OPINION

from

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Subject: Competition procedure for the academic position of "professor" in the field of higher education 4. Natural sciences, mathematics and informatics, professional direction 4.4. Earth Sciences, scientific specialty "Ecology and Ecosystem Protection" in the discipline "Solid Waste Processing Technologies" for the needs of the Faculty of "Ecology and Landscape Architecture", announced in the State Gazette, № 100/16.12.2022.

The candidate in the competition Assoc. Prof. Dr. Ekaterina Todorova, presents one monograph, 78 scientific publications, of which 43 are publications on procedures for the educational and scientific degree "doctor" and academic position "associate professor" and 195 citations. He is the supervisor of two successfully defended PhD students, participates in 26 national scientific and three international projects, of which he is the supervisor of 8 national projects. In the presented reference, the candidate exceeds the required minimum of scientific metric indicators in components G, D and E.

The published scientific works are defined in three scientific directions: 1. Minimization and utilization of waste as a raw material and energy resource, including through industrial symbiosis. 2. Environmentally friendly management of mining waste. 3. Environmental efficiency of waste treatment technologies.

In the first scientific direction, the monograph "Industrial symbiosis of biodegradable waste – a key element for its prevention" was developed. The development is developing opportunities for using sludge from sewage treatment plants (WWTP), green biowaste and biowaste from food, in connection with our country's obligations to introduce a circular economy. In the specifics of industrial symbiosis, specific technological solutions are offered based on the quantitative and qualitative composition of biodegradable waste and its life cycle. A scheme has been developed for the minimization and utilization of non-hazardous sludges from wastewater treatment plants by obtaining compost and lubricompost. It has been confirmed the need for the sludge to undergo a process of anaerobic biotechnological treatment, and not to be used directly in agriculture, thus obtaining the maximum benefit from this waste. On the one hand, its energy

capacity will be used to obtain electrical energy, then its raw material capacity will be used by using the obtained fermentation product in agriculture. A scheme of industrial symbiosis of hazardous sludge from sewage treatment plants has been developed based on thermal methods (gasification-plasma plant, thermotribochemical catalytic plant, etc.) to obtain various chemical products that are an alternative to natural gas and oil. An industrial symbiosis scheme has been proposed between companies-generators of biodegradable waste and companies from the chemical industry, electric and topolo energy companies, agricultural products and fertilizers companies, and biogas, synthesis gas, synthetic oil and other substances and products can be obtained by heat treatment. In parallel with the presented monograph, 18 publications with № 44(G7.1), 45(G7.2), 52(G7.9), 54(G8.2), 55(G8.3), 57(G8.5), 58(G8.6), 59(G8.7), 60(G8.8), 62(G8.10), 64(G8.12), 66(G8.14), 69(G8.17), 71(G8.19), 72(G8.20), 75(G8.23), 77(G8.25) and 10 projects, of which the candidate is the head of 4 projects.

In the "Environmentally sound management of mining waste" direction, 13 publications have been developed with № 46(G7.3), 47(G7.4), 49(G7.6), 50(G7.7), 53(G8.1), 56(G8.4), 61(G8.9), 63(G8.11), 65(G8.13), 67(G8.15), 68(G8.16), 73(G8.21), 74(G8.22) and 15 b projects. The main scientific and scientific-applied contributions are related to establishing that mining waste from the processing of copper and polymetallic ores containing gold and silver do not contain substances hazardous to the environment and human health, especially As, Cd, Co, Cr, Cu, Hg, Mo, Ni, Pb, V and Zn, including in the fines of the waste, in concentrations leading to their classification as hazardous waste under both chemical and waste management legislation. It is confirmed that mine tailings from cyanide gold mining meet regulatory requirements and the concentration of weak acid decomposable cyanide at discharge points does not exceed 10 mg/kg, which is in accordance with the best available techniques. It is proven that utilization of mining waste for backfilling of mine workings does not lead to additional leaching of the impurity elements contained in it. It is proven that the preliminary treatment of mining waste by separating the clay from it is a prerequisite for minimizing the amount of waste and utilizing the clay as an alternative to naturally mined clay. It is proven that the application of mining waste in the construction of forest roads is effective for their strengthening and leads to the utilization of significant amounts of mining waste. A methodological approach has been developed for the classification of mining waste and its behavior in the environment by applying static and kinetic leaching test. It has been confirmed that mine wastes containing sulphide sulfur > 0.1% tend to form acidic waters. The presence of sulphide sulfur above the specified concentration is a prerequisite for the classification of the waste as hazardous.

The direction "Environmental efficiency of waste treatment technologies" is protected by 4 publications with № 48(G7.5), 51(G7.8), 70(G8.18), 72(G8.20) and a manual of one infrastructural and scientific project with international funding. The main scientific and scientific-applied contributions are related to the establishment that in the assessment of the ecological efficiency of various actual plants for composting and thermal treatment of bio-waste, based on the international standard ISO 14045:2012, the ecological efficiency depends to a different extent, as from the economic value as well as from the environmental impact that the technology has. The results of the evaluation confirm that the methods that utilize the energy and raw material potential of waste have a higher ecological efficiency. By means of quantitative parameters, the ecological efficiency was calculated for various thermal methods of waste treatment, incl. plasma-gasification, and their environmental compatibility has been proven. Among the investigated installations, the installation for obtaining electrical energy has the highest efficiency, followed by the installations for the production of ammonia and diesel. It was found that by calculating the ecological efficiency, the appropriate methods for treating hazardous waste can be identified, which is a prerequisite not only for reducing the impact of this group of waste on the environment, but also for turning it into an energy and raw material resource. It is proven that in waste recycling, the ecological efficiency depends to a significant extent on the economic value of the process (respectively, the amount of recycled waste). Recycling, as part of the circular economy, has its financial side, but collecting and recycling one ton of recyclable materials is much more economical than landfilling one ton of waste. It has been found that as disposal costs increase, thermal methods will become more environmentally efficient. The methodological contribution is related to a proposal for a unified system for a detailed, concrete and reliable assessment of environmental performance through thirteen groups of indicators, each of which includes a different number of specific indicators for environmental protection, human health protection and sustainable development. This system can be used to evaluate investment proposals in terms of their impact on the environment.

On the basis of the analysis of the documentations and the results in the scientific work of Associate Professor Dr. Ekaterina Todorova, I can express a positive opinion and recommend that she be confirmed in the academic position of "professor" in the field of higher education 4. Natural sciences, mathematics and informatics , professional direction 4.4. Earth Sciences, Science Specialization "Ecology and Ecosystem Conservation".

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Sofia

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