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High Efficiency Dc-Dc Converter for Renewable Energy application (solar, wind and rain water)

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ABSTRACT In modern world electricity is the most wanted one. Without electricity no one will accomplish the normal work. So the power demand is very high. Various types of conventional resources are used to produce the electricity to overcome the power demand. Nowadays conventional resources are not sufficient to overcome the power demand. Also steam power plant and nuclear power plant causes pollution and lack of fuels. So the recent severe energy emergency has forced the world to develop new innovative methods of power generation. Renewable sources like solar, wind, hydro and others are used to solve the power demand. But renewable sources are produced low voltages output. To handle above issues, this paper elucidates about generation of power from solar, wind and rain water with high voltage gain using dc-dc converter. MATLAB simulation is used to get outputs.

KEYWORDS : dc-dc converter, High Voltage gain, Renewable sources, conventional resources and MATLAB.

Introduction

In the last few consecutive years, there has been an excessive increase in the demand for electricity. The lack of non-conventional sources is the reason for power demand issues. The non-conventional have polluted the atmosphere to a great extent. The nuclear energy may produce hazards radiation in case it is not properly controlled. These factors have leaded the world to renewable energy sources. So the use of non-conventional sources like steam power plant, nuclear power plant and fossil fuels are totally replaced by the renewable resources. The solar, wind and rain water play a major role among the existing renewable sources poses major challenges such as:

- Finest consumption of the sources due to their non-linear characteristics. Example: Maximum power point Tracking (MPPT) algorithm is needed to track the maximum available of power from solar.
- Due to safety issues, they are usually operated at low output voltage levels (12 V to 50 V). This makes some difficulties for grid connected system or stand-alone loads application. Because grid connection and stand-alone loads are need high voltage.

A suggestion of above points is that the use of a special dc-dc converter is essential. Because conventional dc-dc converter produces high losses, conduction losses and diode reverse recovery become major concern. In this view, there is clearly need to build up and use special high gain, high efficiency dc-dc converters for MPPT and step up the voltage level. The following circuits are used to achieve high voltage at the converter (Das Moumita & Vivek Agarwal, May 2016).

- Direct voltage step-up using high frequency transformer.
- Use of coupled inductor to increase the voltage level using turns ration.
- Active and passive clamp circuits to recovery leakage energy.
- Use of intermediate energy storage capacitors as additional buffers to increase the voltage gain.
- By varying the duty cycle of the converter (Das Moumita & Vivek Agarwal, May 2016).

Solar energy

Solar play an important role in electricity generation because solar energy is the most readily available source. Energy from the sun is the best decision for electricity generation as it is available everywhere and it is free to harness. The average sun light hour in India is about 6 hours also the sunlight in India for about 9 months in a year. Earth surface receives 1.2×10^{17} Watts of power from the sun. Energy supplied by the sun in one hour is nearly equal to the amount of energy required by the human population in one year. The solar energy is directly converted into electricity by solar photovoltaic modules (SPV). In this paper nearly 12V supply is generated by solar photovoltaic modules (SPV) (Shammi Bahel, Harinder Singh & Ravinder Kumar, November 2015).

The main disadvantage of solar power is that it clearly cannot be created during the night time. The power generated is also reduced during times of rainy seasons or cloudy time. Even today most efficient solar cells only convert just over 20% of the sun rays to electricity (Damaschke Nate).

Wind energy

Wind energy is a free energy resource from the nature. But is much irregular than solar. Wind power systems convert kinetic energy of the wind into electricity. In wind power system, the power generation increases in proportion to the cube of the wind speed. Wind power generation is also pollution free and economically balanced (Sivaramakrishna N, Kasi Ramakrishna Reddy Ch, May 2013). Wind energy conversion is simple concept, but turbine design can be quite difficult. Simple wind turbine uses a horizontal axis configuration with two or three blades, a generator and a tower to support rotor. Working speeds of wind are between 5 m/s and 15 m/s. wind speeds may vary within minutes and affect the power generation and in case of high speeds may result in overloading of generator. The main disadvantage is we can not the judge the winds. The turbines are takeout 59% of the generated wind's power. This shows that, wind farms are insufficient at the static moment (Matthew Johnson, June 9, 2014).

Rain Water

The potential energy of rain has certain potential in power generation. In the water cycle, water evaporates via solar energy and gains potential energy that is then lost again when the rain fall. This cycle of evaporation, rain, turbine, provides a mechanism for the conversion of solar into electrical energy. At best, the amount of electrical energy that can be generated is equal to the potential energy of the rain. Trapping rain, storing it, and running it past a turbine is one mechanism of converting the energy of rainfall into electricity. Another option that can be used in tandem is to capture the kinetic energy of the rain directly. This can be done using piezoelectricity, where crystals convert mechanical motion into electricity. Again making the unrealistic assumption of perfect conversion, the amount of kinetic energy in an object is half the mass times the velocity squared (Curt Harting , November 28, 2010) & Zhicheng Huang (2016). The velocity of rain is limited by air resistance and typically has a maximum of around 8 m/s (Gunn R and Kinzer G D). Doing the calculation, the amount of kinetic energy

falling on a 185 m^2 roof is about 59.2 kJ (0.016 kWh) per cm of rain. This is only about 1.6 kWh of energy per year in an area that receives a meter of rain per year (Kanth Phani P, Ashwani & Sharma Sajeev, 2012).

Solar, Wind and rain Water – Integrating power generation system

The above mentioned drawbacks of individual renewable power generation system like Solar or Wind or Rain Water etc, in this paper we design a new electricity or power generating system is eliminated by integrating all the renewable power sources available from natural resources simultaneously, so that power supply remains continuous without any sort of interruptions and high gain voltage produced. This Solar-Rains-Wind energy integrating power generation system can produce enough amount of power for household as well as commercial purposes and for grid in all times. Thus, above mentioned resources are not to depend on certain natural condition i.e. the sun or the rains or the wind speed at all. If the sun does not appear throughout a day or appear for lesser time in a day, then the probability of appearing rains are too much high in that day and most of the cases the rains fall in that day. Therefore, we consider that there are two conditions of environment in a day, i.e. either the summer seasons or the rainy seasons. Also in the rainy seasons, generally wind flow is higher. Therefore, these three natural sources are intelligently used for power generation. So, we integrate all the resources in the nature like Solar, Rains and Wind in a unique way. If we take average of two consecutive days, [generally, at present solar power system, full charged battery or storage circuit may not supply the requisite power to the load more than two consecutive days], then these two conditions i.e. the summer season or the rainy season will appear in major time period and in between these two conditions, cloudy time remains very short period i.e. cloudy time (when there is no sun or no rains) can be overlooked in a day(Pijush Kanti Bhattacharjee,April,2010). If we able to supply electricity to the load or charge the battery or store electrical power during the rainy times, we have the power sources without interruptions and dc-dc converter is also used to produce high voltage gain to overcome the power demand.

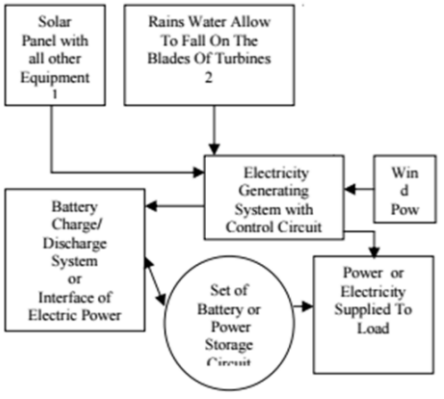
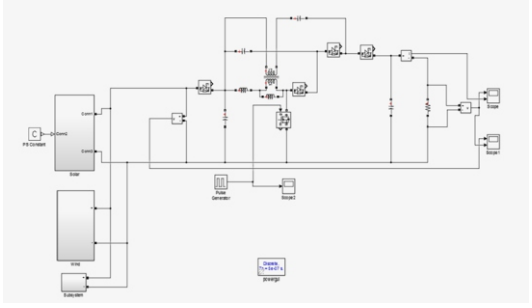
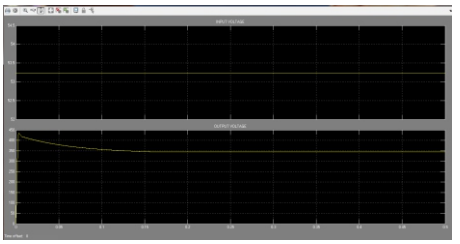


Figure 1: Block diagram of integrating renewable resources

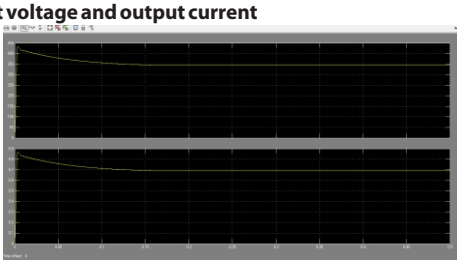
MATLAB Circuit diagram & Waveforms



Input voltage and Input Current



Output voltage and output current



Conclusion

This paper presents a power generation using solar, wind and rain water. By using the renewable sources, the proposed system is suitable for the long-term application with long service. This hybrid renewable energy source will be highly effective in all places. It is pollution free and used to minimize the power usage from grid. Moreover there is no power interruption and the output of renewable sources boosted up to 440V Using dc-dc converter-duty cycle methods and MPPT algorithm. MATLAB software is used to give the various stage outputs. This method is used to overcome the power demand issues. The high gain, high efficiency converter proposed in this paper is highly suitable for low output voltage sources.

References

1. Ben Coxworth(March 27,2014)., Rainwater used to generated electricity., Retrieved from http://newatlas.com/pluvia-rainwater-microturbine/31379.
2. Curt Harting (November 28, 2010)., Rainfall as an Energy Source.,
3. Retrieved from http://large.stanford.edu/courses/2010/ph240/harting2.
4. Damaschke Nate., Retrieved from http://www.tc.umn.edu/~dama0023/solar.html
5. Das Moumita, Vivek Agarwal (May, 2016)., Design and Analysis of a High Efficiency DCDC Converter with Soft Switching Capability for Renewable Energy Applications Requiring High Voltage Gain., IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS., Volume:63, Issue:5.,Retrieved from http://ieeexplore.ieee.org/document/7374681.
6. Gunn R and Kinzer G D., The Terminal Velocity of Fall for Water Droplets in Stagnant Air. J. Atmosph. Sci. 6, 243 (1949).
7. Kanth Phani P, Ashwani & Sharme sajeev., House Hod Power Generation Using Rain Water., The International Journal of Science and Engineering., Volume 1, Issue 2,Pages:77-80, 2012.
8. Matthew Johnson (June, 2014)., Retrieved from https://blog.udemy.com/disadvantages-of-wind-energy.
9. Pijush Kanti Bhattacharjee(April,2010)., Solar-Rains-Wind-Lightning Energy Source Power Generation System., International Journal of Computer and Electrical Engineering, Vol. 2, No. 2, April, 2010 1793 8163.
10. Shammi Bahel, Harinder Singh & Ravinder Kumar (November, 2015)., Distributed Generation using hybrid model of Solar, Wind and Small Hydro Plant: A Review., International Journal on Emerging Technologies (Special Issue on RTIESTM-2016) 7(1): 63 67(2016)., (Published by Research Trend, Website: www.researchtrend.net .
11. Sivaramakrishna N, Kasi Ramakrishna Reddy Ch (May,2013)., Hybrid Power Generation through combined solar –wind power and modified solar panel., International Journal of Engineering Trends and Technology (IJETT) - Volume4,Issue5.
12. Xu Dongwei, Ning houfei & Zhang yongbin., A new technology of high rise rainwater power generation based on the concept of cross flow generation., SHANXI ARCHITECTURE.Vol.40, No.31 Nov. 2014.
13. Zhicheng Huang (2016)., The research on rainwater power generation system., 5th International Conference on Advanced Materials and Computer Science (ICAMCS 2016).,China.