Brief information about the project

Title	AP22685893 «Investigation of the aerodynamic characteristics of asymmetric shaped blades used in a wind power plant to increase turbine efficiency»
Relevance	The blades are the key component of a wind energy unit, as they are responsible for converting the kinetic energy of the wind into the mechanical energy of rotor rotation. To achieve maximum efficiency of a wind energy system (WES), researchers aim to improve the aerodynamic performance of the blades. The presented project is focused on the development and investigation of the aerodynamic characteristics of WES blades with an asymmetrical shape, utilizing their potential to enhance wind energy conversion efficiency, as well as addressing the self-starting problem of WES at low wind speeds.
Goal	Modeling and experimental investigation of the aerodynamic characteristics of asymmetrical blades to improve the efficiency of a vertical-axis wind energy unit (VAWT).
Tasks	Objective 1. Aerodynamic modeling: Development of numerical models and conducting computational aerodynamic studies to assess the aerodynamic characteristics of asymmetrical blades. Objective 2. Analysis of blade design influence on the performance of a vertical-axis wind energy unit: Investigation of how blade geometry affects the operation and efficiency of a vertical-axis wind turbine. Objective 3. Fabrication of asymmetrical blades: Manufacturing of asymmetrical blade prototypes and conducting physical experiments in a wind tunnel to measure their aerodynamic parameters. Objective 4. Preparation of scientific reports and publications: Documentation of all research results and preparation of scientific reports and articles for publication.
Expected and Achieved Results	1. Expected Result: 2. . Based on the results obtained, a dissertation for the Numerical models will be developed and computational aerodynamic studies will be conducted to obtain accurate data on the aerodynamic characteristics of asymmetrical blades, including lift coefficient, drag coefficient, and other parameters. 3. Expected Result: The evaluation of the impact of blade design modifications on the overall performance and efficiency of the wind energy system will help determine the extent to which improved aerodynamic characteristics contribute to increased efficiency. 3. Expected Result: Physical experiments in a wind tunnel will provide real data on the aerodynamic parameters of the blades and will serve to validate the results of numerical modeling. 4. Expected Result: The research findings will be documented in scientific reports, which will be published in academic journals and

	presented at conferencesdegree of Doctor of Philosophy (PhD) will be prepared and submitted for defense. Achieved Results 1. Numerical models were developed and computational aerodynamic studies were conducted to investigate the aerodynamic characteristics of asymmetrical blades. During the research, key parameters such as the lift coefficient (Cy), drag coefficient (Cx), and others were determined. 2. It was demonstrated that changes in blade geometry have a positive impact on the overall efficiency of the vertical-axis wind energy system. Numerical analysis confirmed that the use of an asymmetrical shape contributes to improving the efficiency of wind energy conversion. 3. The results of physical experiments conducted in a wind tunnel showed good agreement with the numerical modeling data, confirming the accuracy of the applied computational models. 4. Based on the obtained results, scientific reports and articles were prepared, published in reputable scientific journals, and presented at international conferences. As a result of the research, a dissertation for the degree of Doctor of Philosophy (PhD) was prepared and successfully defended. The results of the conducted research and the obtained data were compiled into conference abstracts, presented, and published in the proceedings of the following international scientific conferences: 1. Articles published in international peer-reviewed journals indexed in the Scopus / Web of Science databases: – Isataev M., Manatbayev R., Seydulla Z., Bektibai B., Kalassov N. Study of Aerodynamic Characteristics of Asymmetrical Blades and a Wind-Driven Power Plant with a Vertical Axis of Rotation. Applied Sciences, 2024, 14, 11654. https://doi.org/10.3390/app142411654 – Isataev M., Manatbayev R., Seydulla Z., Kalassov N., Yershina A., Baizhuma Z. Experimental and Computational Study of the Aerodynamic Characteristics of a Darrieus Rotor with Asymmetrical Blades to Increase Turbine Efficiency Under Low Wind Velocity Conditions. Applied System Innovation, 2025, 8, 49. https://doi.org/10.3390/asi8020049 2. Articles published in journals recommended by the Committee for Quality Assurance in the Sphere of Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan (CQASSHE MES RK): – Isatayev M.S., Ershina A.K., Manatbayev R.K., Seydulla Zh.K. Experimental study of the characteristics of a wind energy unit with asymmetrical blades in a wind tunnel // Bulletin of the Almaty University of Power Engineering and Telecommunications, No. 1 (68), 2025. – pp. 80–90.

	https://doi.org/10.51775/2790-0886_2025_68_1_80 – Seydulla Zh.K., Isatayev M.S., Manatbayev R.K., Ershina A.K., Dodayev S. Aerodynamic study of asymmetrical blades for a vertical-axis wind turbine // Bulletin of the Toraygyrov University. Energy Series, No. 1, 2025. – pp. 330–343.https://doi.org/10.48081/PLVX7878 3. Intellectual Property Protection: An author's certificate for the invention has been obtained: – Seydulla Zh.K., Isatayev M.S., Manatbayev R.K. "Darrieus Wind Turbine with Asymmetrical Blades" Registered by the Ministry of Justice of the Republic of Kazakhstan, RSE "National Institute of Intellectual Property", Certificate No. 53576, 2025.
Names and Surnames of Research Group Members with Their Identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and Links to Corresponding Profiles	**Project Leader:** Zhanibek Kanatbekovich Seydulla Education: Al-Farabi Kazakh National University (Bachelor's degree, 2013, Kazakhstan); Al-Farabi Kazakh National University (Master's degree, 2015, Kazakhstan); Al-Farabi Kazakh National University (PhD, 2021, Kazakhstan). **Scopus ID:** 57202515147 (SCOPUS h-index = 1) **ORCID:** https://orcid.org/0000-0003-0413-6557 **Scientific Advisor:** Mukhtar Sovetovich Isatayev Al-Farabi Kazakh National University, Candidate of Physical and Mathematical Sciences **h-index:** 2 **ResearcherID:** N-4870-2014 **ORCID:** ORCID 0000-0001-8248-670X **Scopus Author ID:** 56943370900
Publications list with links to them	1. Seydulla, Z.K., Isataev, M.S., Toleuov, G.K. Study of aerodynamics of the jet spreading over cy-lindrical surface // Journal of Physics: Conference Series, Volume 1382, Issue 1, 28 November 2019, # 012038. SJR-0.221. Q4. Процентиль – 17. https://doi.org/10.1088/1742-6596/1382/1/012038 2. Isataev, M.S., Toleuov, G., Seydulla, Z.K. Aerodynamics of cylindrical finite length bodies // International Journal of Fluid Mechanics Research, 2023, 50(4), страницы 13–20. **Q3.** SJR: 0.256. Процентиль – 49. https://doi.org/10.1615/InterJFluidMechRes.2023047828 Консультант проекта: кандидат физико-математических наук **Исатаев Мухтар Советович,** SCOPUS h – индекс 2. https://orcid.org/0000-0001-8248-670X, Scopus Author ID 56943370900. *Сведения об основных публикациях научного консультанта проекта:* 1. M.S. Isataev, G. Toleuov, K.A. Esenalina. Experimental investigation of the propagation of the three-dimensional turbulent jets outflowing from rectangular nozzles // Journal of Engineering Physics and Thermophysics, Vol. 90, No. 6, (USA) New York, 2017. – P.1469-1474. SJR: 0.357. Процентиль – 48. https://doi.org/10.1007/s10891-017-1707-6 2. Исатаев М.С., Кантаева Г.Н., Кантаева М.Н. Применение вычислительной гидродинамики для получения максимальной эффективности крыла беспилотного летательного аппарата // ВЕСТНИК КазНПУ им. Абая. Серия «Физико-математические науки» № 2 (66), 2019. С. 141-146.

	https://bulletin-phmath.kaznpu.kz/index.php/ped/issue/view/9/7 3. Сейдулла Ж.К., Исатаев М.С., Толеуов Г., Султан М.Р. Расчет распределения статического давления в струе, распространяющейся вдоль шероховатой криволинейной поверхности // Вестник КазНИТУ. – Алматы, 2020. - №2 (138). – С. 668-672 https://vestnik.satbayev.university/index.php/journal/issue/view/60/57 4. Isataev, M.S., Toleuov, G., Sultan, M. Experimental Investigation of a Free Turbulent Air Jet Outflowing from a Nozzle of Square Shape // Journal of Engineering Physics and Thermophysics, Vol. 93, No. 1, (USA) New York, 2020. – P.172-177. SJR: 0.357. Процентиль – 44. https://doi.org/10.1007/s10891-020-02105-8 5. Туманов И.Е., Болегенова С.А., Исатаев М.С., Орынбаев С.А., Куттыбаев Г.У. Устройство автономного теплоснабжения и горячего водоснабжения с использованием солнечной и ветровой энергии. Патент на полезную модель №7096 от 13.05.2022. https://kazpatent.kz/ru/content/poleznaya-model-13052022 6. Isataev, M.S., Toleuov, G., Seydulla, Z.K. Aerodynamics of cylindrical finite length bodies // International Journal of Fluid Mechanics Research, 2023, 50(4), страницы 13–20. **Q3.** SJR: 0.256. Процентиль – 49. https://doi.org/10.1615/InterJFluidMechRes.2023047828
Patent information	The patent is not considered within the framework of this project.