Brief information about the project

Title	AP25794587 «Creation of biotechnology for atmospheric carbon sequestration by microalgae for green innovations»
Relevance	The development of civilization is directly proportional to the growth of energy demand. In this case, due to the growing demand for energy, coal continues to be one of the main sources of energy raw materials, but coal consumption is believed to emit the bulk of the world's anthropogenic CO2. In this regard, a relatively new and less studied third-generation biofuel is put forward - microalgae biomass. CO2 sequestration through a microalgae system is considered a promising and feasible option. The combination of CO2 sequestration process and biofuel production in pellet form can provide an extremely promising alternative to existing fuels and CO2 reduction technologies.
Goal	Create a biotechnology for atmospheric carbon sequestration using unique, natively adapted coal microalgae for green innovation.
Tasks	Tasks project • To isolate, identify and characterize (microbiological, functional and chemical properties) microalgae from different water bodies contaminated with coal. • To determine the optimal growth conditions for microalgae and promote their mass cultivation, collection and processing. • Select microalgae strains with excellent resistance to high CO_2 concentrations . • Determine conditions for maximum productivity of these biosystems, including algae type, light sources, nutrients, pH , temperature, and mass transfer . • Design a photobioreactor with appropriate equipment suitable for growing microalgae biomass. • To study the ability of algae to capture carbon dioxide by introducing highly concentrated CO_2 gas , commonly found in flue gases from industry. • Collect and characterize coal samples based on their chemical composition and morphological characteristics using technical (proximate) and elemental (ultimate), spectroscopic and microscopic analyses. • To study the thermogravimetric characteristics of coal and determine the composition of gases emitted during coal combustion. • To investigate the effect of using algae on reducing emissions of pollutants, CO_2,NOx and SO x • To study the potential of using microalgae as a binding agent in the creation of pellets from a complex of microalgae biomass and coal. • To investigate the importance of the selected proportion of microalgae and carbon for the best strength of the granule structure and maximum calorific value.

	• Design a form of granulated biofuel from coal and microalgae. • To study the processes of step-by-step conversion of biomass: ignition, decomposition (pyrolysis) and combustion. • To examine the thermogravimetric characteristics of formulated coal and microalgae pellets and to determine the composition of gases emitted during coal combustion. • To investigate the behaviour of formulated coal and microalgae pellets under co-firing. • To study the characteristics of pellets through compressive strength and water resistance analyses. • To explore the emissions (gases, soot, ash) formed after combustion of coal with microalgae. • Scaling up the production of fuel pellets from coal and microalgae to assess commercial potential and test technological risks.
Expected and Achieved Results	Expected Results: - By 2025: Microalgae samples will be selected and characterized. The optimal conditions for microalgae growth will be determined. The ability of microalgae to capture carbon dioxide (CO_2) will be studied. - By 2026: Coal samples will be collected and analyzed; the thermogravimetric characteristics of coal will be determined, as well as the composition of gases released during coal combustion. The effect of used microalgae on the reduction of pollutant emissions, including NOx and SOx, will be analyzed. Through a comprehensive analysis, the potential of using microalgae as a binding agent in the creation of pellets from a complex of microalgae biomass and coal will be studied. The importance of the selected proportion of microalgae and coal for the best structural strength of the pellets and maximum calorific value will be assessed. - By 2027: The form of granulated biofuel from coal and microalgae will be developed. All step-by-step conversion processes—ignition, decomposition (pyrolysis), and combustion—will be studied. The thermogravimetric characteristics of the formulated coal and microalgae pellets will be determined. The behavior of these formulated pellets under co-firing conditions will be examined. The characteristics of the pellets will be assessed through compressive strength and water resistance analyses. Emissions generated after the combustion of coal with microalgae (soot, ash, volatile compounds) will be studied. Large quantities of fuel pellets from coal and microalgae will be produced to evaluate their commercial potential and to test technological risks. Data will be obtained on the overall process efficiency, including investment and operational costs. Scientific articles will be published in international peer-reviewed journals: at least two (2) articles in journals ranked in the top three quartiles by impact factor in the Web of Science database or with a CiteScore percentile of at least 50 in the Scopus database. Target journals for submission include: *Fuel Processing Technology*: Quartile 1 (Q1), CiteScore percentile – 93 (General Chemical Engineering) https://www.scopus.com/sourceid/16315 *Scientific Reports*: Quartile 1 (Q1), CiteScore percentile – 92 (Multidisciplinary)

	https://www.scopus.com/sourceid/21100200805
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Publications list with links to them	Evaluating the low-rank coal degradation efficiency bioaugmented with activated sludge , Scientific Reports (№14, 2024) https://doi.org/10.1038/s41598-024-64275-2 Hydrogenotrophic methanogenesis in coal-bearing environments: Methane production, carbon sequestration, and hydrogen availability, International Journal of Hydrogen Energy (2023) https://doi.org/10.1016/j.ijhydene.2023.09.223
Patent information	Patent № 10021 Пайдалы модель Төмен сортты көмірді еріту тәсілі Способ солюбилизации низкосортного угля Method of solubilization of low-grade coal