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HARMONIC ANALYSIS OF DROOP BASED ISLANDED MICRO GRID

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ABSTRACT

This project mainly focuses on harmonic analysis on micro grid. Harmonics are waveform distortions in electrical frequency, caused by the change in the load. Frequency in the grid is inversely proportional to the load. We need frequency as constant. We need to calculate all form of harmonics generated at the load side and analyze how frequency and voltage is changing according to the load. Micro grids are a type of grids which are isolated from the utility grid but not totally isolated. If there is any power disruption between micro grid and utility grid, micro grid can generate its own electricity by using alternate generating sources. Micro grid can store and use the energy if there is excess energy in the micro grid it can supply the energy to the utility grid. To provide a reliable system in the islanded micro grid, which type of harmonics are produced by the system when there is change in the load, how to reduce the harmonics produced by the system, how to control the frequency that varies when the micro grid is running on the stored energy using converters. If we improve the operation and stability of the grid, it will reduce the line losses, fuel use, reduces carbon footprint and runs at high efficiency. Using battery management system and renewable energy sources we can increase the efficiency of the grid

Keywords: Harmonic analysis, Islanded micro grid, droop based operation.

INTRODUCTION

Power Quality which is a power problem manifested in the deviations of Voltage, Current or Frequency results in the malfunctioning of equipment. In micro grid we use inverters to convert the stored DC energy in the energy storage systems. Micro grid is a type of grid where it has its own energy production from solar, wind, diesel generators, small scale hydro plants (SHP). All the energy is stored in energy storage systems.

In micro grid or in utility grid we need to maintain frequency as constant (50hz). In utility grid we use turbine governor to maintain frequency like if there is increase in load that decreases the frequency of the system so keep up with that we increase the voltage of the generation by increasing the turbine output to increase the generation, but in micro grid we don't have turbine to control the output. So, we use droop control if there is increase in load that is sensed by the sensors and micro grid control center will give instructions to the inverter to increase the output and to increase the output of the distributed generations. Even after increasing the output if the system is not stabilized MGCC will shed unimportant load. To analyze the stability we calculate total harmonic distortion of the system it should be less than 5percent. So that we can say the system is stable.

Figure 1: Micro grid

MICROGRID

A micro grid is a single, controllable, independent power system comprising distributed generation (DG), load, energy storage (ES), and control devices, in which DG and ES are directly connected to the user side in parallel. A micro grid is any small, localized power plant with its own power sources, storage capacity, and definite limits. Micro-grids are bi directional, they may receive power from both the traditional grid and alternative energy sources like solar, wind, and other renewables. These renewable energy sources must be connected to the microgrid using various types of inverters, battery storage, and converters. However, the

major goal of a micro grid is to have it operate in an isolated state where it may operate independently in a location where a traditional network is less stable.

Micro grid components:

1. Distributed generation

2. Loads

3. Controller

4. Point of common coupling

5. Immediate storage

Micro grid operates in two modes:

(i)Grid connected mode: When the micro grid operates in grid connected mode,

1. Utility grid will be active

2. Static switch is closed

3.The utility grid supplies power to every feeder

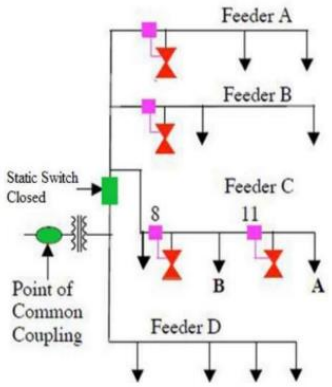


Figure 2: Grid Connected Micro grid

(ii)Islanded mode: When the micro grid operates in islanded mode,

1. There is no electricity coming from the utility grid.

2. Static switch is open

3. Micro sources are supplying feeders A, B, and C, and feeder D (not sensitive) is deceased

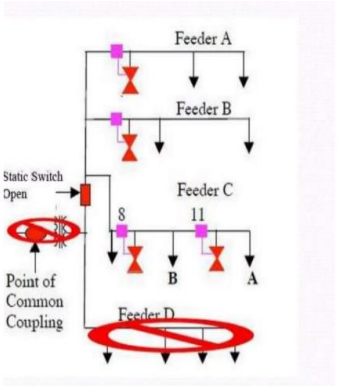


Figure 3:Islanded Micro grid

When operating in grid-connected mode, a micro grid that produces alternating current is connected to the utility grid from the generating plant. In island mode, the micro grid is cut off from the electric grid and runs on its own power produced by DGs. We use inverters to convert the stored dc to ac current. In islanded mode if there is excess energy it will supply energy to the utility grid.

HARMONICS

Harmonics are integral multiples of fundamental component of frequency ($fh = h * f1$). These are unwanted signals which draw current abruptly in short intervals of time which can harm components and shortens life time. They also overheat the devices like transformers, which results in losses. This harmonics on system causes problems like telephone interference. These harmonics leads to different effects on different equipment like heating, overloading, overstressing, losses etc. Triple harmonics are the dangerous harmonics which damage the equipment.

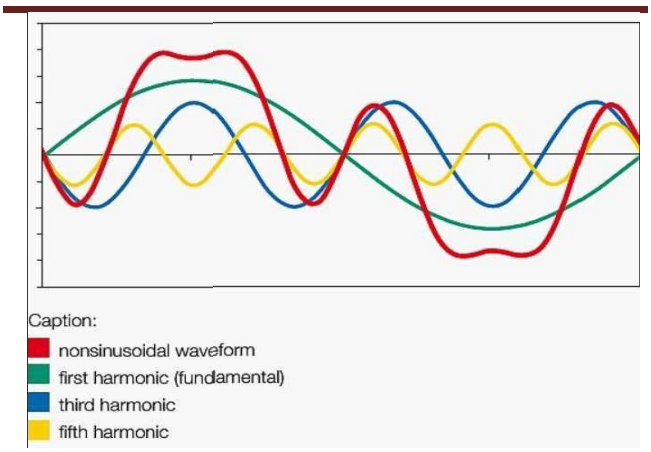


Figure 4:Representation of Harmonics

1. Harmonics are caused by loads like
    - Controlled Rectifiers
    - AC & DC variable speed drives
    - Solid state control heaters
    - Rectifier transformers
    - Zero switching of transformers

During starting, linear loads may produce harmonics. Harmonics are also produced by capacitor swapping. The impact of harmonics in capacitors is exacerbated by the presence of harmonics in the applied voltage. Even when applying a linear voltage waveform, loads still draw nonlinear current, which is the main source of harmonics.

BLOCK DIAGRAM AND WORKING

1.1.1 BLOCKDIAGRAM

Most of the components are modeled in MATLAB-Simulink. In this we used solar and wind as power generators in micro grid. The power from the wind is AC or it can be either AC or DC depending on the type of the generator. The power from the wind is converted in to DC using converters, and the converted DC is boosted using DC to DC boost and fed to the energy storage system. In the same way power from solar is fed to DC to DC boost and fed to the energy storage system. Whenever the power is needed the stored energy is used. Inverters will convert the DC in to AC according to the load (230 volts and 50hz frequency). There is a PCC (point of common coupling) which will connect and disconnect to the main grid and islanded mode according to instruction given by the micro grid control center. This MGCC will control all the components in the micro grid.

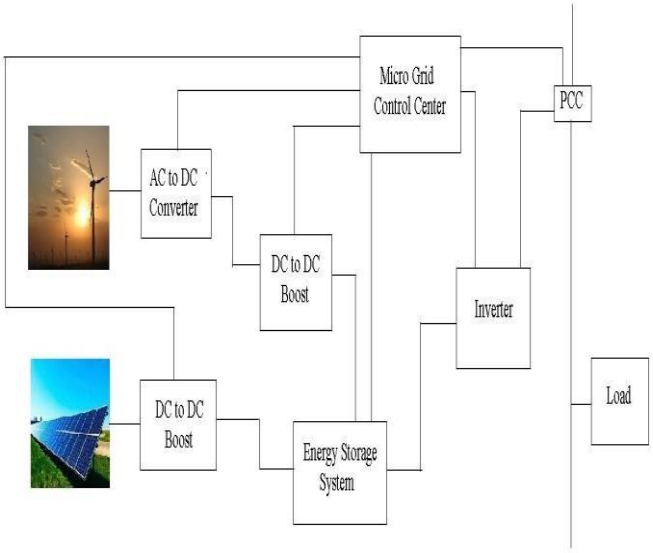


Figure 5:Block diagram

1.1.2 WORKING

In micro grid we use distributed generation like solar, wind, diesel, bio gas, small hydro power plant which generates direct current. We use dc to dc converters to boost the voltage generated. We store the energy generated by the DG's in batteries. Micro grid operates in two modes: Grid connected mode Islanded mode. In grid connected mode, micro grid is connected to the utility grid from the generating station which generates alternating current. In islanded mode, micro grid is disconnected from then utility grid and operates independently by generating its own power from DG's. We use inverters to convert the stored dc to ac current. In islanded mode if there is excess energy it will supply energy to the utility grid. Harmonics are waveforms distortions in electrical frequency caused by the change in load. Frequency in the grid is inversely proportional to the load. We need to maintain the frequency as constant. We need to calculate all forms of harmonics generated at the load and analyze how frequency and voltage is changed. Droop control is a strategy to control the active and reactive power in the grid. By measuring the change in frequency at the load. If there is any change in frequency we need to change the voltage to maintain constant frequency. In inverters we use pulse width modulation to control the inverter. If there is increase in load, frequency decreases. To maintain constant frequency we need to increase the voltage by using pulse width modulation

RESULTS

For R load:

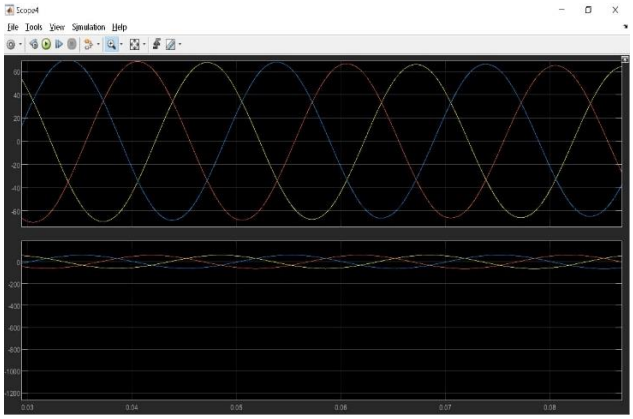


Figure 6:

For RL load :

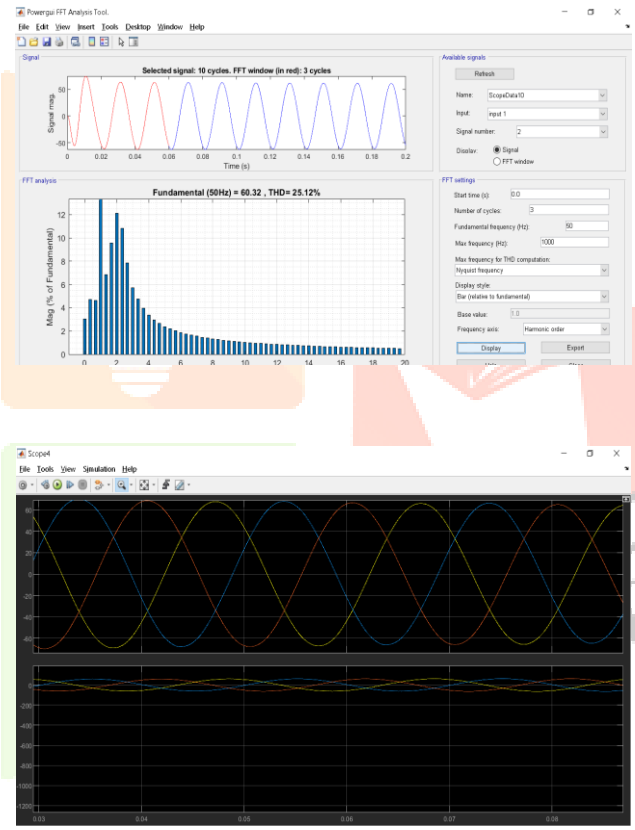
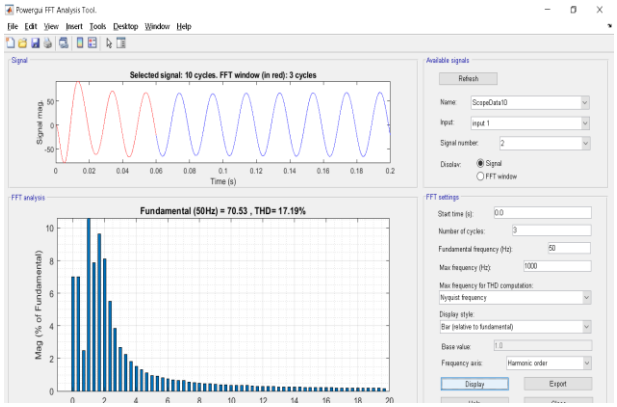


Figure 7:

For RLC load:



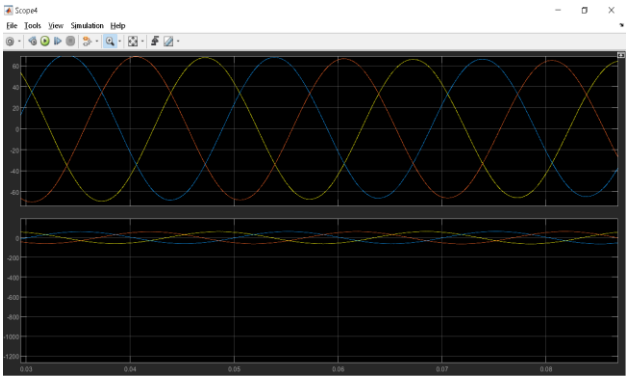


Figure 8:

CONCLUSION

A modified harmonic droop controller has been presented in this paper for a low voltage islanded micro grid Traditional droop controller performs in coordination with the modified harmonic droop controller to share harmonics equally in the existence of non-linear loads Proposed technique minimizes the voltage distortions at the PCC autonomously between different DG units without the information of line impedances. In smart grid micro grid and distributed generation plays a crucial role. So, controlling and maintaining stability of the micro grid and DG is important.

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