PROJEKAT ZAŠTITE ŽIVOTNE SREDINE I KORIŠĆENJA OBNOVLJIVIH IZVORA ENERGIJE ZA POVEĆANJE ENERGETSKE EFIKAŠNOSTI U OBJEKTU SREDNJE TEHNIČKE ŠKOLE „MIHAJLO PUPIN“, KULA, VOJVODINA

PROJECT - ENVIRONMENTAL PROTECTION AND THE USE OF RENEWABLE ENERGY SOURCES FOR INCREASING ENERGY EFFICIENCY IN SECONDARY TECHNICAL SCHOOL „MIHAJLO PUPIN“ IN KULA, VOJVODINA

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Opšti cilj projekta jeste da doprinese smanjenju emisije CO₂. Realizacijom projektnih aktivnosti bićemo u mogućnosti da postojeći sistem grejanja zamenimo sistemom toplotnih pumpi i u potpunosti izbacimo upotrebu fosilnih goriva koje koristimo za zagrevanje naših objekata.

Pored instaliranja sistema grejanja i hlađenja putem toplotnih pumpi, projekat predviđa i formiranje edukativnog centra, gde bi se svi zainteresovani edukovali o obnovljivim izvorima energije i gde bi se omogućilo polaznicima da na konkretnom primeru uvide održivost i sve prednosti sistema grejanja i hlađenja korišćenjem OIE. Plan je da Škola postane primer dobre prakse i edukativni centar za region Vojvodine i šire i na taj način doprinese podizanju svesti stanovništva o OIE. Kao i pokretanje inicijative za uvođenje novog obrazovnog profila četvrtog stepena u području rada elektrotehnike – elektrotehničar obnovljivih izvora energije.

Ključne reči: obnovljivi izvori energije, povećanje energetske efikasnosti, zaštitna životne sredine, smanjenje emisije CO₂.

Overall objective of the project is to contribute to reducing CO₂ emissions. By realizing project activities we will be able to replace the existing heating system by heat pumps system thus completely stop using fossil fuels for heating.

In addition to installing heat pumps system for heating and cooling, this project envisages the establishment of an educational centre where everyone who is interested could learn about renewable energy sources and where participants could see, on the specific example, all the benefits and sustainability of heating and
cooling systems that use renewable energy. The plan is that the school becomes an example of good practice and educational centre for the region of Vojvodina and beyond, and in doing so contribute to raising awareness of renewable energy sources, and to initiate the introduction of new four-year educational profile in the field of electrical engineering - Renewable Energy Technician.

**Keywords:** renewable energy, increasing energy efficiency, environmental protection, reducing CO₂ emissions.

**INTRODUCTION:**

In its development plan, Secondary Technical School "Mihajlo Pupin", Kula, Serbia, envisages becoming an educational centre from Vojvodina in the field of renewable energy, increasing energy efficiency, environmental protection and reducing CO₂ emissions. This will contribute to raising students’ and local populations’ awareness and will become an example of good practice. Realization of this project (working title "Green School"), bearing in mind the necessary funds (based on preliminary project - close to 45 000 000 €) is possible only within the IPA program of the European Union (Instrument for Pre-Accession Assistance) - The Republic of Serbia and the Republic of Croatia.

![Secondary Technical School "Mihajlo Pupin", Kula-object appearance.](image)

**2. Technical solutions for using renewable energy sources, increasing energy efficiency and reducing CO₂ emissions.**

The design solution is based on using renewable energy sources and increasing energy efficiency in Secondary Technical School "Mihajlo Pupin" - Kula and using similar solutions for Technical School "Nikola Tesla" - Vukovar, Croatia. In this paper we will present the basic concept of the design solution for the building of the Secondary Technical School "Mihajlo Pupin" from Kula. Project phases:

**2.1.** Inspecting buildings using a thermal imaging camera to determine points of heat loss and quality of installed windows and other glass surfaces. The results of this recording will be presented in the project, and it will refer to the current state. In Figure 2.a. current appearance of the building’s external walls is shown, and in Figure 2b we can see picture of a thermal imaging camera which is necessary for inspecting.
2.2. Project design (conceptual design and as-build state) with technical solutions in the field of:
- architecture and civil engineering
- mechanical engineering (thermal engineering)
- electrical engineering
- hydro technical engineering.

Increased energy efficiency will be achieved and various forms of renewable energy sources will be used in these fields.

2.3. Given that we are talking about the technical schools that offer students vocational educational programmes from the following fields: mechanical engineering (thermal) and electrical engineering (electrical energy and renewable energy, mechanical technician for computer design), different types of renewable energy sources will be used in school facilities:
- geothermal for heating and cooling of the building with the use of geoprobes and brine-water heat pumps
- photovoltaic panels for the commercial electrical generation and placement of that electricity in the low voltage distribution network with the aim of selling it to the local electric utility company at the price defined by law
- solar collectors for producing hot water to be used for different purposes in the building (heating assistance, domestic hot water)
- wind-energy, or use of wind turbines, that would be used more as an educational tool since wind speeds at these locations are not suitable for this type of energy source
- also, students will have the opportunity to visit the first wind farm MK FINTEL WIND (location Štolc - Kula), that was built and put into operation in November 2015.

2.4. Reconstruction of electrical installations in the school in order to create a central system for monitoring and managing from one place, so-called "school’s central control room", where from all systems in the school could be managed. With this system we could easily see the achieved effects of using the renewable energy sources and we could monitor functioning of every element of each system indivi-
dually. Also, this system is educational, because by this particular example pupils can learn that we can intervene not only after being alerted of malfunction, but also at the first sign of failure of any element of the system.

2.5. Installing technical systems that would enable various multimedia and educational events within the school or via video-conference system. Laying the necessary installation cables would create technical possibilities and thus provide conditions for equipping every classroom, specialized classroom, auditorium, gymnasium, teachers’ lounge, meeting room, teacher-training room and every other rooms with necessary equipment such as interactive whiteboards, projectors, projection screens, video conferencing systems, alarm systems, presence control system, video surveillance and other multimedia systems that are currently on the market, during next phases.

2.6. Installation corridors for newly designed installations, needed for renewable energy system and smart building system, are planned to go through school’s hallways. This will not interfere with the current operation mode of the school, and the implementation of these systems can be done in several phases depending on available funding.

2.7. Putting these systems into operation leads to assumption that a technical school, besides its primary purpose, can offer following additional, socially useful and commercially viable activities:

- training technical staff in the use of renewable energy sources and measures for increasing energy efficiency in buildings in the field of building and construction,
- educating people living in the community, the municipality or beyond about renewable energy and measures for increasing energy efficiency in the existing residential and commercial buildings,
- increasing primary school children’s interest in technical profession, thus influencing their choice of secondary school,
- trained teachers will perform professional activities for the local government in the field of renewable energy and the implementation of various measures for increasing energy efficiency in buildings in the field of building and construction,
- enabling schools to generate additional income which could be used for teacher training, education of students, study tours, purchase of equipment and similar,
- encouraging existing actions that have already produced good results, such as the event and the conference "European Solar Days" in Kula, which was held this year on May 5 for the seventh time, as well as similar events.

3. The existing renewable energy sources, located on the premises of the Secondary Technical School "Mihajlo Pupin" – Kula

A solar photovoltaic power plant of 5.04 kW is located on the roof of our school, it is the first power plant connected to the power distribution system of Vojvodina on 19 May 2011. Solar water heating system is also located on the roof.
Description of Solar Power Plant
Secondary Technical School "Mihajlo Pupin", Kula

Based on the Programme of the Energy Efficiency Agency of the Republic of Serbia, in accordance with the reference number 312-01-20 / 2008-01 / 008 from 08.06.2009., Secondary Technical School "Mihajlo Pupin" from Kula was elected as the associate on the project "Improving the use of solar energy in the Republic of Serbia". The project is funded through a donation from the Kingdom of Spain, the Agency was the grant recipient.

The plant consists of 22 photovoltaic panels, each with peak power of 230W, connected in parallel in two photovoltaic chains of 11 panels. Photovoltaic output is connected to the inverter inputs via automatic DC fuses, bimetallic strip and double-pole switch. The inverter has a built-in system for tracking the maximum power point so-called -MPPT (Maximum Power Point Tracking), this way the delivery of produced electricity to the power distribution network is secured. The total production of the solar power plant from 19 May, 2011 until 11 June, 2016 amounts to 30626 kWh, the total operating time is 20588 h.

Description of the solar water heating system located on the roof

Within this project an additional system is planned, system for producing thermal energy required for heating , that is, technical preparation of water , it is consisted of solar collectors systems 4 x Viessmann Vitosol 200-F. Total absorption surface is 4x2.33 = 9.32 m². The collectors are arranged in a single collector array of installed capacity of 7.05 kW. Placement of collectors was planned to be on the roof of the building directly above the toilets at the side facing the southwest, through the adjustable collector bracket attached to the roof structure. The collectors have been installed at 45° angle of inclination.

In Figure 3 we can see the photovoltaic panels and the adjoining structure on the roof of the Secondary Technical School "Mihajlo Pupin", Kula and in Figure 4 the solar water heating system.

![The photovoltaic panels on the roof of the STS "Mihajlo Pupin" and the solar water heating system on the roof of the school](image-url)
4. SWOT analysis of the project "Green School" in the building of the Secondary Technical School "Mihajlo Pupin", Kula

The strengths and the opportunities of implementing project under the working title "Green School" are:
- a number of highly educated technical education teachers,
- school’s high reputation in near surroundings, and even further,
- previous experience in project implementations - in the field of RES and EE,
- good connections with the local government and other educational institutions,
- the growing interest of students in enrolling technical schools,
- well equipped laboratories and classrooms (in every classroom there is a computer, a video projector, Internet access),
- obligations of the Republic of Serbia in terms of increasing the use of renewable energy sources,
- increased interest of investors in RES and EE in the Republic of Serbia,
- education of children and local population,
- energy saving
- reducing environmental pollution
- increased consumption of renewable energy sources

CONCLUSION

This preliminary design envisaged a system for the use of renewable energy sources. Using geothermal energy for heating and cooling of the school facilities will reduce costs of purchasing energy products, as well as products of combustion of solid fuels such as harmful gases: CO₂, N₂O, CH₄, HFCs, PFCs, and SF₆, which pollute the atmosphere and cause the greenhouse effect.

The school will have the technical systems that enable different multimedia and educational events, within the school or via video-conference system. There will be a possibility that through laying the necessary installation cables we create the conditions that during next phases we equip every classroom, specialized classroom, auditorium, gymnasium, teachers’ lounge, meeting room, teacher-training room with necessary equipment such as interactive whiteboards, projectors, projection screens, video conferencing systems, alarm system, presence control system, video surveillance and other multimedia systems that are used today. Putting these systems into operation will show that Secondary Technical School "Mihajlo Pupin" from Kula, besides its primary purpose, can offer following additional, socially useful and educational activities:
- education of students about environmental protection, use of renewable energy sources and measures for increasing energy efficiency in buildings in the field of building and construction,
- education of the residents of the municipality of Kula and of entire territory of Vojvodina about environmental protection, use of renewable energy sources and
measures for increasing energy efficiency in existing residential and commercial buildings,

- increasing interest of primary school children from the municipalities of Kula, Vrbas, Srbobran, Bačka Topola, Sombor and Odžaci in technical professions thus in technical schools. In addition to current technical educational programmes, the school could introduce new educational profiles such as: renewable energy technician, energy efficiency technician, environmental protection technician, photovoltaic installation technician, etc.,

- trained teachers will perform professional activities for the local government in the field of renewable energy and the implementation of various measures for increasing energy efficiency in buildings in the field of building and construction,

- enabling school to generate additional income which could be used for teacher training, education of students, study tours, purchase of equipment and similar,

- direct incentive to the existing actions that have already produced good results in the municipality of Kula, such as "EUROPEAN SOLAR DAYS" in Kula and similar.

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