International Journal of Electrical, Electronics and Computer Engineering 7(2): 35-41(2018)

ISSN No. (Online): 2277-2626

A Review of Renewable Energy Resources in Reluctance Motor Drive for Electric Vehicles

Md Haroon[1] and Ms Alka Thakur[2]
[1]Research Scholar, Department of Electrical Engineering,
Sri Satya Sai University of Technology and Medical Sciences, Sehore (Madhya Pradesh), INDIA
[2]Associate Professor, Department of Electrical Engineering,
Sri Satya Sai University of Technology and Medical Sciences, Sehore (Madhya Pradesh), INDIA

(Corresponding author: Md Haroon)
(Received 07 August, 2017 Accepted 14 October, 2018)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: A Review of Renewable Energy Resources in Reluctance Motor Drive for Electric Vehicles of alternative energy resources being studied for hybrid vehicles as preparation to replace the exhausted supply of petroleum worldwide. The use of fossil fuel in the vehicles is a rising concern due to its harmful environmental effects. Among other sources battery, fuel cell (FC), super capacitors (SC) and photovoltaic cell i.e. solar are studied for vehicle application. Combinations of these sources of renewable energies can be applied for hybrid electric vehicle (HEV) for next generation of transportation. Various aspects and techniques of HEV from energy management system (EMS), power conditioning and propulsion system are explored in this paper. Other related fields of HEV such as DC machine and vehicle system are also included. Various type models and algorithms derived from simulation and experiment are explained in details. The performances of the various combination of HEV system are summarized in the table along with relevant references. This paper provides comprehensive survey of hybrid electric vehicle on their source combination, models, energy management system (EMS) etc. developed by various researchers. From the rigorous review, it is observed that the existing technologies more or less can capable to perform HEV well; however, the reliability and the intelligent systems are still not up to the mark. Accordingly, this review have been lighted many factors, challenges and problems sustainable next generation hybrid vehicle.

Keywords: Reluctance Motor, Distributed power generation, fuel cells, photovoltaic(PV), power electronics, renewable energy.

I. INTRODUCTION

An emphasis on green technology is greatly demanded of modern cities. The significant growth of today's cities has led to an increased use of transportation, resulting in increased pollution and other serious environmental problems. Gases produced by vehicle should be controlled and proactive measures should be taken to minimize these emissions. The automotive industry has introduced hybrid cars, such as the Honda Insight and the Toyota Prius that minimize the use of combustion engines by integrating them with electric motors. Such technology has a positive effect on the environment by reducing gas emission.

The greatest challenge in research activities today is developing near zero emission powered vehicles. Electric vehicles powered by renewable energies offer a possible solution because they only emit natural byproducts and not exhaust fumes, which improve the air quality in cities and, thus the health of their populations.

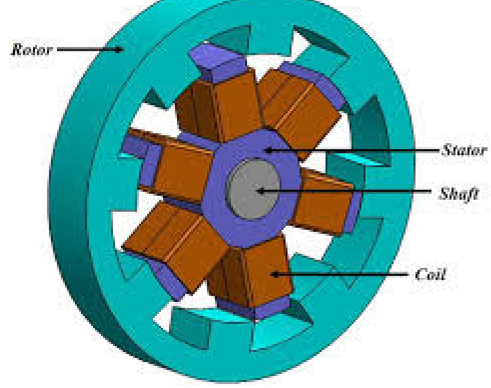
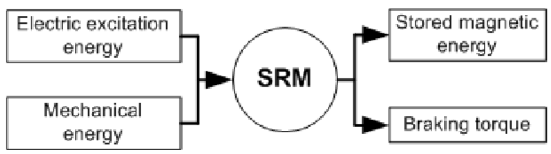
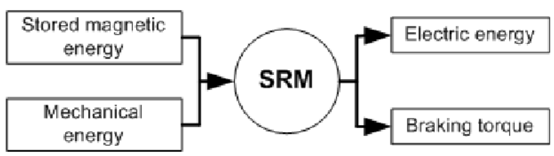


Fig. 1. Switched Reluctance Motor for Electric vehicles.

One potential renewable energy device to power vehicles is the FC. A FC is an electrochemical device that produces DC electrical energy through a chemical reaction. It consists of an anode, an anode catalyst layer, an electrolyte, a cathode and a cathode catalyst layer. Multiple FCs are arranged in series or parallel in a stack to produce the desired voltage and current FCs can be used for transportation applications from scooters to tramways, for combined heat and power (CHP) systems and in portable power supplies.



(a) Excitation mode



(b) Generation mode mechanism of braking of an SRM.

Fig. 2. SRM system.

In fact, the applications of FCs start at the small scale requiring 200 W and can reach the level of small power plants requiring 500 kW FC technology uses hydrogen as the main source of energy that produces the electricity needed to drive an electric vehicle. In comparison to an internal combustion engine (ICE) that emits gases such as NOx and CO_2, FC emits water as byproduct However, the downside to FCs is their slow dynamic properties, and therefore, they require auxiliary sources, such as batteries and SCs Batteries, which have high power density but low energy density have problem in longer charging time which can take from 1 hour to several hours for full charge. On the positive side, batteries supply voltage more consistently than FCs. Batteries that are typically used with FCs, which are lead–acid, Li-ion and Ni–MH batteries in the energy management system for hybrid vehicles, batteries can be charged during operation.

II. ENERGY MANAGEMENT SYSTEM

For HEV the objective of the control system in an EMS is to improve the efficiency of the vehicle system. Without efficiency in the control system, the performance of the hybrid system is at an unsatisfactory level because each power source has capacity limitations. Selecting which power source to use or when a combination is necessary requires an intelligent control system. A powerful control system is essential for a good energy management system. For example, in order to optimize the FC/SC system a control algorithm was designed that relied on the power demand condition and is summarized as follows In a low power demand condition, the FC system will generate power to the load and any excess power will recharge the SC.

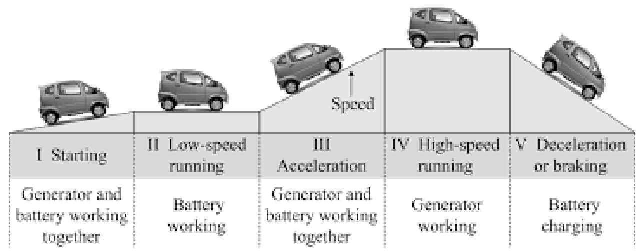


Fig. 3. Multilevel Converter.

In a high power demand condition, both the FC and SC will generate power. The generating power of the FC must be greater than 700 W to avoid FC activation losses. The release energy from regenerative braking will charge the SC. The buck-boost dc/dc power converter is used to provide a constant load bus voltage. The Control strategy for vehicle applications. Another study of control strategy was conducted by Garcia and Miller et al. They investigated the application of a FC battery hybrid system for tramways, focusing on the configuration of a FC-battery powered system for a tramway in Metro Centre in Seville, Spain. The research involved designing an EMS with fixed reference signals for the FC dc/dc boost converter, electrical motor drives and energy dissipation in the braking chopper. The tramway EMS optimized the generated energy system in response to demand. It also managed the operation of the braking chopper when regenerative braking occurred. The EMS was controlled based on three levels of SOC as high (60%–65%), medium (42%–60%) and low (o40%), respectively. Renewable energy technologies such as fuel cell and solar are gaining popularity for vehicle application. Not only these energy sources reduce gas in the cities but they also reduce dependability on the fossil energy As a platform to exchange ideas and research findings related to solar vehicles, North American Solar Challenge. One of the highlights of the event is the solar race car. This initiative ignites interests of many researchers to develop high efficiency power generated solar, improve aerodynamic and reduce losses in mechanical and electrical in the car. As solar power depends on the sunlight, such vehicle needs secondary sources to drive at night or in cloudy conditions.

Alternatively, fuel cell can work all day long as long as hydrogen is available in the tank. Unfortunately, fuel cell has slow response in high power condition and it also needs SCs to overcome its low start-up time as SCs are a mandatory part in every fuel cell powered system in hybrid electrical vehicle (HEV) In order to minimize the usage of energy and fulfill different stage of power condition, an innovative energy management system is required to coordinate these multi energy sources. This review paper handles novel research paper focusing on solar cell, fuel cell and SCs for vehicle. For a better understanding, topic related to these energy sources will be basically explained and then, the handled research papers are discussed in details. Solar cell technology Solar cells or photovoltaic (PV) solar cells are electronic devices that convert sunlight energy into electricity. The physic of solar cell is derived from the principles of semiconductor known as diodes and transistors. The advantage of solar cell is their ability to convert free solar energy from the sun into electricity without producing any pollution that could affect the ecology. This kind of energy sources is classified as a renewable and sustainable energy. The photovoltaic effect was first studied in 1839 by Alexander-Edmund Becquerel. He observed that electric current is produced when certain light – induced from chemical reactions. After a few decades, it was Charles Fritz who invented the first solar cell. The material that was used is made of a thin layer of gold coated with semiconductor selenium. The device was found to have efficiency of 1% only. In year 1954, Chapin, Fuller and Pearson announced the first silicon solar cell with 6% efficiency Since then, technology continues to evolve and becoming more significant as years passes by. [5]

Electric vehicles have been around since early 19th century However, the electricity was primarily generated using coal and other fossil fuels. Driving electric vehicles meant double energy conversion, first one was from fossil fuel to electric energy and the second one was from electric energy to kinetic energy. [7] This made it economically expensive solution. In addition to that, ample oil reserves were discovered and gasoline powered vehicles became the most cost and energy efficient means of transport. Now that the world is facing severe shortages in the gasoline and rising effects of environmental pollution such as climate changes, efforts are being carried out to reduce the pollution and improve the carbon footprint. Every country has set out policies and framework for achieving this target. This has given a significant boost to the research and development in the areas of renewable energy sources and electric vehicles. There is a strong connection between the two. As the renewable energy sources have become cheaper and commercially attractive, more energy is being generated by them. These sources are intermittent and hence they need storage for their complete utilization. With ever-evolving storage technologies, the electric vehicles became economically a more viable option. Besides giving power to the electric vehicles, storage made them an important element in the smart grid. There are many different terminologies for the electric vehicles based on their utilization of electricity. Grid connected electric vehicles are the ones which use the electricity from overhead or underground cables. Typically, electric trains and trolley buses are developed using this concept. Battery based electric vehicles have rechargeable batteries on the vehicles. The vehicle uses the energy from the battery. Battery needs to be charged after the drive. The Hybrid Electric Vehicles (HEV) use a battery and conventional fuels to run the vehicles. The battery in the hybrid electric vehicles does not need separate charging as it gets charged from the vehicle stoppings, also known as regenerative braking. The Plug-in Electric Vehicles (PEV) use batteries which can be charged from regular electricity power outlet in a house or any commercial place. The plug-in hybrid electric vehicle uses a similar concept for a hybrid electric vehicle. Since large-scale grid-connected electric vehicles like trains and trolley buses require a lot of infrastructures, most of the electric vehicles research focus is shifted towards either entire storage based electric vehicles or hybrid electric vehicles which have the ability to run on electricity and conventional fuels.

Depending on the type of the electric vehicle, various technology areas are being worked upon. One of the technology areas in the electric vehicles is the development of newer control architectures. Researchers are working on many different electrical topologies and control strategies to improve the overall performance of the electric vehicles. These topologies are primarily for driving the electric motor. Development of battery charging circuits is another research area. Various battery chargers such as on board, off board and wireless chargers are being developed Grid stability and electrical load management issues are also studied extensively in connection with the electric vehicles Using the battery in electric vehicles, excess grid energy from the renewables can be stored and also the same battery can be used by the grid operator to help the grid recover from short-term voltage sags and dips caused by load changes. Despite this academic level research on various aspects, the entire growth in the storage device driven electric vehicle industry in the commercial segment is focused on a single problem. This problem is to extend its driving distance with longer charge durations.

The purpose of this paper is to present a literature review of the various methods researchers have developed to improve the driving range. To improve the driving range of the vehicle, it is necessary to understand its basic building blocks and its connection to the driving range. Hence, discusses the basic structure of the electric vehicle. presents various methods to improve the driving range. A comparison of methods and their impact on the driving range is performed in and concludes the paper.

III. HYBRID SYSTEM

Climatic conditions determine the availability and magnitude of wind and solar energy at particular site. Pre-feasibility studies are based on weather data (wind speed, solar insolation) and load requirements for specific site. In order to calculate the performance of an existing system, or to predict energy consumption or energy generated from a system in the design stage, appropriate weather data is required. The global whether data could be obtained from internet and other sources like local metrological station. The global weather pattern is taken from NASA surface metrological station and the red and yellow indicate high wind energy is available while the blue colors reflect lower wind energy potential zone. the solar insolation level at different areas of the world. Wind and solar hybrid system can be designed with the help of these global weather patterns, for any location all over the world. Deciding on the best feasible solution will need to be done, on a site-to-site basis. Some sites can be best serviced by mains or grid power, others by generators, and some by Various hybrid energy systems have been installed in many countries over the last decade, resulting in the development of systems that can compete with conventional, fuel based remote area power supplies [2] in many applications. Research has focused on the performance analysis of demonstration systems and the development of efficient power converters, such as bi-directional inverters, battery management units. Maximum power point trackers. Various simulation programs are available, which allow the optimum sizing of hybrid energy systems. The recent state of art hybrid energy system technological development is the result of activities in a number of research areas, such as Advances in electrical power conversion through the availability of new power electronic semiconductor devices, have led to improved efficiency, system quality and reliability. Development of versatile hybrid energy system simulation software; continuing advances in the manufacturing process and improve efficiency of photovoltaic modules. The development of customized, automatic controllers, which improve the operation of hybrid energy systems and reduce maintenance requirements. Development of improved, deep-cycle, lead-acid batteries for renewable energy systems. Availability of more efficient and reliable AC and DC appliances which can recover their additional cost over their extended

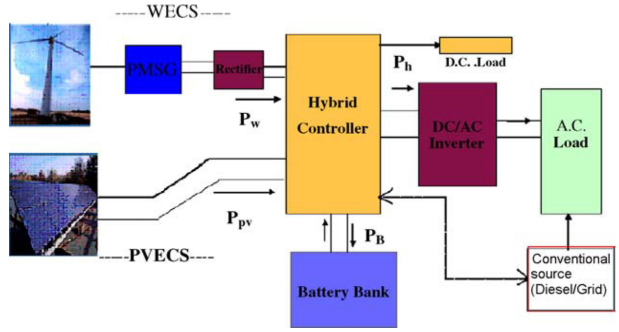


Fig. 4. Hybrid energy systems.

The task for the hybrid energy system controller is to control the interaction of various system components and control power flow within the system to provide a stable and reliable source of energy. With the wide spread introduction of net-metering, the use of small isolated or grid connected hybrid energy systems is expected to grow tremendously in the near future. The aim of this paper is to review the current state of the design and operation of hybrid energy systems, and to present future developments, which will allow a further expansion of markets, both in industrialized and developing countries.

IV. THREE LEVEL VSI BASED SHUNT ACTIVE POWER FILTER

The configuration of the standard neutral point-clamped three-level VSI for the SAPF application. shows Basic block diagram of shunt active filter illustrating the hardware modules required. It can be implemented using DSP TMS320F28335 as a controller. Size of ripple filter can be decreased Using three level inverter based shunt active power filter. Classification based on Power Topologies,

- Two Level VSI
- Three Level VSI
- Multilevel VSI

A review of shunt active power filter is discussed to understand various topologies, reference current prediction methods, current control methods and dead time compensation methods. All control methods for shunt active power filters have been compared from the research papers. It is concluded that three level inverter based shunt active power filter with FFT algorithm for reference current prediction will give better performance. PI based current control method can limit switching frequency but degrade transient performance.

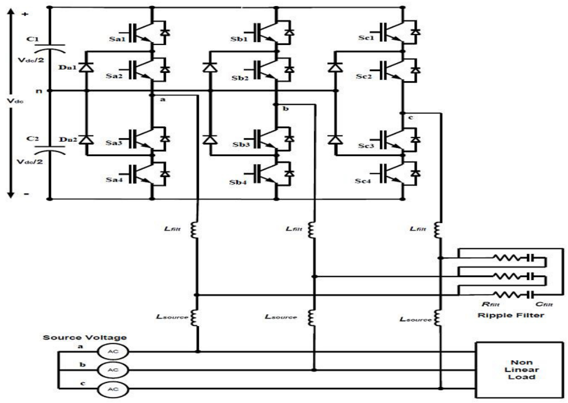


Fig. 5. Two and three-level VSI Block.

SVHCC method is robust to grid parameter variations and load changes. It is considered that this review will be useful to researcher and professionals working in this area.

V. HIGH-VOLTAGE DC CABLES BETWEEN

The PV modules and the inverter, power losses due to a centralized MPPT, mismatch losses between the PV modules, losses in the string diodes, and a nonflexible design where the benefits of mass production could not be reached. The grid-con The present technology consists of the string inverters and the ac module . The string inverter, version of the centralized inverter, where a single string of PV modules is connected to the inverter [7]. The input voltage may be high enough to avoid voltage amplification. This requires roughly 16 PV modules in series for European systems. The total open-circuit voltage for 16 PV modules may reach as much as 720 V, which calls for a 1000-V MOSFET/IGBT in order to allow for a 75% voltage de-rating of the semiconductors. The normal operation voltage is, however, as low as 450 510 V. The possibility of using fewer PV modules in series also exists, if a dc–dc converter or line-frequency transformer is used for voltage amplification. There are no losses associated with string diodes and separate MPPTs can be applied to each string. This increases the overall efficiency compared to the centralized inverter, and reduces the price, due to mass production. [16] The ac module depicted in(d) is the integration of the inverter and PV module into one electrical device It removes the mismatch losses between PV modules since there is only one PV module, as well as supports optimal adjustment between the PV module and the inverter and, hence, the individual MPPT.

It includes the possibility of an easy enlarging of the system, due to the modular structure. The opportunity to become a "plugand- play" device, which can be used by persons without any knowledge of electrical installations, is also an inherent feature. On the other hand, the necessary high voltage-amplification may reduce the overall efficiency and increase the price per watt, because of more complex circuit topologies. On the other hand, the ac module is intended to be mass produced, which leads to low manufacturing cost and low retail prices. The present solutions use self-commutated dc–ac inverters, by means of IGBTs or MOSFETs, involving high power quality in compliance with the standards.

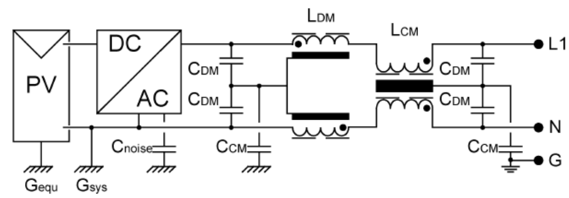


Fig. 6. Transformer less high-input-voltage PV inverter with single-phase common-mode.

Recent developments in power electronics technology have spurred interest in the use of renewable energy sources as distributed generation (DG) generators. The key component in DG generators is a grid-connected inverter that serves as an effective interface between the renewable energy source and the utility grid. The multifunctional inverter (MFI) is special type of grid-connected inverter that has elicited much attention in recent years. MFIs not only generate power for DGs but also provide increased functionality through improved power quality and voltage and reactive power support; thus, the capability of the auxiliary service for the utility grid is improved. This paper presents a comprehensive review of the various MFI system configurations for single-phase (two-wire) and three-phase (three- or four-wire) systems and control strategies for the compensation of different power quality problems In recent years, the installation of more distributed enerators (DG) in power distribution networks has elicited increased attention. A number of reasons can explain this trend. Such reasons include environmental concerns, electricity business restructuring, and the rapid development of small-scale power generation technologies and other micro-grid related devices and systems. In practice, DG units can be constructed with various renewable energy sources However, the real power output from these energy resources is essentially unstable.

Given the increasing number of RESs and DG installations, new control strategies must be developed for the proper operation and management of new power grids embedded with DG units to maintain or improve system quality and reliability. Power electronics and smart technologies play an important role in DG operations, in which the effective integration of RES into the power grid is the major objective. A comprehensive review of AC and DC micro-grid systems with RES-based DG units, energy storage devices, and loads available in recent literature was presented in A fuel cell system-based power generation system which was presented in Several typical PV-based DG systems were designed in and and a DG system based on a wind power generator was presented in Utility is of concern because of the high penetration level of intermittent RES in distribution systems. This situation may cause a hazard to the network in terms of power quality (PQ), voltage regulation, and stability [15]. The electric PQ guidelines and standard limits can be found in The negative effects of poor PQ were well investigated in and The relation between DG and PQ is ambiguous. Many authors have stressed the positive effects of DG on PQ problems. In the sources of PQ problems in DG systems were analyzed; this study has contributed significantly to this new research field. In , the resonance phenomenon in a PV plant was discussed to define the unwanted trip off of grid-tied inverters, a phenomenon that shows the significance and necessity significance of PQ enhancement in DG systems. In the field of exhaustive PQ evaluation, presented several useful suggestions to form a quantitative exhaustive indicator, including various PQ indicators. Exhaustive evaluation can provide a decision on the existing PQ, which A new type of multilevel inverter is introduced which is created by cascading two three-phase three-level inverters using the load connection, but requires only one dc voltage source. This new inverter can operate as a seven-level inverter and naturally splits the power conversion into a higher-voltage lower-frequency inverter and a lower-voltage higher-frequency inverter. This type of system presents particular advantages to Naval ship propulsion systems which rely on high power quality, survivable drives. New control methods are described involving both joint and separate control of the individual three-level inverters. Simulation results demonstrate the effectiveness of both controls. A laboratory set-up at the Naval Surface. Warfare Center power electronics laboratory was used to validate the proposed joint-inverter control. Due to the effect of compounding levels in the cascaded inverter, a high number of levels are available resulting in a voltage.

CONCLUSIONS

This paper has studied a Renewable Energy Resources of higher level with other suggested methods. For purpose of minimizing THD%, a selective harmonic elimination pulse width modulation technique can be also implemented. Battery, FC, SCs and solar energy have potentials in the development of an electric vehicle. Many researches are trying to combine various energy sources including internal combustion engine. These combination techniques required an innovative energy management system. This technology has improved the efficiency of the vehicle, minimize the usage of energy and exhaust less polluted emission. For congested big cities where small size vehicle is a preferable, this kind of vehicle gives certainly huge benefit. A vast study has been done in fuel cell and solar array in transport application. Various kind of energy management has been designed with positive feedback. Thus, there is no doubt that these renewable energies will be our next generation of energy sources in the near future. A method of measuring the torque and the electromagnetic flux in a switched reluctance motor. The investigations carried out determine the possibility of applying SRM in electric and hybrid vehicles. An algorithm of realization of a traction characteristic required for the drive of mechanical vehicles

REFERENCES

[1] Mierlo J.V., Maggeto G., Lataire P. Which energy source for road transport in the future? A comparison of battery, hybrid and fuel cell vehicles. Energy Conversion and Management, **47** Nr. 17, 2748-2760. 2006.

[2] Purvis G. Momentum is a winner, *III-Vs Review* **18** 35. 2005.

[3] Thounthong P., Chunkag V., Sethakul P., Sikkabut S., Pierfederici S., Davat, B., Energy management of fuel cell/solar cell/supercapacitor hybrid power source, *Journal of Power Sources*, **196** Nr. 10, 313-324. 2010.

[4] Mierlo J., Bossche P.V.d., Maggeto G. Models of energy sources for EV and HEV: fuel cells, batteries, ultracapacitors, flywheels and engine-generators, *Journal of Power Sources,* 28 Nr. 1, 76-89. 2004.

[5] Markvart, T. Solar Electricity, West Sussex: John Wiley & Sons.2010.

[6] Parida B., Iniyan S., Goic R. A review of solar photovoltaic technologies, *Renewable and Sustainable Energy Reviews*, **15** Nr. 3, 1625-1636. 2011.

[7] Alamgir K., Pervaiz T., Arif S. Characterization of Cadmium Selenide Thin Film for Solar Cell Application, *Energy Source* Part A, **34** Nr. 4, 297-305. 2016.

[8] Borkowski P., Rakus, J. The concept and mathematical model simulations of light rail vehicle power using photovoltaic panels, Przeglad *Elektrotechniczny (Electrical Review),* **11a** (2012),115-118.

[9] Liu G., Nguang S.K., Partridge A., A general modeling method for I–V characteristics of geometrically and electrically configured photovoltaic arrays, *Energy Conversion and Management,* **52** (2011), Nr. 12, 3439-3445.

[10] Khatib T., Mohamed A., Sopian K., Mahmoud M. Modeling of Daily Solar Energy on a Horizontal Surface for Five Main Sites in Malaysia, International Journal of Green Energy, 8 (2011), Nr. 8, 795-819.

[11] Khatib T., Mohamed A., Sopian K., Mahmoud, M. 2012. Estimating Ambient Temperature for Malaysia using Generalized Regression Neural Network, *International Journal of Green Energy,* **9**, 195-201.

[12] Mulhall P., Lukic S.M., Wirasingha S.G., Lee Y.J., Emadi A., Solar-Assited Electric Auto Rickshaw Three-Wheeler, *IEEE Transaction on Vehicular Technology,* **59** (2010), Nr. 5, 2298-2307.

[13] Wang Y., Chen K.S., Mishler J., Cho S.C., Adroher X.C., A review of polymer electrolyte membrane fuel cells: Technology, applications, and needs on fundamental research, Applied Energy, **88** (2011), Nr. 4, 981–1007.

[14]. Stambouli A.B., Fuel cells: The expectations for an environmental-friendly and sustainable source of energy, *Renewable and Sustainable Energy Reviews*, **15** (2011), Nr. 9, 4507-4520.

[15]. Basu, S. Recent Trends in Fuel Cell Science and Technology, New Delhi: Springer, (2007).

[16]. Correa J.M., Farret F.A., Canha L.N., Simoes M.G., An Electrochemical-Based Fuel-Cell Model Suitable for Electrical Engineering Automation Approach, *IEEE Trans. Industrial Electronics,* **51** (2004), Nr. 5, 1103-1112.