Two-Wheeled Light Electric Vehicle

Authors: Mihaela SCORȚESCU, Relu BALABAN, Loren TROCAN, Gabriel RÂŞNOVEANU, Mihaela CHEFNEUX*

Abstract

The authors of the paper present the first step done by ICPE - carrying out an electric scooter- the target of their research being an ecologic transportation system based on individual electric vehicles, supplied from photocells, adapted to the needs of a medium size community placed in a quite large area, where the metropolitan public transportation system is not available, such as the "Politehnica" campus.

Keywords: DC motors, land vehicles, synchronous motor drives, motors, road vehicles, synchronous motors, transportation

1. Introduction

The authors of the paper present the results obtained within a national project, having as main objective manufacturing an electric scooter by ICPE Servomotor Department.

The modern society has at the moment some major challenges: the reduction of per unit energy consumption, changing the primary energy sources from hydro carbonates to renewable energies, and, finally, to limit the emissions (CO, CH, NO_X, particulates, greenhouse gases, as CO_2, etc.) not only at the production stage, but also at end-users. These generous ideas dominate both people's mentality and political structures, pressed by the former. So many rules more and more restrictive are in charge. Romania as an EU country is an active partner of this process which affected not only the developed countries (USA, Japan, etc.), but also China and India. In this context, the transportation systems are considered one of the main factors responsible for both energy consumption and environment pollution. On the other hand, the transportation necessity grows every year, and becomes completely necessary to the modern comfort.

Considering this, the authors of the paper propose an ecologic transportation system based on individual electric vehicles, supplied from photocells, adapted to the needs of a medium size community placed in a quite large area, where the metropolitan public transportation system is not available.

The solution can be successfully applied to other such applications: exhibitions' platform, holyday resorts, parks and leisure sites, and other protective areas. The project the authors of the paper are carrying on emphasizes the energy transmission of the transportation system, considering all its components: from production with photocells, to electronic control, optimized battery charging and finally the high efficiency, zero-emission, electric drives as propulsion system. In addition, of course, the ecologic aspect of the project is very important, always combined with the energetic one.

In the mentioned project, ICPE - as a partner - developed a two-wheeled light electric vehicle that means a scooter that will be carried out within ICPE-Servomotor Department.

2. Propulsion Systems – a First Step for Implementing Light Electric Vehicles

ICPE (the Research Institute for Electric Engineering) developed in the Servomotor Department a series of propulsion systems for light electric vehicles, with synchronous permanent magnet motors.

The idea started from the following reasons:

- The inexistence in Romania of an

* Mihaela SCORȚESCU, PhD, Department Manager, Relu BALABAN, researcher, Loren TROCAN, researcher, Gabriel RÂŞNOVEANU, researcher, Mihaela CHEFNEUX, senior researcher – ICPE.

electric vehicle manufacturer;
- The trends all around the world in the field of developing a durable surface transportation system, based on electric vehicles;
- The interest of the Servomotor Department in developing other products that are required on the market;
- The ICPE research team experience in brushless servomotors.

The propulsion systems that are carried out by the Servomotor Department from ICPE consist of:
- The permanent magnet synchronous servomotor with speed and position transducer;
- The drive system that ensures the following functions:
  - The motor speed regulation in accordance to the inputs coming from the special sensors mounted on the vehicle.
  - The functioning of the system propulsion from the DC power supply.
  - Current limited at the preset value.
  - Regenerative braking.

The main technical characteristics of the series are:
- Supply voltage: 12-24-26-48 V DC;
- Rated power : 250 W - 4KW.

The propulsion system design was carried out by the authors of the paper and is now manufactured at ICPE for special orders. The design was done gradually, in steps, in order to optimize the whole product, by developing specific manufacture technologies. The propulsion systems were developed within a national project, which was carried out by the research team from ICPE Servomotor department. During the projects, we solved some problems as:
- Identifying the technical specification for the products.
- Adopting an intelligent energy management system.
- Efficiency optimization, correlated to the functioning conditions

The propulsion system, "the heart" of the electric vehicle, may define the technical characteristics of the vehicle, that's why the design and manufacturing must lead to a high performance product.

The propulsion system (Figure 1) SP-EV-36-1, manufactured by ICPE, Servomotor Department, has the following main characteristics:
- Supply Voltage: 36V DC,
- Continuous power: 1 kW,
- Rated speed: 2.500 rpm,
- Rated torque: 4 Nm.

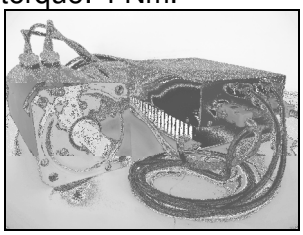

Figure 1. SP-EV-36-1

3. Electric Scooter Carried Out by ICPE

Two-wheel vehicles have always been a practical transportation solution for individuals in urban agglomerations, where the average speed of travel for a vehicle with 4 wheels often fall under the walking speed due to the number of cars and transportation infrastructure. When this mobility is combined with a special propulsion system the result is a clean vehicle that contributes substantially to solving two of the most distressing problems of the inhabitants of cities and local government: transportation and environmental protection.

Motorcycles and electric scooters enjoy growing popularity, due mainly to continued growth in oil prices. Battery technology made significant progress, making this mode of transportation ever more interesting for potential users.

Benefits**:**
- The energy cost per km is about 25% of the gasoline equivalent;
- Much less noise pollution;
- No noxious emissions;
- Recharge possibility of the batteries wherever public network power supply is available (even at home);
- Reduced maintenance costs for labor and consumables (e.g. it does not require oil changes, various filters, etc.).

*Disadvantages***:**
- Reduced autonomy, but sufficient for commuting within the city / town;
- Relatively high recharge time (many hours).

Characteristics of main parts which equips the electric scooter.

The *batteries* are located in the space under the scooter saddle and are covered by

the shroud; a special support and attached elements permit easy removal and replacement.

The batteries have the following characteristics:

- type of batteries: VRLA lead-acid batteries or, depending on price, Ni-MH or Li-ion batteries;
- total voltage: 48 VDC;
- capacity: 24 Ah;
- maximum continuous operation current 50 A
- sealed, maintenance-free batteries can operate in any position.

The brushless DC permanent magnet *electric motor* was chosen because of their superior characteristics vs. brushed DC motors regarding reliability, gauges, and thermal characteristics. The engine has a rated power of 1.3 kW at a speed of 5000 rpm.

The electronic drive system that controls the motor has the following main features:

- control circuit type: PWM, analogue, controlled by resistive position transducer;
- power circuit type: switching, 3 phases, equipped with V-MOS power transistors;
- automatically limiting the load current;
- load short-circuit protection;
- over-heat protection of power transistors.

The electronic battery charger ensures full and proper recharging of the batteries in a reasonable amount of time (typically 10h):

- supply voltage: 220 V AC single phase 50 Hz;
- SCR type rectifier circuit with load current measurement and control;
- maximum current: 3A DC;
- automatic limitation of the maximum load voltage.

The propulsion system was mounted on an electric scooter (Figure 2)

Figure 2. Electric Scooter

The main technical characteristics of this scooter are:

- Speed: 45 km/h,
- Payload: 1-2 persons,
- Autonomy: 2 hours drive at 20 km/h.

The scooter was tested and presented at a national workshop.

4. Implementing the Electric Scooter in an Individually Transportation System

Starting from this electric scooter carried out by ICPE, the authors of the paper are now carrying on a new project, with the target of creating an electric bike car sharing system in the campus of the Polytechnic University from Bucharest.

The vehicle component of the transportation system is based on the electric scooter developed by ICPE, which means the system will be a small fleet of two-wheeled light electric vehicle (the first stage will be seven such vehicles). This type has the advantage of being suitable for young people (students).

The infrastructure component will be two parking terminals interconnected in a bike-sharing system, with docking points to guard the vehicles and recharging points from solar panels based on photocells.

The third component of the system is the management, considering the implement-ation of a time-sharing automatic hiring system.

For this project, the users will be selected and trained. The users will be the students. They will receive a badge, or a numerical code, to be recognized by the system. They can bring an available vehicle from any terminal, use it and then park it in any available terminal, coupling it to the docking point to optimally recharge the batteries. This coupling marks the end of the use and is registered, together with the user identity. The terminal control system will have other functions, too: to optimally charge the batteries, control the solar panel, interface the panel with the electric network, to establish user monitoring and evidence (access right, using time, access cost, etc.), wireless communication with other terminals, and others. From time to time, the users may receive a bill to charge the costs of the service.

The project impact will be in many directions:

- First of all, it will be an extraordinary impact in human mind. It will demonstrate the viability of a clean

energy, in a clan environment, at international standards.

- The project will increase the research capacity of partners and of Romania, allowing connection to the European research network, establishment of strong national and international contacts and partnerships.
- The project will allow, according to the European direction of research, to validate principles and technologies with strong impact for the economy and environment.
- The project will allow the valorisation of research to design and manufacture of propulsion systems for electric vehicle, development of renewable energy power supplies and ecologic transportation systems for restricted areas, and to evaluate the impact to the environment;

The strong social effect will allow:

- involvement of many young researchers and students, improving their capacity and passion for high level research;
- new jobs in the field of integrated transportation systems based on electric vehicles supplied from renewable sources;
- new highly educated engineers in the field of integrated transportation systems based on electric vehicles supplied from renewable sources;

The effect to the UPB community is also very important. It will change the style of the traffic in campus, will preserve the environment and increase the road safety, will increase the interest of the students for a high level research and will improve the comfort in campus.

5. Conclusions

The project of creating an individually transportation system in the University of Bucharest, based on the electric vehicle, is carried out now by the authors of the papers. The first steps were done: building the electric scooters within a national project and obtaining financial resources in another national project, for carrying out the transportation system.

Now, the project is under development: a new experimental model of an e-bike is under development and the infrastructure is now designed. In 2011, the students from the Polytechnic University from Bucharest will have access to a new ecological transportation system.

References

[1] RACICOVSCHI V., DANCIU GR., CHEFNEUX M., The Electric and Hybrid Vehicles, Ed. Electra, ISBN 978-973-7728-93, Bucuresti, 2007.

[2] EET-2007, European Ele-Drive Conference, http://www.ele-drive.com