One of the main tasks of scientists around the world in recent years is to work on storage of **large amounts of energy**, i.e. batteries that would store the generated energy and thereby contribute to a more efficient **energy transition**.
Among the numerous researchers is a group of six young scientists from Serbia who are looking for a battery that would not contain extremely toxic and at the same time rare materials such as lithium or cobalt.
Under the name **HiSuperBat (Healthy super battery)** they have created a system that does not contain lithium and cobalt but calcium or magnesium, and also uses an aqueous electrolyte that is not flammable and toxic like commercial organic electrolyte.
Doctor Milica Vujković, who manages the project, states that the development of such battery systems could be an excellent energy solution, because thereby the usage of expensive and scarce lithium will be avoided, the cost of the battery will be reduced and safety will be increased…
That is why the search for new, cheap and safer materials, capable of storing a large amount of multivalent ions, is of great importance and is the subject of numerous researches in the world, including the HiSuperBat project, which received 180,000 euros.
Their two-year project, which ends at the end of 2022, is one of 59 selected projects supported through the Promis project supported by the **Science Fund of the Republic of Serbia**.
"The project is focused on the development of electrode materials for the next generation of **electrical energy storage**devices, based on more naturally occurring elements such as calcium, aluminum, and magnesium," Milica Vujković, a research associate at the Faculty of Physical Chemistry, said for the N1 portal.
She points out that all young experts have expertise in the synthesis and structural study of micro/nanomaterials, electrochemistry, batteries and supercapacitors, that the project has provided new fundamental and practical knowledge in the field of energy storage, which has been published in 11 international scientific journals and 18 conference announcements.
Materials have been developed that can store a large amount of multivalent ions per unit mass.
"On the one hand, carbon material has been developed as an electrode material for supercapacitors of the latest generation, which can store large amounts of aluminum, magnesium and calcium ions on the basis of charge.
A supercapacitor was constructed at the level of a single cell, with carbon electrodes obtained from waste biomass (from the wine industry) and an aqueous electrolyte based on aluminum positive ions, whose optimal operating voltage in terms of long-term

charge/discharge is 1.5 volts (V), which is half a volt more than a classic water supercapacitor," she says.
These results were published in the prestigious electrochemical magazine Journal of Power Sources, and were done in cooperation with Montenegro and Slovenia.
In addition, the young scientists showed how the voltage and capacity properties of the carbon cathode can be improved by mixing aluminum and calcium ions.
Vujković also points out that a cathode material for batteries based on vanadium oxide has been developed that can store a large amount of calcium ions, showing higher capacities compared to the storage of lithium ion charges.
"By combining the aforementioned carbon material as an anode, calcium vanadium oxide as a cathode and an electrolyte based on calcium salt, we assembled a hybrid cell that has an optimal voltage of 1.4-1.5 volts (V).
The advantage over classic lithium-ion systems is that the constructed battery cell does not contain **lithium and cobalt**, and uses an aqueous electrolyte that is not flammable and toxic like commercial organic electrolytes," she says.
As a disadvantage, Vujković cites a lower voltage compared to a commercial lithium ion cell due to the use of an aqueous instead of an organic electrolyte.
"However, something like that could be replaced by sequentially connecting more cells, which would produce a heavier battery."
For this reason, their potential application is currently limited to systems where weight and volume are not limiting and price plays a primary role", says our interlocutor.

Production in Serbia

The research was started with the idea that potential discoveries can be made in Serbia. It is the same now. Milica says that the constructed carbon supercapacitor as well as the hybrid cell have the potential to be produced in Serbia.
"Their performance is obtained at the level of a coin-shaped cell, which would enable application in some everyday needs: watches, toys, kitchen scales, car keys, calculators…" she states.
However, before this could happen, additional experiments are necessary in terms of optimizing cell performance.
"There is room to improve the material's performance and overcome its weak points, and we have several ideas in mind that could be implemented."
After the completed phase at the laboratory level, the transfer of knowledge to the industrial sector would entail testing the reproducibility of the synthesis of the given materials on a larger scale and their functionality, as well as the optimization of the cell assembly

procedure for mass needs.
Such batteries would have the potential to replace lead accumulators or nickel-cadmium water systems, and theoretically speaking, they would also have the potential for application in large stationary energy storage systems connected to renewable sources, where price and safety are more important than mass and energy," Vujković points out.

Contemporary world research

Modern world research is focused on the development of different types of batteries, based on different chemistry.
For the development of all types of batteries, it is important that they can be used in different applications, because each type of battery has certain advantages and disadvantages. Milica, on the other hand, points out that you never know in advance what can be discovered through research.
"For now, the market is mainly dominated by Lithium-ion batteries based on carbon as the anode, organic electrolyte containing lithium ions, and lithium-nickel-cobalt-manganese oxide (NMC) as the cathode."
However, we are aware of the fact that lithium is a limited resource and that its reserves will not be able to meet the future needs of the galloping electric car industry," she points out.
"I am convinced that the situation in that field will also change significantly." As for our research, in the course of the project, in addition to the development of carbon and vanadium oxide, we also started the development of new types of cathodes for sodium ion batteries, based on sodium and iron.
Therefore, the further direction of our research, in addition to the improvement of the developed multivalent model, will also be focused on the development of the sodium ion system, with the aim of obtaining the best possible model not only in terms of energy, but also in terms of price and environmental acceptability.
Of course, I expect that this type of research will be recognized through future national and international calls to which we apply", concludes Milica Vujković.