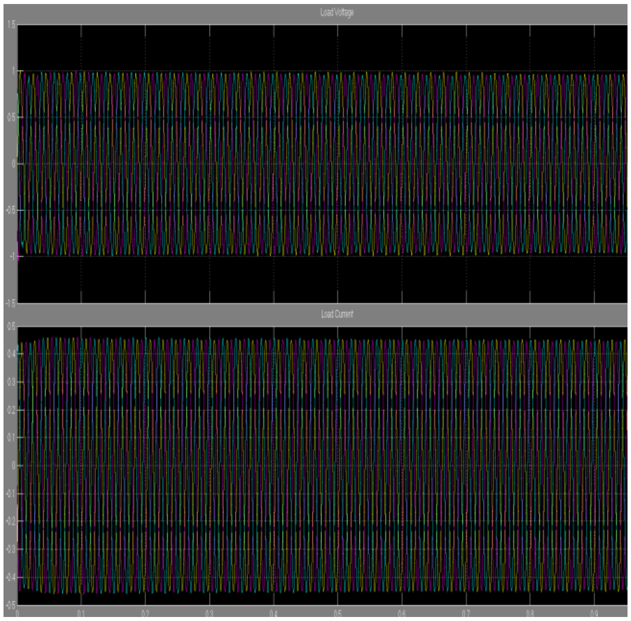
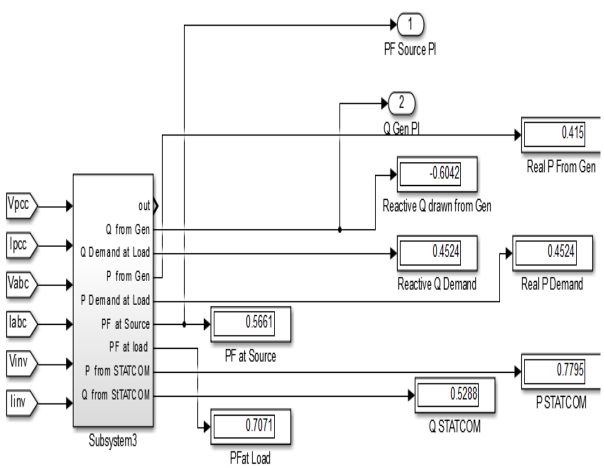


Figure grid output voltage



CONCLUSION

This project proposed a methodology for evaluating the technical cost of operating a PV-STATCOM at nighttime using electromagnetic transient simulations. The DC capacitor and the converter ageing due to increased use was not considered. This methodology was applied to PV farm to obtain its reactive power support capability map and associated technical cost. It is therefore preferable for PV-STATCOM operation at nighttime. This analysis is of interest to both PV farm owners and grid operators in order to evaluate the financial gain of this kind of operation.

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