Learning the Importance of the Sun as an Important Energy Source by Building "Solar Cars"

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Introduction

Due to the increasing demand onenergyand the need to replacefossil fuel, responsible for significant pollution problems, and the increase in global warming due to high emissions of CO_2 to the atmosphere, there is a growing interest is producing energy directly from renewable green sources, namely producing electricity directly from the sun.

Photovoltaic cells are the answer to this goal. Although the photovoltaic effect was discovered in 1839 by the French Physicist Edmond Becquerel, only in 20th century (1954) the first inorganic modern solar cell was announced by the Bell laboratories [1]. Since then, lots of progresses were made. The efficiency of the inorganic photovoltaic cells was improved and nowadays there are standard solar cells with efficiencies around 15%. Due to the development of different materials and production techniques, the price of these devices as also had a significant decrease [1], making them more competitive for energy production. In parallel with the inorganic materials, the development of organic and polymer based photovoltaic elements introduced the possibility of commercializing flexible, low weight and low cost cells to produce energy from light [2-3].

At first, solar cells were used in space applications such as space stations and satellites, small objects, like calculators and toys, and other minor uses. Nowadays solar cells are commonly used in power plants to produce electricity in a large scale and in remote places. More recently solar cells were integrated in buildings' roofs and walls, as a part of glasses, roof tiles and wall coatings [4]. In the next few years, with the decrease of their price and the increase of their efficiency, solar cells may further gain a significant importance in the world's energy production [1].

It is important that young people get in touch with this technology, understanding the basic physics concepts involved, rather important in physics and science teaching, and all its benefits for the environment. To do so we implemented a very simple approach to the study of solar energy, allowing young students to create and develop solar car models by their own. Just the basic information is provided about

the world's energetic situation, energy resources and in particular solar cells basic working principles, basic electricity concepts and, only when necessary, helping them in some construction problems that they may face.
Because thissolar cars project is designed to target young students, the best place for itsimplementationis at school. To achieve thisit is important to motivate school teachers to theproject, because they will have the leading role on its development. To do so, we provide theminitial training courses were we present the objectives of the project, all the necessary theoretical information andalso an application guide for classrooms.
In order to introduce students to the project, whenever possible, they should visit an electricity solar plant or, in alternative, another "green"electric plant.After an initial theoretical briefing, students are encouraged to use all kind of materials and everyday objects that we can found at our homes and that otherwise will be considered as trash, recycling them, to build their solar cars. The only non recycled materials will be the solar panels and the electric motor (that can also be foundin an old toy car, for instance).

Implementation

In the next paragraphs we will show an example of how a class of nineteen students, with 13 years old, engineered solar cars. Before the physical construction of the car, we divided our class of students in small groups (a maximum of 3 individuals is advisable). Then, each group has to create a solar carproject, making the entire task planning, identifying the materials needed and estimating the time needed to complete the project. This is important for students because they have opportunity to think autonomously, and to develop their skills in abstract thinking and group dynamics.

Figure1. Materials used by a group of students to build a solar car

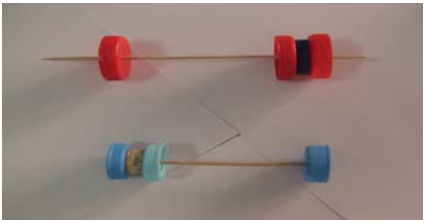

Figure 2. Two different solar car transmission axis

The choice of the car chassis is a first very important step in its construction process because it has to be resistant,sinceall other components will be assembled there, but at the same time very light due to the relatively low power generated by the solar cells. Our goal is to have the students using everyday materials that otherwise will be considered as trash.Thusthe chassis can be a simple plastic bottle, a juice or milk pack, styrofoam from any appliance, or other material that has the desirable lightness and robustness characteristics. Below we describe the solar car building of a group of students that chose a milk pack as chassis, the material used (Fig. 1), and all its construction steps.

After choosing the chassis it is important now to choose the car wheels and axis. Students chose plastic bottle caps perforated in the middle in a way that they can use wood sticks, used in barbecues, as axis. The transmission has also to be included in the wheels axis. It can be a smaller cap, or cork, sandwiched between two larger caps, serving also as wheels (Fig. 2). The students chose this type of transmission because they will use a small elastic rubber band to transfer the rotation movement from the electric motorto the wheels axis.

Figure 3. Solar car chassis with drilled holesforaxis support

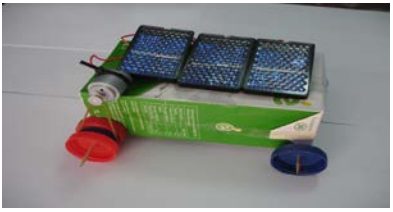

Figure 4. Assembled solar car

After washing the milk pack the students drilled holes on it to introduce the car axis. It is important that the holes are perfectly aligned, so that the front and back wheels and axis are parallel to each other. To reduce the friction between the wood axis and the milk pack a strawwas introduced in the front and back holes with enoughdiameter to allow the wood stick to rotate freely (Fig. 3).

The first part of the car construction was completed and thereafterit was necessary to build the electrical part. In this case, the studentsused 3 small solar panels (each one generating 0.2 W) connected in series. It is possible to use just one panel if it is capable of generating a higher power, oreven more than 3 panels. Nevertheless it is important to balance the panells power with their weight.The panels were connected to the electric motor using small diameter wires.

The last step of the construction process is to place the solar panels and the electric motor in the chassis. It is very important that the transmission and the electric motor rotating axis are perfectly aligned. The distance between these two components has to be set in a way that the small elastic rubber band, responsible for the movement transmission, gets the correct tension. The electric motor wasattached to the chassis using a plastic clamp and solar panels were attached using double-sided adhesive tape.The construction was now completed and the carwas tested to make the necessary improvements or adjustments (Fig. 4). At this point it is possible to use the solar cars to explore some physical concepts. For example, students can be induced to understand the effects of using different diameter caps on wheels or transmission, introducing important physics concepts like velocity or acceleration.

After this construction stage it is important that student's don´t forget their cars! Teachers and students should organize solar car races (in their school and with other schools), so that they can see the result of their creations, and its applicability. This willhelp them to assess the quality of theircar and to come up with improvements to its characteristics, adoptinga critical attitude and encouraging

them to think autonomously. All these aspects are very important to help them develop a scientific thought.

Future developments

From the success with basic school students we are now starting to present the “solar cars project” to older students (secondary school grades). Although the goals are basically the same, working with older students opens the possibility of more daring projects. In future we will communicate more details of its implementationand the results obtained.

Conclusion

Our experience shows that children that participated in this project improved their capacity of problem solving and their self critic. At the same time their interest for scientific disciplines, and for school itself, was boosted and consequently their grades improved, especially in scientific areas. In the above mentionedclass, with 19 students, the number of negative grades in physics and chemistry was reduced to zero (from aninitialnumber of three), and the number of higher grades improved 66%, in comparison with the previous year. This was achieved by letting the students put their “hands-on science”!

References

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