POWER QUALITY IMPROVEMENT IN A GRID CONNECTED RENEWABLE ENERGY SYSTEM

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Abstract- In distributed system, renewable energy resources (RES) are increasingly incorporated using power electronics interfaces. Extensive use of power electronics devices generate harmonic current and may reduce quality of power. In this paper, renewable energy resources (RES) is connected to the grid through a grid interfacing inverter for power quality improvement. The grid interfacing inverter is connected to a 3-phase 4-wire system and hysteresis current control method is used to generate gate pulses. Here renewable energy resource (RES) is represented as a dc source. The grid interfacing inverter has the capability of injecting RES power to the grid and also reduces load unbalance, load harmonics and reactive power demand is compensated. Total Harmonic Distortion (THD) of the grid connected system is analyzed. The simulation has been carried out in MATLAB/Simulink.

Keywords- Grid interfacing inverter, Hysteresis Current control, Power Quality Improvement, Renewable Energy Resources (RES).

I. INTRODUCTION

The energy demand is increasing day by day which can create problem for electric utilities and end users of electric power. Renewable energy resources such as solar photovoltaic, wind, fuel cell etc are largely integrated into in power system. The integration of Renewable Energy Resources at the distribution level

II. RES AND POWER QUALITY ISSUES

The quality of power exchanged at the point of common coupling (PCC) is termed as power quality. It also depends on the quality of voltage and current.

Some of the power quality issues are

Over voltage and voltage dips

Over voltages mainly occur due to environmental phenomena such as lightening on grid. These are rare events and can be reduced using grid components.

Fast reclosing action of switches in order to eliminate transient faults may cause voltage dips.

Harmonics

Loads equipped with electronic devices that absorb high frequency current components produces harmonics in grid current. Voltage harmonics are produced due to converters and by the switching of electronic components.

Flickers

Fast variation of voltage supplied to load is termed as flickers. Repetitive load connection and disconnection causes voltage oscillations.

This paper presents a interfacing inverter for a grid connected renewable energy system. This grid interfacing inverter can be utilized for transfer of active power generated from renewable resources, reactive power compensation and current harmonic compensation at the point of common coupling.

III. BASIC SYSTEM CONFIGURATION

The voltage source inverter is the main component of the Distributed Generation (DG) system as it interfaces the RES to the grid. RES is connected to the dc link of the interfacing inverter as shown in Fig.1.

Fig.1 Basic configuration of the system

The RES can be represented as a DC source or an AC
source with rectifier coupled to dc-link of the inverter.
In this paper RES is represented as a DC source.

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IV. INVERTER CONTROL

The control technique for grid interfacing inverter is
shown in fig.2. Neutral current compensation of the
load current is done by the fourth leg of the inverter.

Design

DC link Voltage: The value of the dc bus voltage
( ) of VSI mainly depends on the instantaneous
energy available. The dc bus voltage is calculated as
follows:

Where V is phase voltage and cos α is taken as 1.

Fig.2 Control technique of grid interfacing inverter

Hysteresis current control technique is used for
generation of gate pulses for the inverter working. In
this technique, actual current continually tracks the
command current within a specified hysteresis band.

V. SIMULATION AND RESULTS

A grid connected renewable energy system with a 4
leg inverter is modelled. Here the renewable energy
resource is represented as a dc source. Different modes
of operation of the system investigated. Behavior of
the system with and without connection of inverter is
studied.

Fig.3 Simulink model of the system

A. Modes of Operation

Mode 1: PQ Enhancement

In first mode of operation, there is no power generation from RES. The grid interfacing inverter is

not connected to the till time t=0.72s. Before time
t=0.72s, the grid current is identical to load current
profile Fig.3 shows the waveform of grid current and
load current.

Fig.4 Grid voltage and grid current waveforms before t=0.72s

Fig.5 Waveforms of load voltage and current before t=0.72s

Fig.6 Active and reactive power flow of grid before t=0.72s

Fig.7 Active and reactive power flow of load before t=0.72s

Mode 2: Simultaneous PQ Enhancement and power
injection

At t=0.72s, the grid-interfacing inverter is connected
to the system. At this time, the inverter starts injecting
the current such that the reactive power demand is

(1)

compensated.

Fig.7 load current waveform

Fig.8 Active and reactive power flow of grid

Fig.9 Active and reactive power flow load

In mode2 of operation, the reactive power demand of
the grid is compensated and the load power remains
constant.

B. Total Harmonic Distortion(THD)

The Total Harmonic Distortion (THD) of the grid
current without inverter and grid current after inverter
connection is investigated. At t=0.72s the inverter is
connected into the grid. The Total Harmonic Distortion (THD) of the grid current without inverter
and grid current after inverter connection are 13.02
and 5.22 respectively. Fig.10 shows the THD values of
grid current and load current before and after
connection of inverter.

Fig.10 THD values of grid current and load current

CONCLUSION

A 3-phase 4-wire renewable energy system with grid interfacing inverter to improve the quality of power at PCC is modelled. Hysteresis current control method is used to generate gate pulses. The inverter is controlled to perform as a multi-function device by incorporating active power filter functionality. The voltage, current and power flow waveforms are obtained. Reactive power demand of the grid is compensated and current harmonics is reduced. It has been found that total harmonic distortion of grid current is reduced from 13.02 to 5.22% and that load current from 13.01 to 6.44%.

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