GADGETS USED IN ENGINEERING EDUCATION OF THE SUSTAINABLE ENERGY

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Rezumat. Educația inginerească în domeniul energiei durabile necesită realizarea a mai multor măsurători, teste, aplicații practice ce necesită instrumente de laborator complexe și greu de utilizat. În această lucrare sunt prezentate aplicații cu ajutorul cărora se poate evalua anumite performanțe ale unor aplicații de energie durabile cu ajutorul unor gadgeturi. În prezent datorită accesibilității tehnologiei informației studenții au acces la diferite nivele tehnice de tehnică de calcul. Această tehnică personală a studenților poate fi transformat cu aceste gadgeturi în adevărate laboratoare de cercetare. În acest articol sunt prezentate și exemplificate aplicații tehnice utilizabile în educația inginerească. Aplicațiile tehnice sunt realizate cu componente Fourier conectate la un gadget de tip NOVA link respectiv NOVA air. Utilizarea lor este exemplificată din domeniul iluminatului fotovoltaic și din domeniul evaluării potențialului eolian pentru diferite regiuni izolate. Rezultatele măsurătorilor sunt prelucrate cu ajutorul tehnologiilor moderne a informației. Metodele prezentate pot fi generalizate și la alte tipuri de aplicații din domeniul de vârf a tehnologilor moderne de energie durabilă și de mediu curat.

Cuvinte cheie: energia solară, achiziții de date, potențial solar, potențial eolian.

Abstract. The engineering education in field of sustainable energy requires using a several measurements, tests, practical application, which needs to integrate complex laboratory instruments hard to use in educational activity. In this paper different technical solutions are presented, which integrate new gadgets. That can be connected to the students' personal IT infrastructures which, in this way, can be turned into real research labs. The used gadget is from Fourier Nova family trade mark. The application presented is focusing on quality evaluation of the photovoltaic street lighting and wind potential assessment for isolated locations. The paper presents the methods of this data evaluation with modern information technology. This methods used by this gadgets can be generalized in practical education technologies in field of sustainable energy and environment.

Keywords: solar energy, data logger, solar and wind energy potential.

1. INTRODUCTION

The engineering education of the sustainable energy is an important section of the environment education. The perception about education has been reflected in the following Chinese proverb:

If you plan for one year, plant rice;
If you plant for ten years, plant trees;
But if you plan for 100 years, educate the people.

Considering this proverb I can state that with an efficient high quality of the education the society can reduce the energy consumption. One way to these achievements is using the green energy sources. With educating the new generation in the spirit of reducing the energy consumption and using the renewable energy sources the society will decrease the energy demands and the quality of life or standard of living will be affected. The energy saving is the most important factor in reducing the quantum the consumption.

The primary objective of Romania is to ensure compliance the mandatory renewable energy target of Directive 2009/28/EC, on the promotion of the use of energy from renewable sources by 2020.

The Romanian solar Energy market, especially a photovoltaic energy conversion represents a stabile investment environment in South East Europe with clear rules and green certificate schemes. The current cumulative installed PV capacity is around 60-80 MW_p, but in the next two years that can reach more than 431 MW_p. This installed application represents in general the PV Parks with 1-5 megawatt installed power capacity, built in different regions of the country. In general these applications are grid connected and have been developed by the local authorities and private investors.

For this growing green energy market is necessary to insure high qualified specialists. This can be realized by high quality education in field of sustainable energy. Recently more Universities have available educational programs in the field of sustainable energy in all levels. This type of education needs theoretical and practical training of the students. The practical form of the training can be realized by developing a different case and feasibility studies (Andron 2008). For this type of application the training courses need fully equipped laboratories for measuring and evaluating the energy performances of the studied applications. That educational structure is important to be based on critical thinking. The critical thinking is the intellectually disciplined process, applying, analyzing, synthesizing and or evaluating information gathered from generated by observation experience, reflection reasoning or communication as a guide to belief and action. That can be applied in process of the educational field of sustainable energy. The result of this process is an environmentally educated person (Cunninghan, 2007). This person understands the scientific concepts and facts that underlie environmental issues and interrelationships that shape nature. In the social context, an environmentally educated person understands how human society is influencing the environment as well as the economic and political mechanisms that provide avenues for addressing issues and situations. In the valuing context, an environmentally educated person explores his or her values in relation to environment issues form an understanding the natural and social context, the person decides whether to keep or change those values. In the action context this person becomes involved in activities to improve, maintain or restore natural resources and environmental quality for all. One educated person will result from a complex process of education based on theoretical and practical knowledge. For practical education of the students for this field of the environment is necessary and that requires a more practical work and case studies. Different new equipment can help the students for preparing this case studies and make different measurements for evaluating the performance of the applications in field of environment and sustainable energy. For this activity, the trainer needs to present high quality technical base equipment but for their procurement significant financial efforts are required. That can be resolved with new technical gadgets, like devices from family Nova, which can transform the computers of the users in real scientific laboratories.

2. NOVA CONCEPT USED IN EDUCATION

This concept is a new data logger and measurement system which will be transforming the practical science education across the globe. The measurement system is built from a budget – friendly sensor interface from different type of sensors and data analyzer software all these form a „Science learning station". The trainers can implement this concept in the practical education of their activity plan. These concepts help the students to develop the following critical skills in the following area:

- Creativity and Innovation;
- Communication and Collaboration;
- Research and Information Fluency;
- Critical Thinking, Problem Solving and Decision Making;

• Digital Citizenship;
• Technology Operations and Concepts.

This concept can be integrated in different levels of education in field of chemistry, biology, physics, mathematics environmental education and sustainable development of the green energy sources. The measured data can be evaluated with a data analyzer software „MultiLab", that provides students with the ability to analyze their data with sophisticated analysis tools such as curve fitting, statistics, and both integral and derivative, using analysis wizards.(www.fourieredu.com)

3. STRUCTURE AND TECHNICAL PARAMETERS OF THE DATA LOGGING UNIT

The structure of the data logging unit is presented in figure 1. It can be seen that the central equipment is a Nova link that logger and is connected directly to the PC or to the laptop and is powered by USB port. For this logger we can connect simultaneous 4 sensors. The logger can work with 65 type sensors from Fourier family. All of these are high quality sensors and are auto detected by the software by plug and play mechanisms.

Nova Link
Data logger
Windows / Mac / Linux based PC with Multilab
Sensors from the Fourier family

Fig. 1. Structure of the science learning station.

The used logger has the following technical parameters.
• sampling resolution: 12-bit
• sampling rate A/D: up to 10 ksps;;
• 1 sensor = 10 ksps;
• 2 sensors = 2 x 5 ksps;
• 3 sensors = 3 x 3.3 ksps;
• 4 sensors = 4 x 2.5 ksps.
Sampling rate calculation = 10K ÷ number of sensors.

4. CASE STUDIES WITH USE OF THESE GADGETS AND MEASUREMENTS RESULTS

One way to educate the new generation in the spirit of critical thinking is the elaboration of different case studies. That can be the answer for the following questions:

What alternatives energy sources are most useful in your region and climate? Why?

What can you do to conserve energy where you live, in personal habitat, at your workplace?

Do you think that building wind farms in remote places, parks or scenic wilderness areas would be damaging our unsightly, that can be have a negative impact assessment to the environmental appearance?

Can you evaluate the wind energy potentials in your region?

Do you think that in your city the streets and parks are correspondingly illuminated, what is your opinion about the efficiency of the solar street lighting in parks? (Bartha, 2012), (Hankins, 2007)

To answer these questions the students can elaborate different case studies. The present paper gives two examples, one for study of the quality of the street and in office lighting and the wind energy potential measurements in the studied area. For these case studies we elaborate two measurement units using the following sensors:

Light multi range sensor „*DT009-4 typ*e, designed to measure three ranges of light, 0-600 lx, 0-6lkx and 0-150 Klux values that is an ideal sensor for indoor and outdoor measurements. The resolution is 12 bit

Anemometer wind speed and direction sensor „AC *012A*"r; - that can be used in realizing of the various climatologically and environmental studies and has the following technical parameters:

– wind speed range: 4-280 km/h;
– resolution: 0.1 km/h;
– accuracy: ± 5%;
– sampling rate: up to one sample per second;
– wind direction range: 0-360;
– resolution: 0.09º;
– accuracy: ± 7%;
– sampling rate: up to one sample per second.

In the first case we elaborated a measurement series of the evaluation of the level of the lighting at main streets and parks and we compared the results with predefined values established in standards (**EN 13201-2**). Based on this standard the requirements for the lighting level is classified in six classes and referring to lighting the streets, roads, residential areas, parking places, etc. From the measured data we can pronounce the following statistics:

– average value of the level of lighting is 11.97 lx;
– min. value: 0.1 lx;
– max. value 94.94 lx.

From this data we established the level of the lighting in the studied streets are corresponding to class *P 2*- especial for *Streets with pedestrian or cyclist traffic*. In case of the measurements realized in a small park where the lighting elements are solar street lamps the results statistics is:

– average level of the lighting is 1.90 lx;
– min. value: 0 lx;
– max. value: 8.34 lx, measured less than 2.3 m to lamp.

Those are corresponding to *P 6* class - Streets with very little pedestrian traffic.

In case of wind measurements the one day value of the wind speed can be seen in Figure 1.

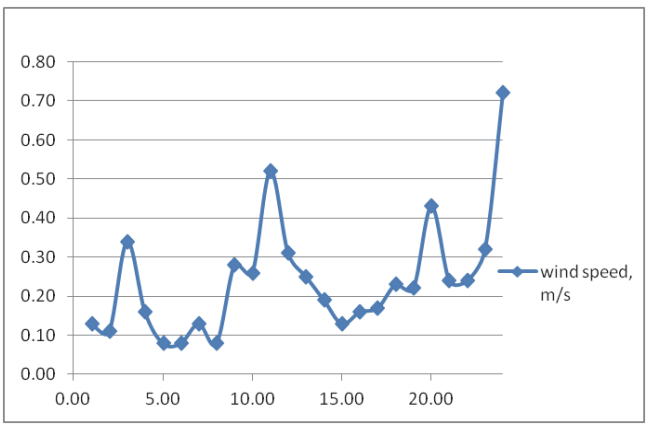

Fig. 1. The daily wind speed profile

5. CONCLUSION

The presented experimental methods in this paper show that the Nova concept can be successfully integrated in education process of the sustainable energy and environment and sustainable development related disciplines.

The NOVA family data loggers were chosen for the following reasons: competitive price, windows based graphical user interface which made them easier to use, the large screen available for manipulating data, the vast range of sensors available for all the science disciplines, their facility to be used from lower secondary schools to upper secondary and university. We are satisfied with the products purchased and with the level of service which we have received from Fourier's local distributor.

We realized that the students can use in easy way these equipments in process of measuring the environmental and technological parameters and with these dates they can elaborate different case studies. This concept can be extended to other areas of the technical education, like biology, physics.

By using these methods in technological education we had seen the effect of increasing student attendance on s hours.

These methods used with these gadgets can be generalized in practical education technologies. The case studies and diploma work realized with helpful of these gadgets from Nova data logger family can arrived a high quality and this measurement technique help the students to elaborate his works in spirit of critical thinking.

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