



iJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 Issue: III Month of publication: March 2018

DOI: <http://doi.org/10.22214/ijraset.2018.3328>

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A Study on Importance of Power Electronics-Based Drives & Renewable Energy Sources and their Consumption

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Abstract: *The global energy consumption is still rising and the demand to increase the power capacity for the production, distribution. The power electronics has main role in last decades. There will be incredible applications of power electronics in the area of the industrial, residential, commercial, transportation, aeronautics, military and electric utility systems. Power electronics will have increasing impact not only in global industrial automation and high efficiency energy systems, but also on energy conservation, renewable energy systems, and electric vehicles. In this paper we will discuss global energy resources, power electronics-based drives & renewable energy resources, and their consumption. The importance of power electronics in energy efficiency improvement, renewable energy systems, electric vehicles and energy storage will be discussed. The Characteristics of power electronics interface is subject to requirements related not only to the renewable energy source itself but also to its effects on the power-system operation, especially where the intermittent energy source constitutes a significant part of the total system capacity It will then review several applications before concluding.*

Keywords: *Power Electronics, Global Energy Resources, Energy Consumption, Energy Storage.*

I. INTRODUCTION

The increasing number of renewable energy sources and power electronics-based technologies using power devices to convert efficiently electric power into the optimum characteristics. To improving the energy efficiency and performance of various equipment, power electronics contributes to the realization of both a prosperous and comfortable way of life and a sustainable society [1]. It is an emerging technology is multidisciplinary in its nature and the design and analysis of power electronics circuits include the applications of circuit theory, electronics, control theory, electromagnetics, semiconductor devices, microprocessors, numerical methods, signal processing, computer simulation, heat transfer, electromagnetic compatibility, and artificial intelligence. In classical power systems, large power generation plants produce most of the power, which is then transferred towards large consumption centers over long distance transmission lines. The system control centers monitor and regulate the power system continuously to ensure the quality of the power, namely frequency and voltage. However, now the overall power system is changing, many dispersed generation (DG) units, including both renewable and non-renewable sources such as wind turbines, wave generators, photovoltaic (PV) generators, small hydro, fuel cells and gas/steam powered Combined Heat and Power (CHP) stations, are being developed [2], [3] and installed. Energy is a critical need in every human endeavor. The capabilities and flexibility of modern electronics must be brought to bear to meet the challenges of reliable, efficient energy. It is essential to consider how electronic circuits and systems can be applied to the challenges of energy conversion and management. This is the framework of power electronics, a discipline defined in terms of electrical energy conversion, applications, and electronic devices. Power electronics involves the study of electronic circuits intended to control the flow of electrical energy. These circuits handle power flow at levels much higher than the individual device ratings. Rectifiers are probably the most familiar examples of circuits that meet this definition. Inverters (a general term for dc-ac converters) and dc-dc converters for power supplies are also common applications. Figure 1 shows the representation of power electronics [4]. Power electronics must be placed on a level with digital, analog, and radio-frequency electronics to reflect the distinctive design methods and unique challenges.

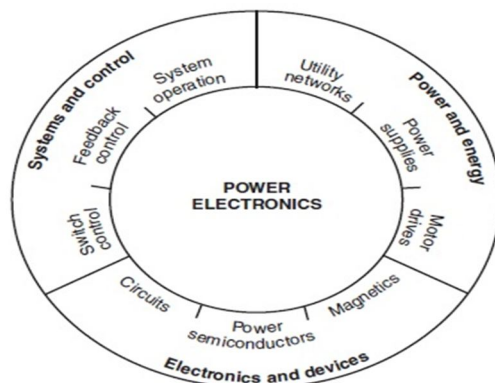
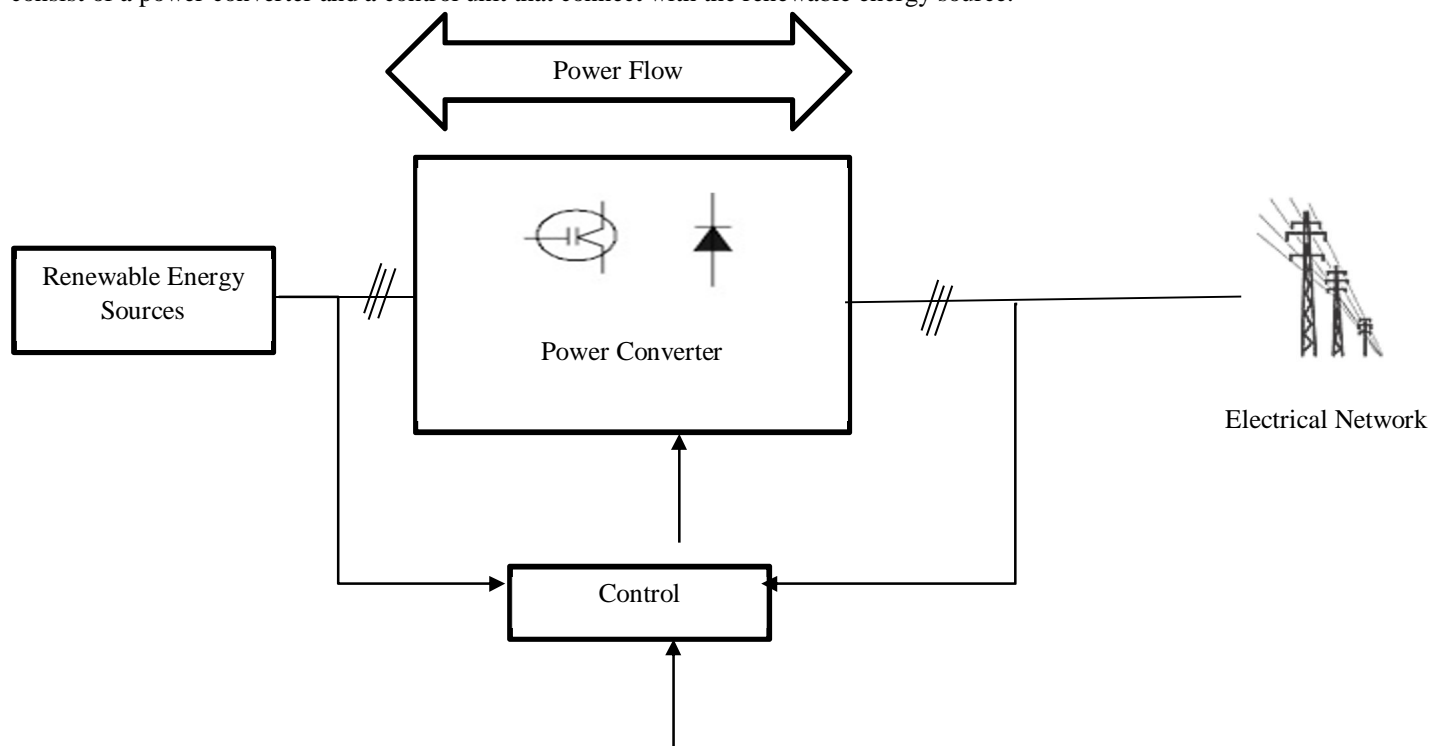


Figure 1: Control, energy, and power electronics are interrelated.

II. MODERN POWER ELECTRONICS

Power Electronics is an interdisciplinary field, which combines power, electronics and control theory for the control and conversion of electric power. It can be viewed as a branch of system engineering. Power Electronics has already found an important place in the modern technology and it is now being used in great variety of high power products. The rapid growth of the power electronics revolution has been caused due to the numerous benefits of power electronics for power control and processing of industrial applications [5]. It also used in the renewable energy sources that convert into the electrical grid, and it is widely used and rapidly expanding as these applications become more integrated with the grid-based systems [6]. Power electronics has changed rapidly during the last thirty years and the number of applications has been increasing, mainly due to the developments of the semiconductor devices and the microprocessor technology. For both cases higher performance is steadily given for the same area of silicon, and at the same time they are continuously reducing in price [7]. Figure 2 represents the typical power electronic system that consist of a power converter and a control unit that connect with the renewable energy source.



Reference (local/centralized)

Figure 2: Typical Power Electronic System

The power converter is the interface between the renewable energy resource and the electrical network. Typically, the power flow is Bi-directional. Three important issues are of concern using such a system namely the reliability, the efficiency and finally the cost. Currently, the power electronics-based drives price is decreasing 1-5% every year for the same output performance. The trend of weight, size, number of components and functions in a standard Danfoss Drives A/S frequency converter can be seen in Figure 3.

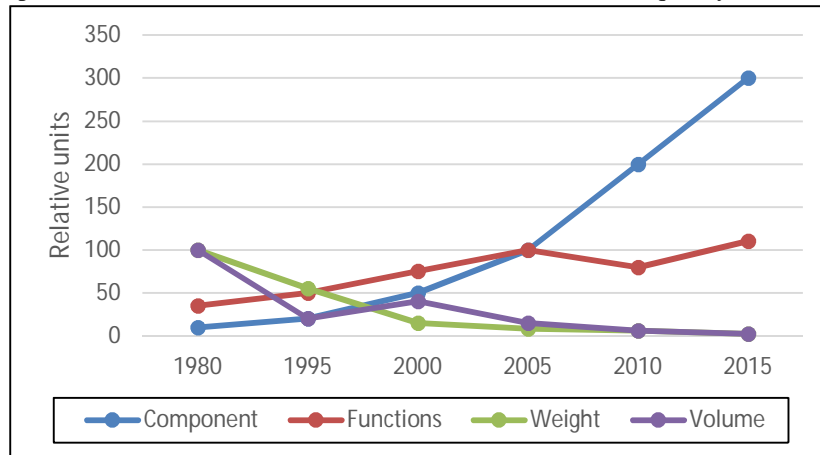


Figure 3: Development of standard Power Electronics-Based Drives for the last decades

Power electronics find applications in most renewable energy systems technologies, solar and wind energy systems being the most important applications. During the last years, there is a constant effort to improve each part of a photovoltaic and wind turbine application. The efficiency of commercial photovoltaic modules now exceeds 17%, inverters have reached almost 99% European efficiency and there are new topologies found which make wind turbine systems more efficient and flexible in their operation. Due to the increased demand, each manufacturer is trying to find new concepts to achieve better system yield, which results in increased economic returns for the investor. Most of the systems used in such applications produce DC current, so inverters are required to convert this power to AC, which is needed in most applications and for grid connection [9].

III. GLOBAL ENERGY RESOURCES

Energy is the life-blood for the progress of human civilization. Per capita energy consumption is the barometer of a nation's prosperity and living standard. It is interesting to note that per capita energy consumption in the world is highest in USA. Global primary energy consumption increased by just 1% in 2016, following growth of 0.9% in 2015 and 1% in 2014. This compares with the 10-year average of 1.8% a year. As was the case in 2015, growth was below average in all regions except Europe & Eurasia. All fuels except oil and nuclear power grew at below-average rates. Energy consumption in China grew by just 1.3% in 2016. Growth during 2015 and 2016 was the lowest over a two-year period since 1997-98. Despite this, China remained the world's largest growth market for energy for a 16th consecutive year. The Consumption of the world energy is shown in the Figure 4 [8].

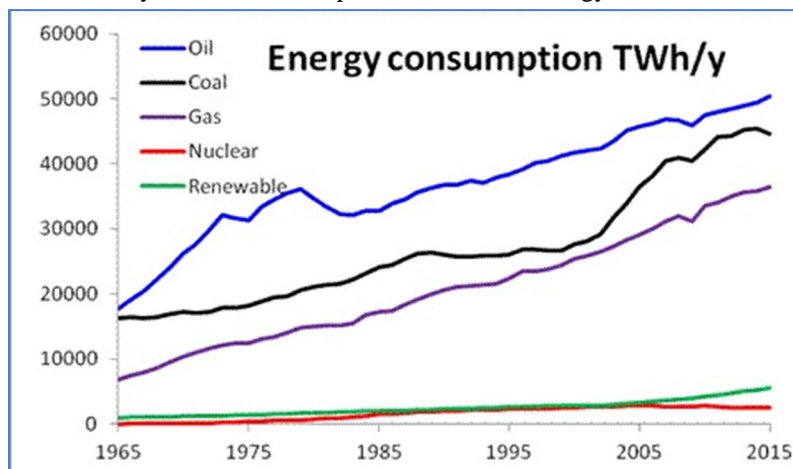


Figure 4: The world's energy consumption

IV. ENERGY STORAGE

As renewable generation grows it will ultimately overwhelm the ability of conventional resources to compensate renewable variability, and require the capture of electricity generated by wind, solar and other renewables for later use. Transmission level energy storage options include pumped hydroelectric, compressed air electric storage, and flywheels. Distribution level options include: conventional batteries, electrochemical flow batteries, and superconducting magnetic energy storage (SMES). Batteries also might be integrated with individual or small clusters of wind turbines and solar panels in generation farms to mitigate fluctuations and power quality issues. Although grid storage requires high capacity and long lifetimes, it often allows a stationary location and housing in a controlled environment, very different from the conditions for portable or automotive storage. Currently, energy storage for grid applications lacks sufficient regulatory history. Energy storage on a utility-scale basis is very uncommon and, except for pumped hydroelectric storage, is relegated to pilot projects or site-specific projects. Some countries such as USA categorize storage as “generation,” and hence forbid transmission utilities from owning it. In addition, utilities do not know how investment in energy storage technologies will be treated, how costs will be recovered, or whether energy storage technologies will be allowed in a regulatory environment.

V. RENEWABLE ENERGY AND NON-RENEWABLE ENERGY

Energy is one of the major inputs for the economic development of any country. In the case of the developing countries, the energy sector assumes a critical importance in view of the ever-increasing energy needs requiring huge investments to meet them. Energy can be classified into several types based on the following criteria:

- A. Primary and Secondary energy
- B. Commercial and Noncommercial energy
- C. Renewable and Non-Renewable energy
- D. Conventional and Non-conventional energy

Renewable energy is energy obtained from sources that are essentially inexhaustible. For example, renewable resources include wind power, solar power, geothermal energy, tidal power and hydroelectric power (Figure 5). The most important feature of renewable energy is that it can be harnessed without the release of harmful pollutants. Non-renewable energy is the Conventional fossils fuels such as coal, oil and gas, that are likely to reduce with time.

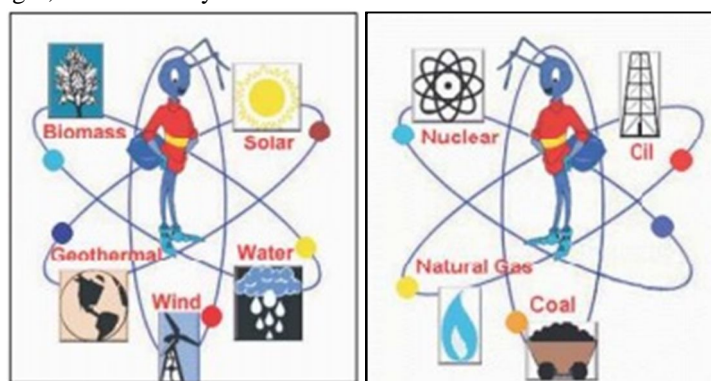


Figure 5: Renewable and Non-Renewable Energy

VI. WHY POWER ELECTRONICS IS SO IMPORTANT?

Power electronics deals with conversion and control of electrical power with the help of switching mode power semiconductor devices, and therefore, the efficiency of power electronics-based equipment can be very high (98-99%). With the advancement of technology, as the cost of power electronics is decreasing, size is becoming smaller and the performance is improving, the application of power electronics is expanding in industrial, commercial, residential, aerospace, military, transportation and utility systems. In industrial applications, power electronics helps productivity and product quality improvement. One important role of power electronics that is being increasingly visible now is the energy saving by improving energy efficiency improvement of electrical apparatus. Again, power

electronics is being increasingly important in renewable energy generation, utility system energy storage and electric/hybrid vehicles.

VII. CONCLUSION

In this paper reviews the global energy and power electronics-based drives and renewable energy resources and their consumption. We discuss the impact of the power electronics in the energy conservation and importance of their storage. We also studied the renewable energy and nonrenewable energy resources and their impact on the climate and reducing the pollution during the last decades and Finally, application of power electronics in the different area of the engineering sciences. It appears that the role of power electronics in our society in future will be as important as computers, communication and information technologies today.

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