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An Review on Recent Developments in CUK Conversion Technology for Self-Sustained Solar/Wind Systems

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Abstract: A bidirectional DC-DC CONVERTER is used to convert DC power to DC power. There are two full-bridge converters, one of which acts as an inverter and the other as a rectifier. This dc-dc converter is perfect for use in battery-powered automobiles. Some of the system's benefits include soft switching implementation without extra devices, great efficiency, and a simple control. The suggested setup consists of a DC load, an ESS (Fuel Cell), and a battery. The Fuel Cell acts as a storage medium for energy, which may be either charged or discharged to keep the PV/battery hybrid power system's power output in check. The PV and load are connected through a phase-shift full-bridge DC-DC converter, which includes an integrated bidirectional buck/boost converter. Using a fuel cell, the AC power is transformed into DC power. Medium and high power applications need converters that are lightweight, compact, and extremely efficient. These applications include fuel cell cars and power generating. There must be a converter. Pulses are being generated via pulse width modulation..

Keywords: Fuel cell, Photo voltaic cell, Inverter, PIC Micro Controller, MOSFET devices.

Introduction

Renewable and eco-friendly energy may be produced using natural resources such as solar photovoltaic systems and wind turbines. It's encouraging to see it making strides, but the challenges of wind and PV integration are clear. Energy needs are met using a hybrid of wind and photovoltaic (PV) systems. To convert solar energy into electrical energy, the PV array creates DC output voltage while the wind turbine generates AC output voltage. Renewable energy sources that rely on the sun and wind have become the norm. Make use of RES (renewable energy sources) to produce electrical power. Wind and PV systems have been combined to provide sufficient power. The output power of wind and solar systems may be controlled with the use of power conditioners. It's stored in batteries. The extra energy is sent back into the grid. High load demands from the wind turbine necessitate drawing electricity from the battery or perhaps the grid. Power electronic equipment is used to convert, regulate, and transmit power between the PV and wind energy systems as well as to monitor and manage the power. The power quality is the most crucial aspect of the overall power system. In order to increase the system's effectiveness, performance, and longevity, it is essential that

the generating, transmission, and distribution sectors all work together to preserve power quality. Therefore, it is necessary for renewable energy systems like wind and photovoltaic (PV) systems. Power quality is achieved when a power system's current and voltage are kept at or very close to their rated values. The pace at which the world's energy supplies are being used up is frightening. A drastic expansion in the usage of renewable energy sources in the current micro grid is an imperative requirement in view of the worrisome situation of global warming and growing emissions. Hybrid electricity is produced in the project using PV and wind energy technologies. The primary goal of the hybrid power production is to enhance power quality. The produced DC power is sent into an inverter, where it is transformed into AC power and utilised to power an AC load. If there is excess power, it may be sold back to the grid. In order to enhance the power quality, multilevel inverter controllers are used. Utilities in various countries implement harmonic norms and recommendations to reduce the amount of current distortion in the grid.

Because of the severe repercussions of using traditional converters, the usage of simple diode rectifiers is discouraged. Rectification with minimal input current distortion and near-uniform power factor is urgently needed. Concern about the planet's future has increased the market for eco-friendly automobiles in recent years. Fuel cells can now be used to power electric cars, thanks to recent developments in the field and in power electronics. Fuel cells provide several benefits, such as efficient operation, little environmental impact, and high current density. However, the fuel cell is quite similar to the standard battery that runs on chemicals. The fuel cell's output voltage drops rapidly when it is initially connected to a load, but it reduces more gradually as the output current rises. The fuel cell also can't be used to store energy. Therefore, electric vehicle applications will always need supplementary energy storage devices (i.e., lead-acid batteries) for cold starts and to absorb energy produced by the electric machine. Starting the car also needs a DC-DC converter to take power from the supplemental battery. If the fuel cell voltage isn't high enough to sustain the high-voltage bus, the battery will start discharging its extra charge. The recovered braking energy may be stored in the battery using the dc-dc converter. An isolated bidirectional dc-dc converter with a complete bridge is one viable alternative.

Literature Review

Shaorong Wang and Muhammad Tajamul Aziz have published "PV-Wind-Battery Based Standalone Microgrid System with MPPT for Green and Sustainable Future" in IEEE [01] in 2019. Modeling hybrid power generation using various power electronics devices in Simulink has been explained in this paper.

Yasser Abdel-Rady and Amr Ahmed A. Radwan says that In this study, we offer novel topologies for wind and PV cogeneration systems that can link to the grid. They are straightforward yet efficient. Voltage-source converters (VSCs) are used to link a large-scale wind turbine to the public power grid.

Pooja Patel, Dr. Vijay Bhuria,. Using hybrid power generation with grid interconnection, this paper explains the various power quality issues and how to address them.

Ravikumar S and Dr. H Vennila In this study, we offer a novel approach to maintaining consistent voltage while supplying clean energy. The voltage from the wind energy conversion system (WECS) and the solar panels is converted using DC DC converters, which are individually regulated and coupled to a shared DC bus. The new controller uses a PI controller in conjunction with an adaptive Honey Bee Optimisation (HBO) algorithm to maintain a constant voltage. The suggested technique is accomplished using the Simulink environment..

Akshay B. Zade, Asha Gaikwad, Prachi M. Jeevane, and Ganesh Lohote. In the research, simulation and hardware analysis of a hybrid solar and wind energy system are used to solve several power quality concerns, including sag, swell, source voltage, source current, and THD %. The simulation findings suggest that a seven-level inverter may be utilised as a controller to enhance power quality. The article examines the outcomes of constructing a prototype model for single-phase supply.

Varun Kumar, A.S. Pandey, S.K. Sinha, This study reviews the role of flexible AC transmission systems in addressing grid integration and power quality concerns that arise when renewable energy technologies are added to the grid. In addition, current advances in power electronics for the combination of wind and PV generators are reviewed. Technologies on Earth and beyond may be impacted by our planet's magnetosphere, for instance. The Sun's coronal mass ejections, solar flares, and solar wind are all sources of radiation and particles. The magnetosphere and upper atmosphere of Earth allow for the employment of GICs in cutting-edge technology that allows humans to travel to other planets in the solar system. Coronal holes, solar flares, and coronal mass ejections (CMEs) are all connected to the sun's 11-year cycle. This cycle is visible from a wide range of solar vantage points. These magnetically complicated and fleeting sunspot zones last for just a few months at a time.

BUCK CONVERTER

The existing power system is not immune to the widespread issue of poor power quality. However, there are a number of challenges associated with adding wind and PV systems to the grid. Problems like this are hard to address. The most prevalent power quality issues are voltage and frequency variations and harmonics. Voltage and frequency changes are caused by the intermittent nature of renewable energy sources, which cannot be controlled. The usage of power electronics in renewable energy production results in the creation of harmonics. Passive filters set to the necessary harmonic frequency were traditionally used for this purpose. Flickering and sudden voltage shifts are symptoms of voltage fluctuation. Passive filters were simple, cheap, and efficient, and they could compensate for reactive power at the fundamental frequency.

Interactions with the utilities and other local loads are one of the downsides. When the line's load varies or there are switching transients, it also performs poorly. Other problems include parallel resonance with network impedance, reactive power overcompensation, and a lack of dynamic compensation flexibility. Planned Construction

Grid-connected wind energy is one of the options proposed. A multistage converter connects the solar electricity to the grid. In order to use the dc power produced by solar panels, an inverter with adjustable output levels is necessary. Connecting the system to a multilayer inverter allows the DC solar electricity to be converted into AC power that is compatible with the grid. In certain cases, the Total Harmonic Distortion (THD) at the Point of Common Coupling (PCC) may be reduced by using a multilayer inverter. Total harmonic distortion (THD) may be lowered by using multi-level inverters. Fewer switches result in a more efficient waveform when creating a multilayer inverter. Everyday life may now be accessed online. The proposed installation would not use the MPPT technology since a boost converter would be used to increase the output of the solar panels.

Almost all of the devices we rely on in our daily lives cannot function without constant access to energy. Therefore, it is now an integral part of our daily routine. The generation of electricity may now be accomplished in one of two ways: either via the use of nonrenewable energy sources or renewable energy sources. Electricity use has been rising at an exponential rate with population and technological growth. We also need to boost power generation to

keep up with rising demand from a growing population. One major drawback of using traditional resources is the pollution they generate. For example, coal power plants produce ash, diesel power plants produce smoke, and nuclear power plants produce radioactive material. Keeping these toxins in check is a difficult and expensive endeavour. We need to immediately begin exploring other means of generating power. The most effective strategy is to switch to alternative energy sources. Solar and wind power are the most efficient alternatives to traditional energy generation. Ocean thermal energy can be utilised in the middle of the sea, but tidal energy can only be used on the sea's beaches, and its installation is just as challenging. The resources necessary to put up a solar or wind power plant are minimal, and these sources of energy are accessible everywhere on Earth. Solar energy is only used during the middle of the day, for around 8 hours; in contrast, wind may be harnessed for power almost nonstop. But if we combine these two, we can make up for that shortcoming. Both may be used simultaneously during fine weather, but only one can be utilised during bad weather. This study, therefore, will explain how a hybrid solar-wind energy system works.

Solar Energy Energy derived from the sun is known as solar energy. It is non-polluting and infinitely renewable. It doesn't cost anything to use. Since the sun shines for almost 300 days a year in India, solar power is a practical method of generating energy there. Solar power plants need little initial investment and are simple to maintain. Also, the system is fairly efficient. Its primary benefits are a long service life and low pollution output.

Wind Energy The kinetic energy of moving air, or wind, is what's referred to as wind energy. A wind turbine uses the wind's kinetic energy to turn a mechanical shaft, which in turn turns a generator, generating electricity. The price at which power may be generated is rather low. The initial cost of the system is variable according on the kind of turbine used. Since wind blows almost continuously throughout the day, the generation of power from wind energy is reliable and uninterrupted. Output is proportional to wind velocity.

Hybrid Systems This has piqued our interest in exploring renewable energy as a viable power generation option. Hybrid systems combine renewable energy sources like solar panels and wind turbines to charge batteries that may be sent to nearby power plants. In this setup, a wind turbine may be utilised to generate power whenever wind is available, and solar panels can be used whenever sunlight is abundant. Both halves may produce energy simultaneously if necessary. Batteries are used to provide a constant flow of energy at all times. The initial cost of this technology is rather considerable. This drawback is outweighed by the product's dependability, longevity, and low maintenance requirements. A rectifier is used to convert the alternating current (AC) electricity produced by the wind turbine into direct current (DC). A 'SEPIC' converter, which employs MOSFET switching, may be used to increase or decrease the voltage. Switching between converters is managed by the microcontroller with the aid of a driver circuit. A CUK converter regulates the solar array's power output..

Block Diagram

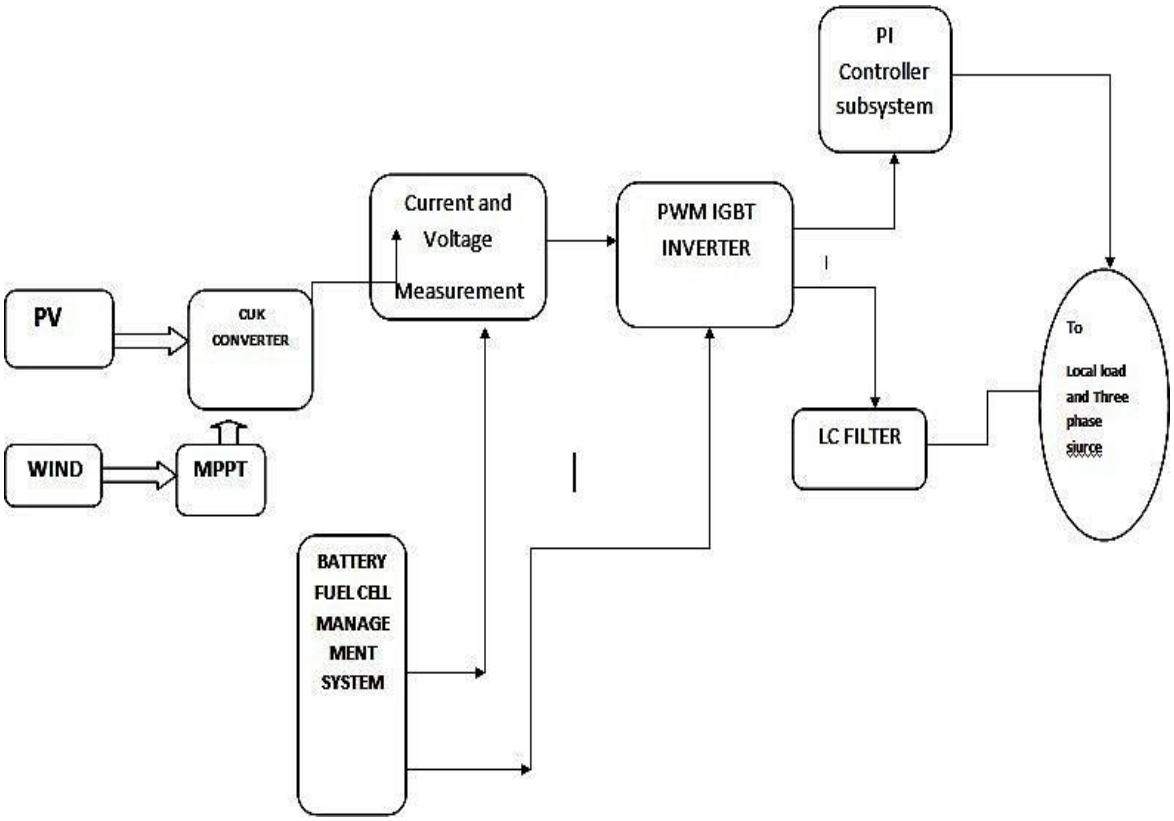

Figure 1.Block diagram of Overall system

Power grids throughout the globe need to be adaptable, dependable, and able to accommodate future growth. Grids must be modernised to accommodate the growing share of renewable and decentralised energy sources. The most important component of any system is the power electronic inverter to which it is attached. Inverter design innovations are required to keep up with the expanding needs of smart grids. The modular inverter design is a cutting-edge approach to engineering for robust buildings of the future. A contemporary inverter, being modular in nature, may accept power from both AC and DC renewable sources.The Cuk-converter relies on the elimination of harmonics, which is achieved in part by including an inductor in the circuit. The Inverter helps the system reconfigure itself despite the battery fuel cell's inconsistent current and voltage.

All of the Renewables have to be online constantly for the system to work. It has passed rigorous testing under a wide range of input parameters. A highly efficient inverter of any size, components, design, and operating mode is the result of the process outlined here.

Conclusion

Creating hybrid systems using a cuk converter is a practical and efficient alternative to using non-renewable energy sources to generate power. It saves money without negatively impacting the environment. In addition, it may be utilized to produce energy in mountainous regions, where it is difficult to transport power via more traditional means. Its configuration is up for grabs, depending on the situation. Everyone on Earth should be encouraged to employ alternative energy sources to generate power so that they may become more self-

sufficient. Its benefits include a lengthy service life and low maintenance requirements. It merely needs a substantial outlay of cash to get started..

References

1. Habib Ur Rahman Habib, Shaorong Wang, Muhammad Tajamul Aziz, "PV-Wind-Battery Based Standalone Microgrid System with MPPT for Green and Sustainable Future", 2019 IEEE.
2. Amr Ahmed A. Radwan and Yasser Abdel-Rady I. Mohamed, "Grid- Connected Wind-Photovoltaic Cogeneration Using Back-to-Back Voltage Source Converters", IEEE Transactions on Sustainable Energy, 2019.
3. Adhiya N N, Nayana G S Nair, Silindas C, Remanikanth S, "Hybrid power generation using dual axis solar tracking system and wind energy system", International Journal of Advance Research, Ideas and Innovations in Technology, Volume 4, Issue 3, pp 2381-2384, 2018.
4. Pooja Patel, Dr. Vijay Bhuria, "Power Quality Issues in Grid Integrated Solar and Wind Hybrid System: A Review", International Journal of Engineering Development and Research, Volume 6, Issue 3, pp 505-509, 2018.
5. Ravikumar S and Dr. H Vennila, "Hybrid Wind Solar System for Efficient Power Generation", International Conference on Electronics, Communication and Aerospace Technology, 2017 IEEE.
6. Lalit Yashwant Bacchav and Dr. Asha Gaikwad, "MATLAB Implementation of Standalone Hybrid Wind-Solar Power Generation with and Without Dump Power Control", International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS-2017), pp 3069-3073, 2017 IEEE.
7. Akshay B. Zade, Asha Gaikwad, Prachi M. Jeevane and Ganesh Lohote, "Hybrid Solar and Wind Power Generation with Grid Interconnection System for ImprovingPower Quality", 1st IEEE International Conference on Power Electronics, Intelligent Control and Energy Systems, pp 1-6, July 2016.
8. R.Karthick, S.Manoharan, "grid interconnection of hybrid power system with power quality improvement features", International Journal of Advanced Engineering Technology, Vol. VII, Issue I, pp 121- 124, Jan-March 2016.
9. Varun Kumar, A.S. Pandey, S.K. Sinha, "Grid Integration and Power Quality Issues of Wind and Solar Energy System: A Review", International Conference on Emerging Trends in Electrical, Electronics and Sustainable Energy Systems, pp 71- 80, 2016 IEEE.
10. N. Kumar, I. Hussain, B. Singh, and B. K. Panigrahi, ''Selfadaptive incremental conductance algorithm for swift and ripple-free maximum power harvesting from PV array,'' IEEE Trans. Ind. Informat., vol. 14, no. 5, May 2018.
11. A. El Khateb, N. A. Rahim, J. Selvaraj, and M. N. Uddin, ''Fuzzylogiccontroller-based SEPIC converter for maximum power point tracking,'' IEEE Trans. Ind. Appl., vol. 50, no. 4, Jul./Aug. 2014. [12] W. M. Lin, C. M. Hong, and C. H. Chen, ''Neural-network-based MPPT control of a stand-alone hybrid power generation system,'' IEEE Trans. Power Electron., vol. 26, no. 12, Dec. 2011.

12. R. B. A. Koad, A. F. Zobaa, and A. El-Shahat, ‘‘A novel MPPT algorithm based on particle swarm optimization for photovoltaic systems,’’ IEEE Trans. Sustain. Energy, vol. 8, no. 2, Apr. 2017.
13. K. Sundareswaran, S. Peddapati, and S. Palani, ‘‘MPPT of PV systems under partial shaded conditions through a colony of flashing fireflies,’’ IEEE Trans. Energy Convers., vol. 29, no. 2,2014.
14. K. Sundareswaran, P. Sankar, P. S. R. Nayak, S. P. Simon, and S. Palani, ‘‘Enhanced energy output from a PV system under partial shaded conditions through artificial bee colony,’’ IEEE Trans. Sustain. Energy, vol. 6, no. 1, Jul. 2015.
15. N. Priyadarshi, P. Sanjeevikumar, L. Mihet-Popa, F. Blaabjerg, and F.Azam,‘‘MaximumpowerpointtrackingforbrushlessDCmotor-driven photovoltaic pumping systems using a hybrid ANFIS-FLOWER pollination optimization algorithm,’’ Energies, vol. 11, no. 5, Apr. 2018. [
16. S. Mohanty, B. Subudhi, and P. K. Ray, ‘‘A grey wolf-assisted perturb & observeMPPTalgorithmforaPVsystem,’’IEEETrans.EnergyConvers., vol. 32, no. 1, Mar. 2017. [18] N. Priyadarshi, S. Padmanaban, P. K. Maroti, and A. Sharma, ‘‘An extensive practical investigation of FPSO-based MPPT for grid integrated PV system under variable operating conditions with an tiislandingprotection,’’ IEEE Syst. J., vol. 13, no. 2, Jun. 2019.
17. N. Kumar, I. Hussain, B. Singh, and B. K. Panigrahi, ‘‘Rapid MPPT for uniformly and partial shaded PV system by using JayaDE algorithm in highly fluctuating atmospheric conditions,’’ IEEE Trans. Ind. Informat., vol. 13, no. 5,Oct. 2017.
18. C. Huang, L. Wang, R. S.-C. Yeung, Z. Zhang, H. S. Chung, and A. Bensoussan, ‘‘A prediction model-guided Jaya algorithm for the PV system maximum power point tracking,’’ IEEE Trans. Sustain.Energy