

Brief information about the project

Name of the project	AP26100165 «Design and Development of a Wind Turbine with a Unique Thermal Protection System for Sharply Continental Regions»
Relevance	Renewable energy sources, particularly wind energy, are currently one of the key directions of energy production. However, under sharply continental climate conditions, the performance of wind turbines decreases due to blade icing. This issue deteriorates the aerodynamic characteristics of the turbine, reducing its efficiency and reliability. Therefore, the development of anti-icing and thermal protection systems is an important scientific and technical challenge for the advancement of wind energy.
Purpose	The objective of the project is to develop a new wind turbine design with a thermal protection system that enables the most efficient utilization of wind energy with minimal energy consumption, thereby improving the overall efficiency of the turbine.
Objectives	• Theoretical investigation and modeling of the blade icing process in wind turbines. • Development of a thermal protection system model for turbine blades. • Calculation and optimization of the geometric parameters of flow channels for heat distribution. • Investigation of aerodynamic and thermophysical characteristics of blades using computational fluid dynamics (CFD). • Analysis of numerical simulation results and their comparison with experimental data. • Development of a prototype wind turbine equipped with a thermal protection system. • Experimental testing of the prototype under real climatic conditions and evaluation of its performance. • Preparation and publication of scientific articles. • Development of design and engineering documentation.
Expected and achieved results	Achieved Results: 1. Validated numerical simulation results were obtained, including ice shape, mass, and icing area. 2. The required heat input was calculated for various weather conditions and operating regimes. 3. The optimal geometric parameters of the flow channel for blade heating were determined and optimized. 4. Participation in international conferences was accomplished. 5. At least one scientific paper was published in journals indexed in Web of Science (Q1–Q3) or Scopus (CiteScore percentile ≥ 50). 6. At least two scientific papers were published in journals recommended by CQAHES (Committee for Quality Assurance in Higher Education and Science, Ministry of Science and Higher Education of the Republic of Kazakhstan). 7. At least one intellectual property object (patent or copyright certificate) was obtained and registered with the National Institute of Intellectual Property of the Republic of Kazakhstan. Expected Results: 1. An effective model of a blade thermal protection system will be developed, taking into account natural convection and airflow effects. 2. Numerical simulation results for the aerodynamic and thermal characteristics of the wind turbine will be obtained.

	3. An experimental prototype of the wind turbine will be developed. 4. The prototype will be tested under real climatic conditions, and the efficiency of the thermal protection system will be experimentally validated. 5. Several scientific publications will be produced based on the research results (Scopus / Web of Science). 6. Several scientific articles will be published in journals recommended by CQAHES. 7. A patent will be obtained, and design and engineering documentation will be developed. 8. The technology readiness level (TRL) will reach TRL-4, making it ready for further scaling.
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	1. Zhandos Eskendiruly Baizhuma, Project Leader, PhD– AGW-6573-2022; ORCID: 0000-0003-3692-2245; Scopus Author ID: 57205433240. https://www.scopus.com/authid/detail.uri?authorId=57205433240 2. Nurdaulet Bolatuly Kalassov, CR, PhD– Researcher ID: CWN-8563-2022; ORCID: 0000-0003-3709-5544; Scopus Author ID: 57222177960. https://www.scopus.com/authid/detail.uri?authorId=57222177960 3. Yelubayeva Balgyn CR, Scopus ID: 60375429700 4. Birzhan Zhapsarbekuly Bektibay, LR, Candidate of Technical Sciences.- .- Researcher ID CGI-6982-2022. https://orcid.org/0000-0001-6411-8049 Scopus ID: 55566693200 5. Bakyt Tileulesuly Amir, JR, Candidate of Technical Sciences, https://www.scopus.com/feedback/author/reviewAuthorProfile.uri?authorIds=59917253600 https://orcid.org/4040009-0003-9347-8379 6. Gulzhan Ospanbekovna Ilyassova, JR,-Researcher ID: PJB-0072-2026; Scopus Author ID Scopus ID: 60375429600 https://ORCID.org/0009-0008-6205-4959 7. Almat Akhmetali, Engineer
Usage	
Priority compared to real-world alternatives	
List of publications with links to them	1. Zhandos Baizhuma, Nurdaulet Kalassov, Gulzhan Ilyassova, Aktolkyn Danlybaeva, Zarina Gabitova, Balgyn Yelubayeva, Aleksandar Georgiev (2026) Heat transfer and flow dynamics in heat exchangers for efficient waste heat utilization. <i>Applied Thermal Engineering Volume 290, Part 2</i>, April 2026, 129994. https://doi.org/10.1016/j.applthermaleng.2026.129994 2. Z. Baizhuma, N. Kalassov, G.Ilyassova. Қалдық жылуды тиімді пайдалану үшін жылу алмастырғышты CFD арқылы талдау. (2025) <i>Bulletin of Toraighyrov University, Energy Series № 4 (2025) PAVLODAR</i>. https://doi.org/10.48081/BGZB9542. 3. Z. Baizhuma, R.Manatbayev, N. Kalassov, A.Sabirova. Оценка производительности вертикальных турбин с вертикальной осью вращения на основе импульсных моделей. <i>Bulletin of Almaty University of Power Engineering and Telecommunications</i>. 3 (70) 2025 Impact Factor - 0.076. DOI 10.51775/2790-0886_2025_70_3_7
Patents	Z. E. Baizhuma, B. T. Amir, B. Zh. Bektibay, R. K. Manatbayev, M. S. Isatayev, Zh. K. Seidulla, N. B. Kalassov, G. O. Ilyassova. №. 2026-20477, 13.03.2026.

	«Method and Device for Thermal Protection of a Vertical-Axis Wind Turbine with a Troposkien System».