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Hybrid AC/DC Nanogrid Infrastructure to Reduce the Unbalanced Resulting in DC Distribution Network

D.Thamunaveni[1], Purushotham.S[2]

Post Graduate Student (PSE), Department of EEE, Sona College of Technology, Salem, Tamil Nadu, India[1]

Assistant Professor, Department of EEE, Sona College of Technology, Salem, Tamil Nadu, India[2]

ABSTRACT:A hybrid AC/DC infrastructure for residential homes (Hybrid Nanogrid) is in the foreseeable future. This paper presents a hybrid AC/DC home infrastructure which involves DC distribution network connected to the current AC infrastructure through an efficient AC/DC controlled converter. DC network in the home allows for efficient integration of renewable sources(solar) and electric vehicles supplying all the native DC loads , while the AC loads will continue to be connected to an existing AC infrastructure. In this paper, a control scheme for the AC/DC converter is proposed based on a modified synchronous reference frame for Active Power Filter control (APF) to mitigate harmonics, providing a power factor correction and compensating for unbalances resulting from nonlinear loads. The objective of the controller is to force the AC grid currents at the point of common coupling (PCC) to be balanced three-phase currents with minor harmonics while maintaining a controllability of power flow regardless of the characteristics of the local AC load. Reduce the unbalanced result and improved power quality at the PCC under various loading conditions.

KEYWORDS: Renewable energy, Active power filter, Power Factor Correction, Hybrid AC/DC Nano grid, Harmonics mitigation, Power factor improvement, Personal Computer.

I.INTRODUCTION

The power quality of electric power processing and delivery is gaining more attention. Bad quality of the electric power wears out the system equipment rapidly, increasing the cost of maintenance resulting in system failure or an inconvenient shutdown while leading to strong negative effect to environment. Nowadays, the unprecedented expansion usage of the native DC electrical equipment such as LED lighting, electric vehicles (EVs), consumer electronics (CEs) and computers put extra burden on the existing AC infrastructure. These DC loads require individual rectifiers to be connected to the ac distribution network to achieve two major jobs. One is to convert the energy from ac to dc to be appropriate to supply the dc load while the second is to work as power factor corrector. DC Nanogrids have a centralized rectifier to supply all dc loads offer a sensible solution for residential home network which replace the rectifiers. DC distributed network system for electrical energy transmission offers several advantages such as higher reliability, smaller footprint, lower costs, higher efficiency, as a result of not only a smaller number of conversion stages, but absence of skin effect and reactive power. Furthermore, most electronic loads, appliances, and variable frequency drives operate with DC voltage. For these reasons, the transition to a DC distribution low voltage network will be the efficient solution for future home. Reduce the unbalanced result and improve power quality. The results show that the developed controller succeeds to maintain bi-directional power flow controllability, while simultaneously acting as an active power filter to assure improved power quality at the PCC under various loading conditions.

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II.CONFIGURATION OF PROPOSED MODEL

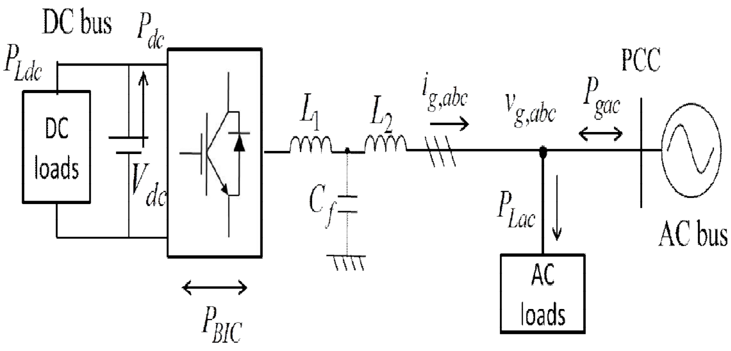

Fig.1.Schematic diagram of proposed model

Control scheme for the AC/DC converter is proposed based on a modified synchronous reference frame for Active Power Filter control to mitigation of harmonics, providing a power factor correction and compensating for unbalances resulting from nonlinear loads. The objective of the controller is to force the AC grid currents at the point of common coupling (PCC) to be balanced three-phase currents with minor harmonics while maintaining a controllability of power flow regardless of the characteristics of the local AC load. The results show that the developed controller succeeds to maintain bi-directional power flow controllability, while simultaneously acting as an active power filter to assure improved power quality at the PCC under various loading conditions.

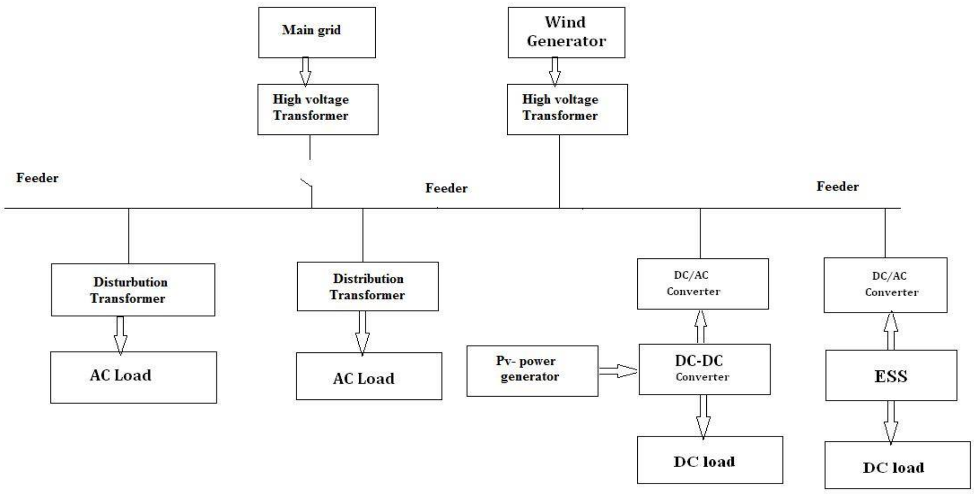

Fig.2.Proposed Block Diagram

Proposed block diagram advantage isit increases the efficiency of conversion, maximize the output power, the cost of the solar arrays and wind turbines is expected to decrease continuously in the future, making them attractive for residential and industrial applications.

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III.CONFIGURATION OF PV PANEL

The solar panel is best applied to a flat solar thermal collector, such as a solar hot water or air panel used to heat water, air, or otherwise collect solar thermal energy. But solar panel may also refer to a photovoltaic module which is an assembly of solar cells used to generate electricity.

Fig.3.PV panel

Solar-thermal panels saw widespread use in Florida and California until the 1920's when tank-type water heaters replaced them. A thriving manufacturing business died seemingly overnight.Solar-thermal are still in production, and are common in portions of the world where energy costs, and solar energy availability, are high.Recently there has been a surge toward large scale production of PV modules.Highfacilities, such as solar power plants typically contain an array of reflectors (concentrators), a receiver, and a thermodynamic power cycle, and thus use solar-thermal rather than PV.The largest solar panel in the world is under construction in the south of Portugal. A 52,000 photovoltaic module, 11-megawatt facility covering a 60-hectare south-facing hillside in the southern Alentejo region and it will produce electricity for 21,000 households.

A.Photovoltaic module

Fig.4. Photovoltaic module

A solar panel (photovoltaic module or photovoltaic panel) is a packaged interconnected assembly of solar cells, also known as photovoltaic cells. The solar panel is used as a component in a larger photovoltaic system to offer electricity for commercial and residential applications. Because a single solar panel can only produce a limited amount of power, many installations contain several panels. Crystalline silicon, which is commonly used in the wafer form in photovoltaic (PV) modules, is derived from silicon, a commonly used semi-conductor. connected electrically to one another and to the rest of the system protected from mechanical damage during manufacture, transport, installation and use (in particular against hail impact, wind and snow loads). This is especially important for wafer-based silicon cells which are brittle. Protected from moisture, which corrodes metal contacts and interconnects, (and for thin-film cells the transparent conductive oxide layer) thus decreasing performance and lifetime.

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B.PI Controller

PI controller will eliminate forced oscillations and steady state error resulting in operation of on-off controller and P controller respectively. However, introducing integral mode has a negative effect on speed of the response and overall stability of the system. Thus, PI controller will not increase the speed of response. It can be expected since PI controller does not have means to predict what will happen with the error in near future. This problem can be solved by introducing derivative mode which has ability to predict what will happen with the error in near future and thus to decrease a reaction time of the controller. PI controllers are very often used in industry, especially when speed of the response is not an issue. A control without D mode is used when

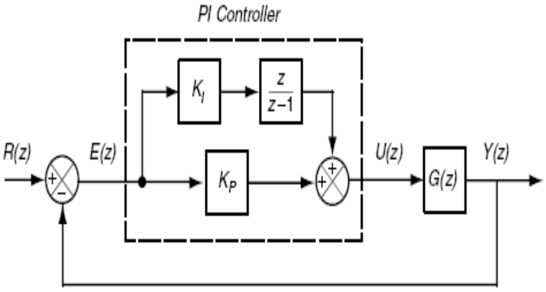

Fig.5.PI controller

The control actions of the proportional or integral controllers are based on thecurrent error or past errors. In derivative control the controller output is proportional to the rate of change of theerror. The idea behind derivative control is that the controller should react immediately to a large change in the control error;in essence, predicting that the error will continue to increase (or decrease) andact accordingly.

C.BI-directional converter

Most bidirectional DC-DC converter topologies can be illustrated as block diagram shown in the Fig.6 below and it also characteristics power flows in both directions [1-3]. Energy storages in general uses bidirectional DC-DC converter for charging and discharging applications may be either in half-bridge or full-bridge arrangement of semi-conductor switching devices. The buck type of converter has energy storage on the high voltage side, whereas boost type of converter has energy storage on the low voltage side.

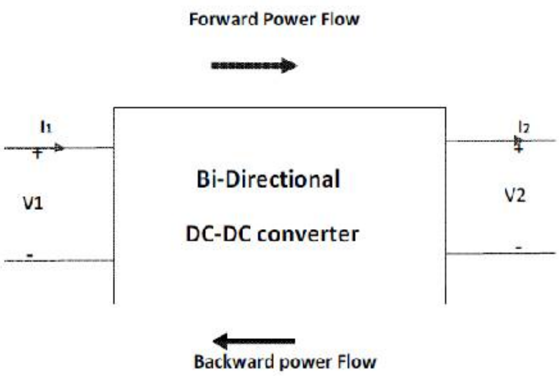

Fig.6.BI-Directional Converter

D.BOOST CONVERTER: (DC-DC CONVERTER)

A boost converter (step-up converter) is a power converter with an output DC voltage greater than its input DC voltage. It is a class of switching-mode power supply (SMPS) containing at least two semiconductor switches (a diode and a transistor) and at least one energy storage element. Filters made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce output voltage ripple.

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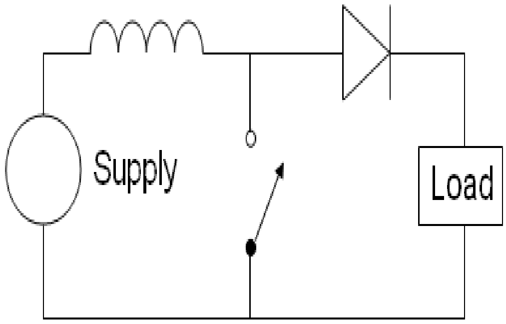

Fig.7. Boost converter

When a boost converter operates in continuous mode, the current through the inductor (IL) never falls to zero. The output voltage can be calculated as follows, in the case of an ideal converter (i.e. using components with an ideal behaviour) operating in steady conditions:
During the On-state, the switch S is closed, which makes the input voltage (Vi) appear across the inductor, which causes a change in current (IL) flowing through the inductor during a time period (t) by the formula:

$$\frac{\Delta I_L}{\Delta t} = \frac{V_i}{L}$$

At the end of the On-state, the increase of IL is therefore:

$$\Delta I_{L_{On}} = \frac{1}{L}\int_0^{DT} V_i dt = \frac{DT}{L}V_i$$

D is the duty cycle. It represents the fraction of the commutation period T during which the switch is On. Therefore D ranges between 0 (S is never on) and 1 (S is always on).

$$V_i - V_o = L\frac{dI_L}{dt}$$

Therefore, the variation of IL during the Off-period is:

$$\Delta I_{L_{Off}} = \int_0^{(1-D)T} \frac{(V_i - V_o)\,dt}{L} = \frac{(V_i - V_o)(1-D)T}{L}$$

$$E = \frac{1}{2}LI_L^2$$

So, the inductor current has to be the same at the start and end of the commutation cycle. This means the overall change in the current (the sum of the changes) is zero:

$$\Delta I_{L_{On}} + \Delta I_{L_{Off}} = 0$$

Substituting and by their expressions yields:

$$\Delta I_{L_{On}} + \Delta I_{L_{Off}} = \frac{V_i DT}{L} + \frac{(V_i - V_o)(1-D)T}{L} = 0$$

This can be written as:

$$\frac{V_o}{V_i} = \frac{1}{1-D}$$

This in turns reveals the duty cycle to be:

$$D = 1 - \frac{V_i}{V_o}$$

From the above expression it can be seen that the output voltage is always higher than the input voltage (as the duty cycle goes from 0 to 1), and that it increases with D, theoretically to infinity as D approaches 1. This is why this converter is sometimes referred to as a step-up converter.

E. Pulse-width modulation

Pulse-width modulation (PWM), or pulse-duration modulation (PDM), is a commonly used technique for controlling power to inertial electrical devices, made practical by modern electronic power switches.The PWM switching frequency has to be much faster than what would affect the load, which is to say the device that uses the power. Typically switching have to be done several times a minute in an electric stove, 120 Hz in a lamp dimmer, from few

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kilohertz (kHz) to tens of kHz for a motor drive and well into the tens or hundreds of kHz in audio amplifiers and computer power supplies.

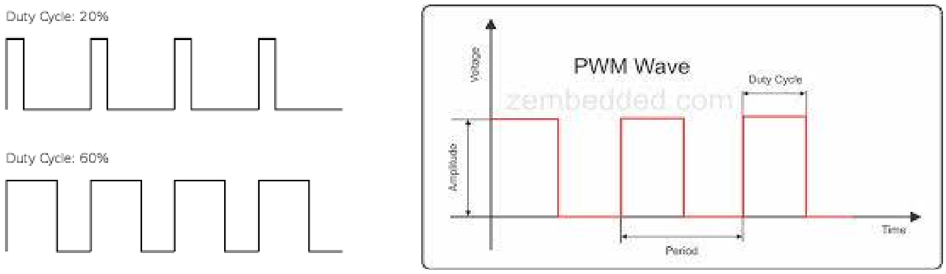

Fig.8.PWM wave

The term duty cycle describes the proportion of 'on' time to the regular interval or 'period' of time; a low duty cycle corresponds to low power, because the power is off for most of the time. Duty cycle is expressed in percent, 100% being fully on.The main advantage of PWM is that power loss in the switching devices is very low.

F.Inverter

An inverter is an electrical device that converts direct current to alternating current. A power inverter can be entirely electronic or may be a combination of mechanical effects and electronic circuitry the converted AC can be at any required voltage and frequency with the use switching, and control circuits. Static inverters have no moving parts and are used in a wide range of applications, from small switching power supplies in computers, to large electric utility high-voltage direct current applications that transport bulk power.

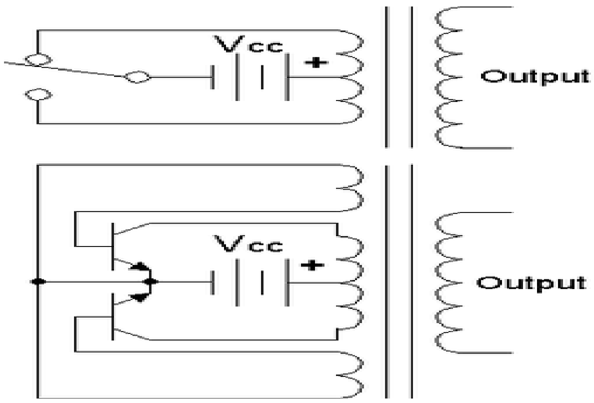

Fig.9.Inverter diagram

IV. MATLAB/SIMULATION RESULTS

These toolboxes are collections of m-files that have been developed for specialized applications. There is also a specialized application, Simulink, which is useful in modular construction and real time simulation of dynamical systems .The AC input voltage is first filtered. Then the output of the isolated converter is fed to the multiple winding transformer, the multiple output is rectified and filtered into four levels of voltage i.e.,+12V,+5V,+3.3V and -12V.

G. Simulation outputs

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AC load voltage and current

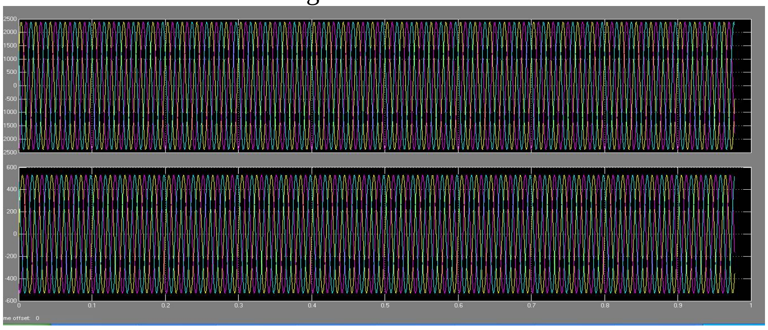

Fig.10.Output voltage and current

DC load voltage and current

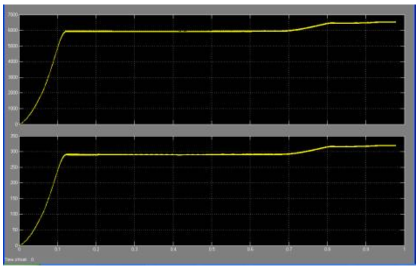

Fig.11.Output voltage

V.CONCLUSION

In this paper, a hybrid AC/DC Nano grid is proposed to offer a solution for the near future smart home. It consists of an AC and DC network and interlinking AC/DC converter connecting them. The linking converter was controlled by an intelligent controller based on modified SRF. This control technique enables the linking converter to act as APF in order to force the AC supply current at the PCC to be a balanced three phase current regardless the loading condition and the deterioration level of the local AC load current. Moreover, the controller provides harmonic mitigation and power factor correction at the PCC. A model for the APF and its controller is built in MATLAB/Simulink. Different loading conditions were simulated to verify the effectiveness of the system. Simulation results show that the controller deals successfully and automatically with various severe power quality issues isolating

REFERENCES

[1] M. Morcos and C. Gomez, “Electric power quality - The strong Connection with power electronics,” in IEEE Power Energy Mag., Sep. 2003, vol. 2003, no. 5, pp. 18–25.
[2] B. H. Chowdhury, “Power quality,” IEEE Potentials, vol. 20, no. 2, pp. 5–11, Apr/May 2001.
[3] E. Waffenschmidt and U. Boeke, “Low voltage dc grids,” in Proc. 35th Int. Telecomm.Energy Conf. ’Smart Power Efficiency’, Oct. 2013, pp. 1-6.
[4] S.Purushotham, Mr. S. Gunasekaran ,Simulation of Constant Current Controller For PV Solar Integrated With The Grid , International journal of applied engineering research (IJAER), 9, 22, Page 6,899 6,907, 01 Aug 2014.
[5] S.Purushotham, J.Preethi, Harmonic Mitigation in Standalone PVSystem for Three Phase System, International Journal of Engineering trends and Technology (IJETT) – Volume 34 Number 6- April 2016,Page 252.
[6] Sannino, G. Postiglione and M. H. J. Bollen, “Feasibility of a DC networkfor commercial facilities,” IEEE Trans. on industry applications, vol 39, no. 5, pp. 1499-1507, September/October 2003.
[7] B. Wunder, L. Ott, M. Szpek, U. Boeke, and R. Weis, “Energy efficient dc-grids forcommercial buildings,” in Proc. IEEE 36th Int Telecommun.Energy Conf., Sep. 2014, pp.1–8.
[8] A. Mohamed, A. Ghareeb, T. Youssef and O. A. Mohammed, "Wide Area Monitoring and Control for Voltage Assessment in Smart Grids with Distributed Generation," Accepted to be Published in the Proc. of the 2013 PES Innovative Smart Grid Technologies Conference (ISGT), Washington, D.C., USA, 24-27 Feb 2013.
[9]Nilsson and A. Sannino, “Efficiency analysis of low and Medium voltage dc distribution systems,” IEEE PES General Meeting, 2004.
[10] Sannino, G. Postiglione and M. H. J. Bollen, “Feasibility of a DC network for commercial facilities,” IEEE Trans. on industry applications, vol. 39, no. 5, pp. 1499-1507,September/October 2003.