WiTricity Generation by Using Renewable Sources

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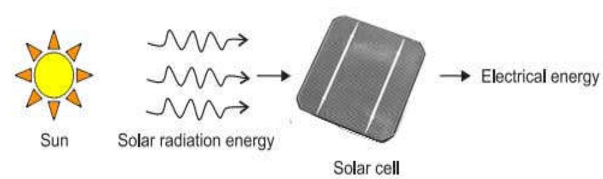
Abstract

Since the advent of modern civilization, humans have always being depended upon the fossil fuels as the source of energy for their circadian requisites. With the exponential magnification in the population, the dependence on these conventional sources for the circadian energy requisites has led to the depletion of the same and adverse ill-effects on the environment. To abate the encumbrance and if possible minimize to zero, energy harvesting has become the desideratum of the hour and the development of the different energy harvesting technologies has been the prime area of research. This paper proposes an incipient control technique, which only employs the primary-side controller and load identification approach to adjust charging voltage/current for compensated wireless power transfer (WPT) systems. The advantages are that dual-side wireless communication for authentic-time charging current/voltage adjustment is eschewed as well as it is opportune for different charging modes, e.g. constant voltage (CV) and constant current (CC) charging defined by the battery charging profile. The load identification approach, which utilizes reflected impedance theory and quadrature transformation algorithm for calculating the active potency, is proposed to estimate the equipollent load resistance of battery. Then, the CV/CC charging for both SS and SP emolument are achieved by the PI controlled phase shift H-bridge inverter. The advances make the WPT very alluring to the electric conveyance (EV) charging applications in both stationary and dynamic charging scenarios. This paper reviewed the technologies in the WPT area applicable to EV wireless charging.

Keywords: Renewable Sources, Solar, Wind, *Pizeo electric Effect*, Dynamic charging, Electric Vehicle (EV), Inductive Power Transfer (IPT), Safety Guidelines, Stationary Charging, Wireless Power Transfer (WPT).

I. Introduction

With the incrementation in the concern for the alarming depletion of fossil fuel reserves and its unpropitious effects on the circumventing environment, the alternative non-conventional sources of energy have gained popularity in the society. Starting from the well-kenned solar cells to the wind turbines, hydroelectric power generation, biodiesel and biogas plants have already being prosperously proven and implemented for equipollent. For power supply desiderata of the portable contrivances the human use, incipient ways have been ascertained to cater the desideratum. Piezoelectric materials and the effect itself have played a major role in solving such quandaries. Energy harvested from the vibrations is one of the most facile and Omni-utilizable techniques. These vibrations can be from human kinetic's, vehicular kinetics', machines and any other surface under vibrations. The conversion of mechanical energy into electrical energy can be done by the utilization of piezoelectric materials. Some of the natural piezoelectric materials already in utilization are quartz. Some artificial piezoelectric materials like BaTiO3, Lead Zirconium Titanate etc. find their applications in modern electronic circuits. Conveyance tires are subjected to mundane and shear loads under static and dynamic conditions. The load can be utilized as a source of mechanical stress for the piezoelectric crystals. The piezoelectric crystals can thus be aligned along the inner lining of the tire where the air pressure does the work. In this paper, different applications of piezoelectric energy harvesting are being illustrated and an endeavor has been made to conceptualize an incipient way of application of the same and certain calculations has been made to visualize the probable energy output from the system.

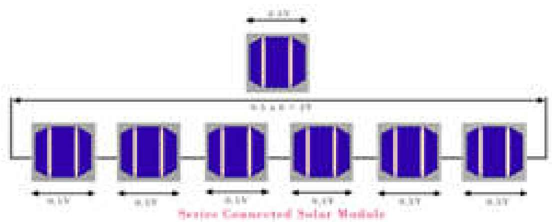


II.Solar Electricity

When sunlight strikes on photo-voltaic solar cells, solar electricity is engendered. That is why this is withal referred to as Photo Voltaic Solar, or PV Solar. Solar energy is radiant light and heat from the Sun that is harnessed utilizing a range of ever-evolving technologies such as solar heating, photovoltaic's, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis. It is a consequential source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar puissance.

Active solar techniques include the utilization of photovoltaic systems, concentrated solar power and solar dihydrogen monoxide heating to harness the energy. Passive solar techniques include orienting a building to the Sun, culling materials with propitious thermal mass or light-dispersing properties, and designing spaces that naturally circulate air. The immensely colossal magnitude of solar energy available makes it a highly appealing source of electricity. Solar power is the conversion of sunlight into electricity, either directly utilizing photovoltaic's (PV), or indirectly utilizing concentrated solar power (CSP). CSP systems use lenses or mirrors and tracking systems to focus an immensely colossal area of sunlight into a minuscule beam. PV converts light into electric current utilizing the photoelectric effect. In the last two decades, photovoltaic's (PV), withal kenned as solar PV, and has evolved from a pristine niche market of diminutive scale applications towards becoming a mainstream electricity source. A solar cell is a contrivance that converts light directly into electricity utilizing the photoelectric effect.

A single solar cell cannot provide required utilizable output. So to increment output power level of a PV system, it is required to connect number of such PV solar cells. A solar module is mundanely series connected ample number of solar cells to provide required standard output voltage and potency. One solar module can be rated from 3 watts to 300 watts. The solar modules or PV modules are commercially available fundamental building block of a solar electric power generation system.



Genuinely a single solar PV cell engenders minutely minuscule amount that is around 0.1 watt to 2 watts. But it is not practical to utilize such low power unit as building block of a system. So required number of such cells are cumulated together to compose a practical commercially available solar unit which is kenned as solar module or PV module.

III. Wind Energy

Wind energy is a dynamic if invisible resource the energy available in a moving mass of air. From grain grinding by simple wind-driven machines in antediluvian cultures to modern electricity-engendering contrivances, the wind has been tapped to work for us.

Wind is a cubic energy resource. As the wind speed increases, the potency available increases cubically. This designates that it's very paramount to get into higher wind speeds, and the way we do that is with taller towers. Regardless of the turbine or tower type, going higher is the endeavored-and-true, reliable way to increment performance in a wind engenderer. And the most mundane mistake in wind electricity is installing a turbine on a short tower.

The swept area of a wind turbine is the second most consequential factor (after the wind resource itself) that determines energy engenderment. The circle "swept" by the blades is the collector area. It's not possible to get a substantial amount of energy out of a minute collector area. Betz' theorem verbalizes we can only decipher about 60% of the energy out of the wind afore we commence decelerating it an extravagant amount of and authentically decrementing performance. In the authentic world, well-designed machines can achieve about a moiety of that.

Turbines can be divided by orientation, directionality, engendering mode, and by other characteristics. Horizontal-axis wind turbines (HAWTs) are the most prevalent and efficacious orientation. Vertical-axis wind turbines (VAWTs) may appeal to the uninitiated, but perpetuate to disappoint as far as performance and longevity—both of the machines and the companies. Upwind (the wind hits the turbine afore it hits the tower) and downwind (the wind hits the tower afore it hits the turbine) designs can both be very efficacious.

Engendering contrivances generally fall into one of three categories. Most home-scale turbines use perpetual magnet engenderers (PMGs), which typically have fine-tuned coils of copper wire and rotating groups of magnets that pass by them. Some older machines use wound-field alternators, which use an iota of the wind energy to engender electro-magnetism in the rotating part of the alternator. Induction motor/engenderers use conventional induction motors, but have the wind push them beyond their mundane operating haste, which takes them from utilizing electricity to making electricity.

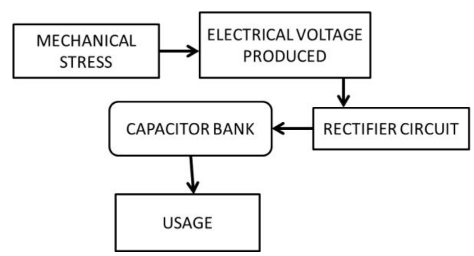
Three rudimental tower types are utilized for residential wind-electric systems. Freestanding towers are the most sumptuous, but can be installed in very proximate quarters, and are perhaps the safest to install and maintain. Tilt-up towers sanction all maintenance and rehabilitate to be done on the ground, but require an immensely colossal open area for installation and use. Fine-tuned-guyed towers include lattice and pole styles that do not tilt, and must be climbed for installation and accommodation. These are typically the least costly, and need a moderate area for installation.

A wind-electric system is much more than just the wind engenderer and tower. Withal required are transmission wiring, electronic controls, batteries if storage or backup is desired, an inverter for household AC or grid-interconnect, as well as metering, over current auspice, and other standard electrical components. All opportune components should be culled for compatibility and functionality—it takes a whole system to make wind electricity.

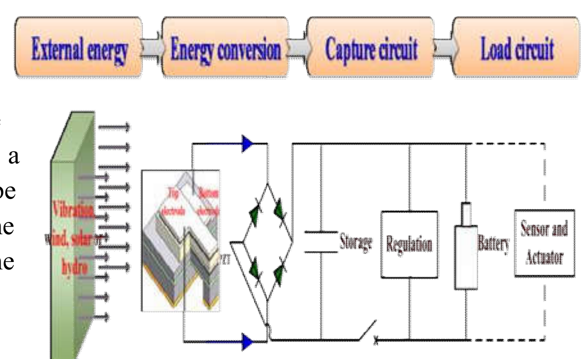
IV. Piezoelectric Effect

A Non-Conventional source of energy is incremented which would not only provide us the energy in substantial amount but withal it will additionally not cause any kind of pollution. In this paper, we are going to introduce you with one such source of energy. The denomination of this innovative energy source is "PIEZOELECTRICITY". Piezoelectricity is the property which is shown by certain materials which are kenned as Piezoelectric Materials. Utilizing this effect electricity can be engendered from the piezoelectric materials.

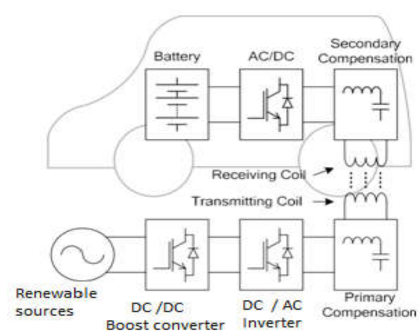
When the pressure is been applied on Piezoelectric Materials there is a tensile stress engendered in them. When the pressure is abstracted from the material there is a compression in the material. The perpetual Tension and Compression Cycle causes Electric Current to be engendered in them. These current can be obtained in from of electricity by betokens of Piezoelectric Engenderers. This effect could be implicatively insinuated in the places where there is a constant Tension and Compression processes are available. In this paper, we are going to discuss about few ways of engendering electricity from piezoelectric materials.



The wireless power transfer (WPT) technology, which can eliminate all the charging onerous, is desirable by the EV owners. By wirelessly transferring energy to the EV, the charging becomes the most facile task. For a stationary WPT system, the drivers just need to park their car and depart. For a dynamic WPT system, which denotes the EV could be powered while driving; the EV is possible to run sempiternally without a cessation. Withal, the battery capacity of EVs with wireless charging could be reduced to 20% or less compared to EVs with conductive charging. Albeit the market demand is sizably voluminous, people were just wondering whether the WPT could be realized efficiently at a plausible cost.



When the WPT is utilized in the EV charging, the MHz frequency operation is hard to meet the potency and efficiency criteria. It is inefficient to convert a few to a few hundred kilowatts power at MHz frequency level utilizing state-of-the- art power electronics contrivances. Moreover, air-core coils are too sensitive to the circumventing ferromagnetic objects. When an air-core coil is annexed to a car, the magnetic flux will go inside the chassis causing high eddy current loss as well as a consequential transmutation in the coil parameters. To make it more practical in the EV charging, ferrite as a magnetic flux guide and aluminum plate as a shield are conventionally adopted in the coil design with the lowered frequency to less than 100 kHz, and the utilization of ferrite, the WPT system is no different from the inductive power transfer (IPT) technology which has been developed for



many years. In fact, since the WPT is predicated on the non radiative and near-field electromagnetic, there is no difference with the traditional IPT which is predicated on magnetic field coupling between the transmitting and receiving coils. Recently, as the desideratum of EV charging and withal the progress in technology, the puissance transfer distance increases from several millimeters to a few hundred millimeters at kilowatts power level. As a proof-of-concept of a roadway inductively powered EV, the Partners for Advance Transit and Highways (PATH) program was conducted.

V.FUNDAMENTAL THEORY

A typical wireless EV charging system is shown in Fig. It includes several stages to charge an EV wirelessly. First, the utility renewable dc or ac power is converted to a dc power source by an ac to dc converter with power factor rectification. Then, the dc power is boost up the voltage by utilizing boost converter. Then, the converter output dc power is converted to a high-frequency ac to drive the transmitting coil through an emolument network. Considering the insulation failure of the primary side coil, a high-frequency isolated transformer may be inserted between the dc-ac inverter and primary side coil for extra safety and aegis. The high-frequency current in the transmitting coil engenders an alternating magnetic field, which induces an ac voltage on the receiving coil. By resonating with the secondary emolument network, the transferred power and efficiency are significantly amended. At last, the ac power is rectified to charge the battery. A wireless EV charger consists of the following main components: The detached (or dissevered, loosely coupled) transmitting and receiving coils. Customarily, the coils are built with ferrite and shielding structure, in the later sections, the term magnetic coupler is utilized to represent the entirety, including coil, ferrite, and shielding the emolument network; the potency electronics converters. The main distinction between a wireless charger and a conventional conductive or wired charger is that a transformer is superseded by a set of loosely couple coils.

VI. MAGNETIC COUPLER DESIGN

To transfer power wirelessly, there are at least two magnetic couplers in a WPT system. One is at the sending side, designated primary coupler. The other is at the receiving side, denominated pickup coupler. Depending on the application scenarios, the magnetic coupler in a WPT for an EV could be either a pad or a track form. For higher efficiency, it is paramount to have high coupling coefficient k and quality factor Q. Generally, for a given structure, the more sizably voluminous the size to gap ratio of the coupler is, the higher the k is; the thicker the wire and the more sizably voluminous the ferrite section area is, the higher the Q is. By incrementing the dimensions and materials, higher efficiency can be achieved. But this is not a good engineering approach. It is preferred to have higher k and Q with the minimum dimensions and cost. Since Q equals ωL/R, high frequency is conventionally adopted to increment the value of Q. The researchers at Massachusetts Institute of Technology (MIT) utilized a frequency at around 10 MHz and the coil Q value reached proximately 1000.

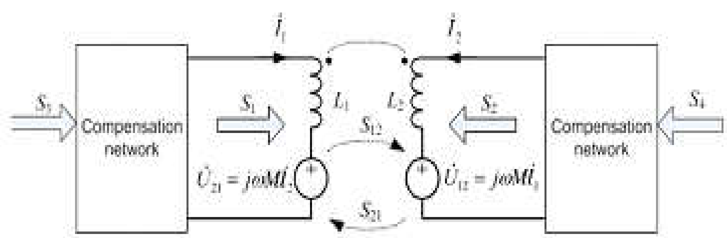


Fig. General two-coil WPT system.

In high power EV WPT applications, the frequency is additionally incremented to have these benefits. In Bolger's early design, the frequency is only 180 Hz. A few years later, a 400 Hz frequency EV WPT system was designed by System Control Technology. Neither 180 Hz nor 400 Hz is high enough for a loosely coupled system. Astronomically immense couplers were employed in the two designs.

Modern WPT system uses at least 10 kHz frequency. As the technical progress of puissance electronics, 100 kHz could be achieved at high power level. The WiTricity Company with the technology from MIT adopts 145 kHz in their design. In the recent researches and

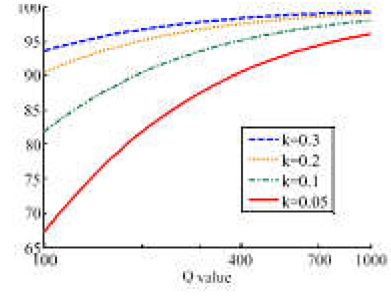
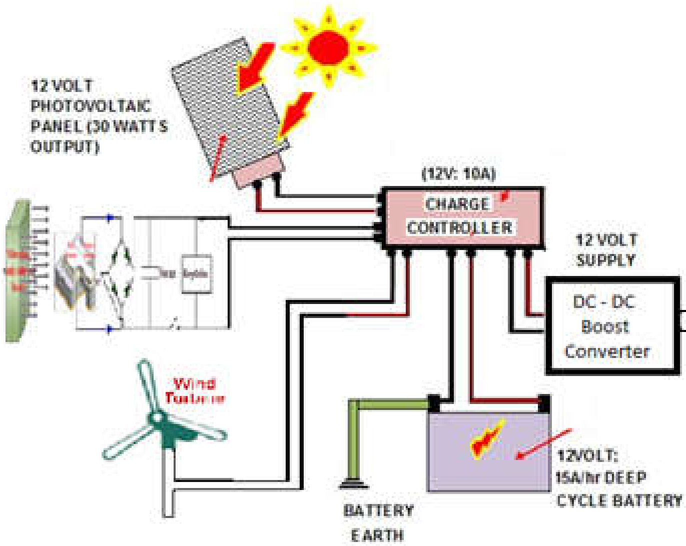
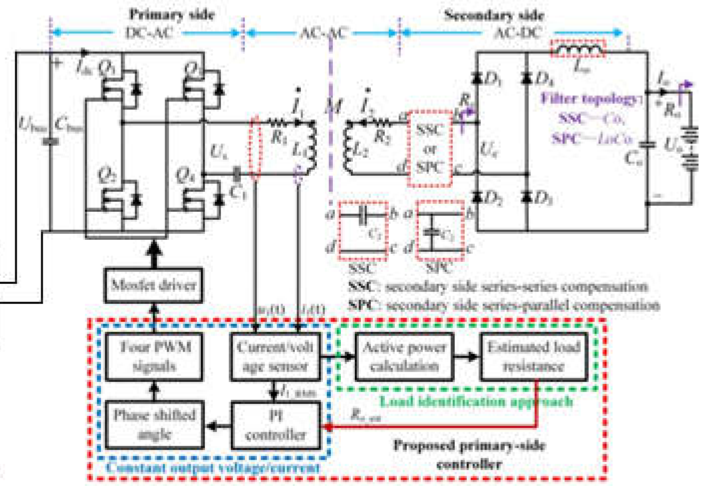


Fig.. Theoretical maximum transfer efficiency between two coils.

applications, the frequency adopted in an EV WPT system is between 20 and 150 kHz to balance the efficiency and cost. At this frequency, to reduce the ac loss of copper coils, Litz wire is conventionally adopted.





Besides the frequency, the coupling coefficient k is significantly affected by the design of the magnetic couplers, which is considered one of the most paramount factors in a WPT system. With homogeneous dimensions and materials, different coupler geometry and configuration will have a paramount difference of coupling coefficient. A better coupler design may lead to a 50%–100% amelioration compared with some non optimal designs.

VII. Inductive Wireless Power Transmission Systems

In inductive wireless power transmission systems, often soft-magnetic shielding is used to avoid lossy eddy currents being induced in electrically conducting components like batteries or ground layers of electronic circuits. Datasheet information on such shielding materials is often limited to magnetic permeability and sometimes exemplary loss information. For designing inductive wireless power systems, e.g., at variable frequency, detailed loss information is of interest. Therefore, it is proposed to measure the impact of these materials on the power transmission in a standardized setup, which is closely related to the real application. This consists of two coils, a transmitting and a receiving coil. Here, a configuration as described in the Qi standard for wireless charging of mobile devices published by the wireless power consortium is used as reference. A figure of merit, i.e., the product of the coupling factor k and the geometric average of the coil's quality factors Q, is proposed to qualify materials concerning both: 1) shielding against conducting components on the backside of the receiving coil and 2) establishing a high mutual inductance of the transformer coils, resulting in higher system efficiencies.

VIII. FULL BRIDGE SYSTEM

Full-bridge dc/dc converters are extensively applied in medium to high power dc/dc power conversion. For power levels up to 3 kW, the full-bridge converters now employ MOSFET switches and use Phase-Shift Modulation (PSM) to regulate the output voltage. In most of these converters, zero voltage switching (ZVS) is achieved by placing a Snubber capacitor across each of the switches and either by inserting an inductor in series with the transformer or by inserting an inductor in parallel to the potency transformer. In a practical full-bridge configuration, the Snubber capacitor may be the internal drain-to-source capacitor of the MOSFET, the series inductor may be the leakage inductor and the parallel inductor may be the magnetizing inductor of the puissance transformer. This makes the puissance circuit of these converters very simple. However, the full-bridge converter with the series inductor loses its ZVS capability at no-load (or light-load), and the converter with the parallel inductor loses its ZVS under short-circuit. Loss of ZVS implicatively insinuates astronomically high switching losses at high switching frequencies and very high EMI due to the high di/dt of the Snubber discharge current. Loss of ZVS can additionally cause a very strepitous control circuit, which leads to shoot-through and loss of the semiconductor switches. The ZVS range can be elongated by incrementing the series inductance. However, having an astronomically immense series inductance limits the potency transfer capability of the converter and reduces the efficacious obligation ratio of the converter.

ZVS in conventional full-bridge PWM converters is achieved by utilizing the energy stored in the leakage inductance to discharge the output capacitance of the MOSFETs; the range of the ZVS operation is highly dependent on the load and the transformer leakage inductance. Thus, this converter is not able to ascertain ZVS operation for a wide range of load variations.

The leakage inductance of the transformer causes the voltage spikes across the output diodes. Theses spikes are intensified by incrementing the switching frequency of the converter. Thus, the diodes should be designed aggrandized to be able to withstand the voltage spikes, which leads to higher losses due to the higher forward voltage drop of the diodes and poorer reverse recuperation characteristics. In advisement, the spikes significantly increase the EMI noise of the converter. This fact makes the topology not very practical for high frequency, high voltage applications. There are quite a few references that proposed solutions for the voltage spikes across the output diodes. Some references endeavored to decrement the leakage inductance as much as possible though the transformer winding structures, which efficaciously decreases the apex of the voltage spikes across the output diodes. However, reducing the leakage inductance decreases the ZVS operating range of the full-bridge converter, which results in a very narrow range of ZVS operation.

The quandary of voltage spikes is essentially cognate to the voltage-driven output rectifiers. This is due to the fact that the full-bridge inverter engenders high frequency voltage pulses across the output diode rectifier, which is connected to the output inductor. The voltage-driven rectifier works impeccably if there is no leakage inductance in between the output of the full-bridge inverter and the diode rectifier. However, the else of the leakage inductance makes the rectifier connect two current sources, i.e., leakage inductance and output inductance, together. This connection engenders high voltage spikes across the output diodes. In this paper, an incipient topology is proposed predicated on a current driven rectifier, which efficaciously rectifies the voltage stress quandaries cognate to the full-bridge DC/DC converter. The proposed topology provides zero current switching (ZCS) for the output rectifiers, which eliminates reverse recuperation losses of the output diode rectifiers.

IX. Results:

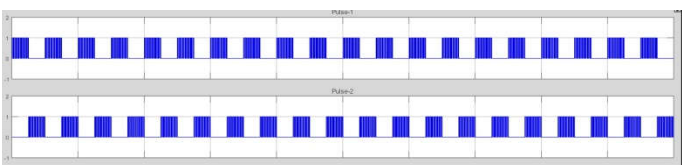


Fig : zvt – zct pwm dc/ dc boost converter pulse

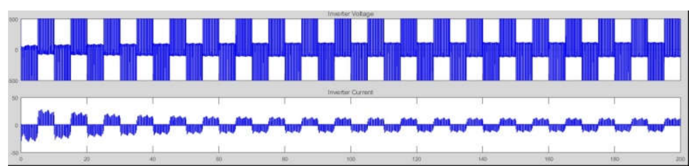


Fig : single phase full bridge inverter voltage and current

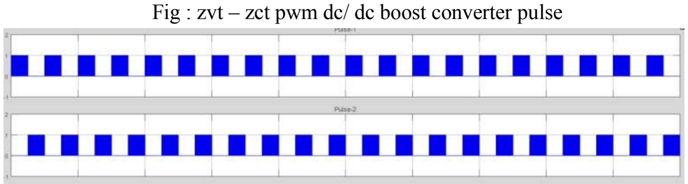


Fig : single phase full bridge converter pwm pulses

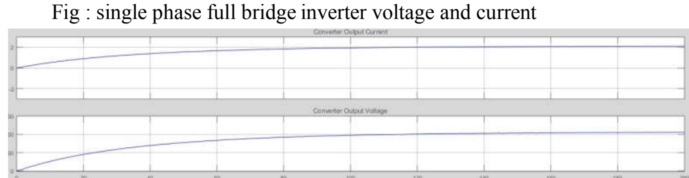


Fig : single phase full bridge converter output voltage and current

X. CONCLUSION

This paper presented a review of wireless charging of electric vehicles. It is clear that vehicle electrification is unavoidable because of environment and energy related issues. Wireless charging will provide many benefits as compared with wired charging. In particular, when the roads are electrified with wireless charging capability, it will provide the foundation for mass market penetration for EV regardless of battery technology. With technology development, wireless charging of EV can be brought to fruition. Further studies in topology, control, inverter design, and human safety are still needed in the near term.

REFERENCES

[1] M. Fan, T. Zhang, X. Zhu, P. Luk, and C. Ma. “Compensation of Cross Coupling in Multiple-Receiver Wireless Power Transfer Systems,” *IEEE Trans. Ind. Inform*, vol. 12, no. 2, pp. 474–482, Jan. 2016.

[2] J. Chow, H. Chung, S, and C. S. Cheng, " Use of Transmitter-Side Electrical Information to Estimate Mutual Inductance and Regulate Receiver-Side Power in Wireless Inductive Link," *IEEE Trans. Power Electron.*, vol. 31, no. 9, pp. 6079 - 6091, Sept. 2016.

[3]]J. Yin, D. Lin, C. K. Lee, and S. Y. R. Hui, “A Systematic approach for load monitoring and output power control of wireless

power transfer systems without any direct output measurement," *IEEE Trans. Power Electron.*, vol. 30, no. 3, pp. 1657–1667, Mar. 2015.

[4] S. J. Gerssen-Gondelach and A. P. C. Faaij, "Performance of batteries for electric vehicles on short and longer term," *J. Power Sour.*, vol. 212, pp. 111–129, Aug. 2012.

[5] V. Etacheri, R. Marom, R. Elazari, G. Salitra, and D. Aurbach, "Chal- lenges in the development of advanced Li-ion batteries: A review," *Energy Environ. Sci.*, vol. 4, no. 9, pp. 3243–3262, 2011.

[6] A. K. A. Kurs, R. Moffatt, J. D. Joannopoulos, P. Fisher, and M. Soljacic, "Wireless power transfer via strongly coupled magnetic resonances," *Science*, vol. 317, no. 5834, pp. 83–86, 2007.

[7] B. L. Cannon, J. F. Hoburg, D. D. Stancil, and S. C. Goldstein, "Magnetic resonant coupling as a potential means for wireless power transfer to multiple small receivers," *IEEE Trans. Power Electron.*, vol. 24, no. 7, pp. 1819–1825, Jul. 2009.

[8] C. Sanghoon, K. Yong-Hae, S.-Y. Kang, L. Myung-Lae, L. Jong-Moo, and T. Zyung, "Circuit-model-based analysis of a wireless energy- transfer system via coupled magnetic resonances," *IEEE Trans. Ind. Electron.*, vol. 58, no. 7, pp. 2906–2914, Jul. 2011.

[9] Y. Nagatsuka, N. Ehara, Y. Kaneko, S. Abe, and T. Yasuda, "Compact contactless power transfer system for electric vehicles," in *Proc. IPEC*, Jun. 2010, pp. 807–813.

[10] J. G. Bolger, F. A. Kirsten, and L. S. Ng, "Inductive power coupling for an electric highway system," in *Proc. 28th IEEE Veh. Technol. Conf.*, Mar. 1978, pp. 137–144.

[11] M. Eghtesadi, "Inductive power transfer to an electric vehicle- analytical model," in *Proc. IEEE 40th Veh. Technol. Conf.*, May 1990, pp. 100–104.

[12] A. W. Green and J. T. Boys, "10 kHz inductively coupled power transfer-concept and control," in *Proc. 5th Int. Conf. Power Electron. Variable-Speed Drives*, Oct. 1994, pp. 694–699.

[13] D. A. G. Pedder, A. D. Brown, and J. A. Skinner, "A contactless electrical energy transmission system," *IEEE Trans. Ind. Electron.*, vol. 46, no. 1, pp. 23–30, Feb. 1999.

[14] H. Abe, H. Sakamoto, and K. Harada, "A noncontact charger using a resonant converter with parallel capacitor of the secondary coil," *IEEE Trans. Ind. Electron.*, vol. 36, no. 2, pp. 444–451, Mar./Apr. 2000.

[15] A. P. Hu, J. T. Boys, and G. A. Covic, "ZVS frequency analysis of a current-fed resonant converter," in *Proc. 7th IEEE Int. Power Electron. Congr.*, Oct. 2000, pp. 217–221.

[16] W. Chwei-Sen, O. H. Stielau, and G. A. Covic, "Design considerations for a contactless electric vehicle battery charger," *IEEE Trans. Ind. Electron.*, vol. 52, no. 5, pp. 1308–1314, Oct. 2005.

[17] A. Kawamura, K. Ishioka, and J. Hirai, "Wireless transmission of power and information through one high-frequency resonant AC link inverter for robot manipulator applications," *IEEE Trans. Ind. Appl.*, vol. 32, no. 3, pp. 503–508, May/Jun. 1996.

[18] J. L. Villa, J. Sallán, A. Llombart, and J. F. Sanz, "Design of a high frequency inductively coupled power transfer system for electric vehicle battery charge," *Appl. Energy*, vol. 86, no. 3, pp. 355–363, 2009.