

Economic and Management Principles of Integrating Robotics, Artificial Intelligence, and Biotechnology into AEROVERTA International Innovation Initiatives

A Case Study of AEROVERTA REE and the Biological Remediation and Robotic Restoration Project

Dr. Andrii Dankevych, Professor, Department of Economics and Law, National University of Food Technologies, Kyiv, Ukraine; Professor, Department of Law, Public Management and Administration, Zhytomyr Polytechnic State University, Zhytomyr, Ukraine. ORCID: <https://orcid.org/0000-0003-1801-7516>

On 24–25 September 2026, the international event AIM 2026 (Artificial Intelligence Marseille), dedicated to the development of artificial intelligence, digital technologies, and innovation, took place in Marseille, France. As part of the activities of AEROVERTA ROBOTICS SAS, Professor Andrii Dankevych contributed to professional discussions and the consideration of two prospective international technology initiatives, serving as a moderator and an expert on economic, investment, and management issues.

The first initiative, AEROVERTA REE, envisages the development of an autonomous system for the exploration, extraction, and processing of rare earth elements using robotics and digital technologies. The second, the Biological Remediation and Robotic Restoration Project, aims to combine biotechnology and robotic systems to restore contaminated areas.



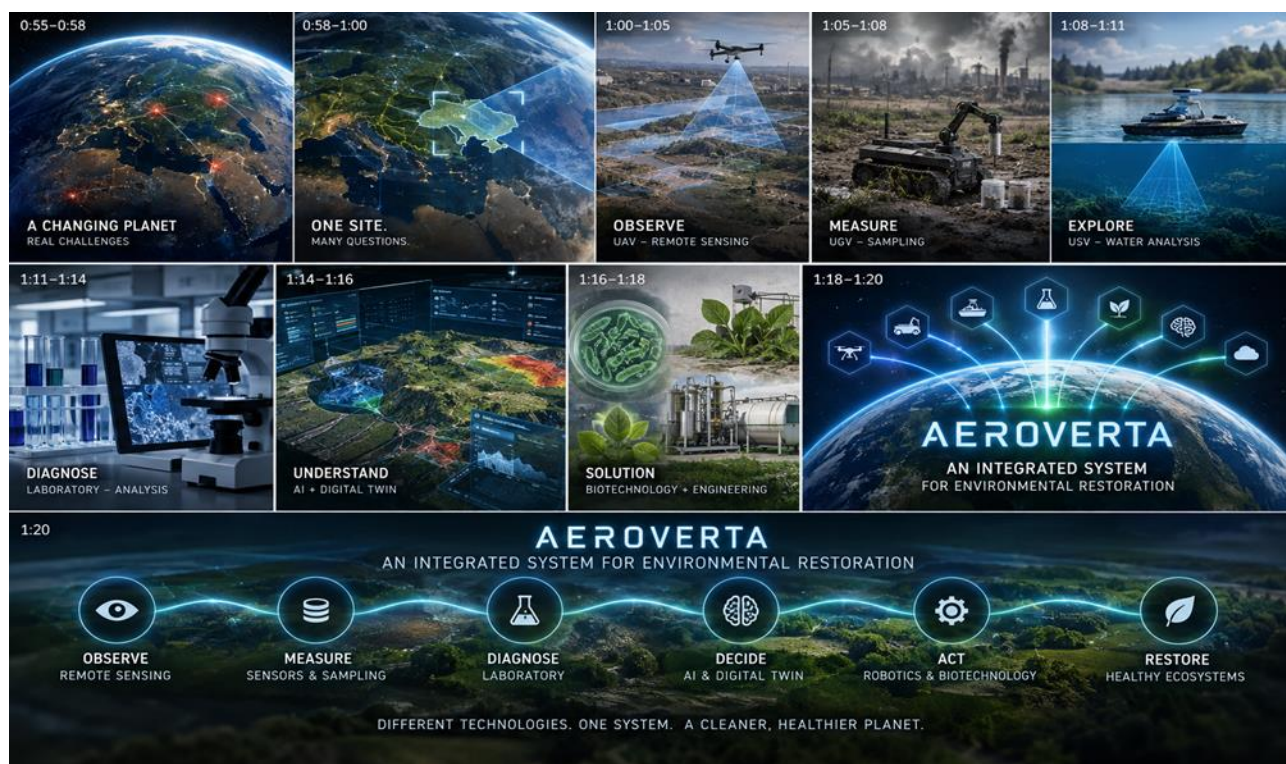
The discussions focused on economic models, investment opportunities, and management approaches that could support further development of these initiatives and preparation for cooperation with international partners.



An important part of the AEROVERTA ROBOTICS SAS team’s work at AIM 2026 was a series of B2B meetings with representatives of GenerationAI and Vermilion REP SAS, devoted to the development of artificial intelligence and its practical application in business operations. The meetings resulted in the establishment of professional contacts, agreements to continue communication, and the coordination of follow-up meetings.

Participation in such international initiatives contributes to the development of international cooperation by the Department of Economics and Law at NUFT, the expansion of professional links with technology companies, and the engagement of the Department’s research and expert capacity in discussions and economic assessment of innovative solutions at the intersection of economics, artificial intelligence, robotics, and biotechnology.

The concept is viewed not as a collection of individual technological solutions, but as an integrated adaptive system in which sensing, data acquisition, diagnostics, digital modelling, decision-making, robotic action, and restoration are connected within a continuous management cycle. Its conceptual logic can be expressed as **“Observe – Measure – Diagnose – Understand – Decide – Act – Restore.”** Within this approach, artificial intelligence and digital technologies transform heterogeneous data from sensors, UAVs, laboratory analyses, and field observations into actionable information, while robotics and biotechnology provide the means for targeted intervention. Digital twins and continuous monitoring create a feedback mechanism through which technological parameters, resource use, environmental conditions, and economic performance can be evaluated and adjusted. This architecture enables a transition from isolated technological applications to adaptive, data-driven systems capable of simultaneously supporting resource efficiency, environmental responsibility, investment feasibility, and scalability.



1. AEROVERTA REE: A Mobile System for the Exploration, Extraction, and Processing of Rare Earth Elements

AEROVERTA REE (AV-REE) is a concept for an autonomous modular platform integrating geological exploration, digital deposit modelling, selective extraction, and processing of rare earth raw materials. The approach is distinguished by the integration of all stages into a single system with digital traceability of material flows, resource control, and environmental oversight.

The technological cycle begins with remote exploration using UAVs equipped with RGB/RTK, LiDAR and, where required, hyperspectral and geophysical sensors. The data are integrated with the results of ground geophysics, drilling, and sampling. The geological and analytical component involves the use of XRF for preliminary screening, XRD to identify mineral phases, and ICP analysis to quantify elemental composition. These data form the basis for a three-dimensional digital deposit model (Digital Deposit Twin), accounting for the distribution of target elements, mineralogical domains, impurities, and the technological characteristics of the raw material.

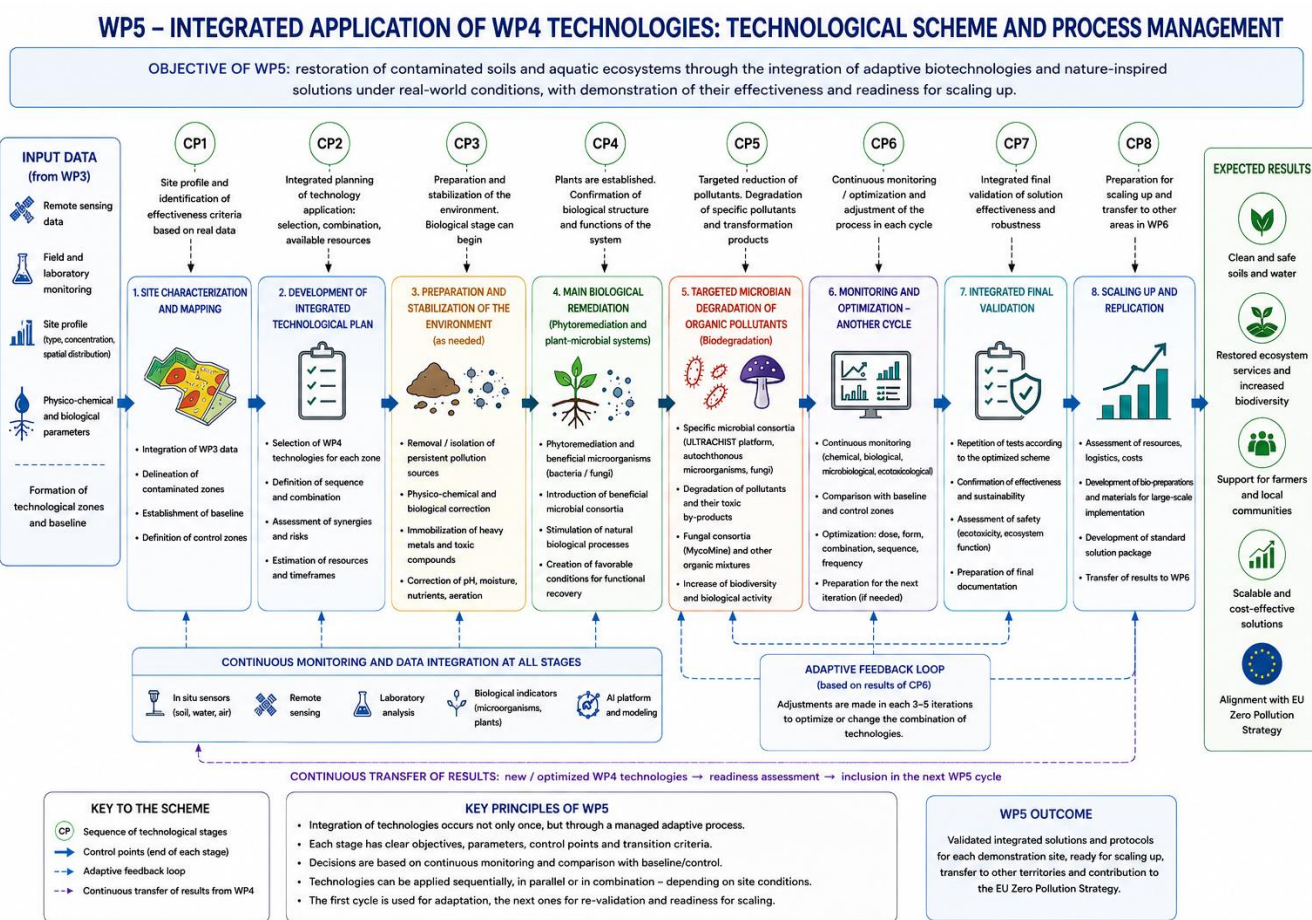
The next stage is selective robotic extraction with separate accounting for ore and waste rock, followed by crushing, grinding, classification, and physical beneficiation. Depending on the mineralogy, gravity, magnetic, electrostatic separation, or flotation may be used. Subsequent hydrometallurgical processing includes controlled leaching, solid-liquid separation, pregnant solution purification, group or selective separation of rare earth elements, and production of a marketable product - a mixed concentrate, carbonate, oxide, or individual compounds.

Important components of the concept include reagent regeneration, water treatment and recycling, tailings and waste control, energy management, and an HSE system. The AV-CORE digital

platform is intended to provide traceability from the geological source and sample to the final product batch and waste streams. A phased deployment is envisaged: exploration and confirmation of potential, pilot testing, a demonstration line, modular production, and replication at other sites. Key indicators for further assessment include target-element recovery, selectivity, product quality, specific reagent consumption, water-recycling rate, energy intensity, and waste volume.

2. Biological Remediation and Robotic Restoration: An Integrated System for Biological Treatment and the Restoration of Contaminated Areas

The second area involves the integrated application of biotechnology, nature-based solutions, robotic systems, and digital monitoring to restore contaminated soils and aquatic ecosystems. The technological logic of WP5 is not based on a one-time treatment of a site, but on an adaptive cycle: diagnosis, technology selection, environmental preparation, biological treatment, effectiveness monitoring, and adjustment of the technological regime.



At the first stage, the site is characterized using remote-sensing data, field and laboratory monitoring, contamination profiles, and physicochemical and biological indicators. The area is divided into operational zones, and baseline indicators and control plots are established. An integrated plan is then developed, with technologies selected for each zone according to the type

and concentration of contaminants, site conditions, and available resources. Solutions may be applied sequentially, in parallel, or in combination.

Where necessary, the environment is prepared and stabilized before biological treatment. This may include the removal or isolation of hazardous fragments, the use of chitosan-based materials to regulate sorption processes, heavy-metal immobilization, and adjustment of pH, moisture, and toxic components. The main biological stage may include phytoremediation and rhizoremediation using selected plants, microbial consortia, and biostimulants to restore soil biochemical processes (see figure).

For the targeted degradation of organic contaminants, the concept provides for bacterial consortia based on the ULTRACHIST platform to address hydrocarbons, light petroleum products, and transport-related pollution, as well as MycoMine fungal consortia for more complex organic mixtures. Depending on the characteristics of the contamination, biodegradation may be combined with bioaugmentation and biostimulation.

Monitoring is a cross-cutting element of the system, combining data from in situ sensors, remote sensing, laboratory analyses, and biological indicators. Results are compared with baseline and control values to assess chemical, biological, and ecotoxicological characteristics. Where necessary, dosage, the composition of biological products, technology combinations, and the sequence of operations are adjusted, and the cycle is repeated. The final stage involves verifying the effectiveness and reproducibility of the solution, assessing biodiversity and ecosystem functions, and analysing resources, costs, logistics, and the need to produce materials for scaling up and transferring the technology to other areas.

Shared Economic Aspects of the Two Initiatives

Both concepts envisage a transition from individual technological solutions to integrated systems whose effectiveness depends on coordinating technical, resource, environmental, and management components. For AEROVERTA REE, key economic issues include the capital and operating costs of modules, productivity, recovery of target components, energy, water and reagent costs, and the possibility of phased capacity expansion. For WP5, they include the cost of diagnostics and treatment, requirements for biological products and materials, the duration of remediation cycles, monitoring costs, and verification of environmental outcomes.

A common theme for the analytical material is the economic and management prerequisites for integrating technologies into AEROVERTA's international innovation initiatives - from the technology concept and resource assessment to performance verification, investment feasibility, and preparation for scaling up. This makes it possible to connect both areas with the author's expert role without claiming unverified production results.

Conclusions

1. The AEROVERTA REE and Biological Remediation and Robotic Restoration Project initiatives illustrate opportunities to combine robotics, artificial intelligence, digital technologies, and biotechnology to address current challenges in critical raw materials and environmental restoration.
2. Economic and management assessment of such technology initiatives should include evaluation of investment needs, operating costs, resource efficiency, technological risks, and scaling prospects. This provides a basis for substantiating further decisions on their development and potential implementation.
3. The international professional dialogue at AIM 2026 provided an opportunity to discuss the prospects of the technology initiatives and establish contacts for further communication. The AEROVERTA ROBOTICS SAS team's B2B meetings with representatives of GenerationAI and Vermilion REP SAS added a practical dimension to this international interaction.
4. For the Department of Economics and Law at NUFT, the participation of its researchers in such professional discussions creates opportunities to expand international connections, foster interdisciplinary cooperation, and apply economic and management expertise to the assessment of innovative technological solutions.
5. For Zhytomyr Polytechnic State University, such international innovation activities create opportunities to strengthen interdisciplinary cooperation in the fields of public management, administration, technology development, and economic assessment of innovative projects. The involvement of the university's academic expertise in international initiatives at the intersection of artificial intelligence, robotics, biotechnology, and environmental restoration can contribute to the development of new research and educational cooperation and to the transfer of knowledge between academic and technology-oriented partners.

References

1. Dankevych, A.; Sosnovska, O.; Dobrianska, N.; Nikolenko, L.; Mazur, Yu. Ecological and economic management of innovation activity of enterprises. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*. 5, 112–118 (2021). <https://doi.org/10.33271/nvngu/2021-5/118>
2. Dankevych, A. Ecological and economic aspects of agricultural land use in terms of private property and market relations. *Land Management Bulletin*. 6, 26–29 (2011).
3. Dankevych, A. Analysis of the investment potential of enterprises in the agricultural sector of the economy. *Problems of Theory and Methodology of Accounting, Control and Analysis*. 3, 37–42 (2017).
4. Dankevych, A. The efficiency of the use of production resources in the conditions of corporatization. *AgroInCom*. 7–9, 122–125 (2011).
5. Dankevych, A. Genesis of large-scale land use in Ukraine. *Land Management Bulletin*. 12, 38–42 (2015).

6. Dankevych, A. Environmental and economic problems of land use in new management conditions. *Herald of DAAU*. 1, 275–278 (2001).
7. Ostapchuk, T., Orlova, K., Biriuchenko, S., Dankevych, A., & Marchuk, G. Defuzzification in the process of managerial estimating the value of agricultural lands. *Agricultural and Resource Economics: International Scientific E-Journal*. 7(4), 62–81 (2021). <https://doi.org/10.51599/are.2021.07.04.04>
8. Denysiuk, O., Svitlyshyn, I., Tsaruk, I., Vikarchuk, O., & Dankevych, A. Diversification in the enterprises' activities for sustainable development in the agricultural sector. *Rivista di Studi sulla Sostenibilità*. 18, 85–102 (2022). <https://doi.org/10.3280/RISS2022-002007>
9. Prodanchuk, M., Dankevych, A., Aksonova, O., & Tomchuk, O. Digital Tools for Accounting and Analytical Support of Enterprises: Innovation and Management Aspect. *Economics Ecology Socium*. 7, 27–39 (2023). <https://doi.org/10.61954/2616-7107/2023.7.4-3>
10. Dankevych, V. Ye., & Dankevych, A. Ye. Internet of Things and Artificial Intelligence as Key Elements of Innovative Enterprise Development in the Era of Digital Challenges. *Aktualni Problemy Ekonomiky*. 7, 165–173 (2024). <https://doi.org/10.32752/1993-6788-2024-1-277-165-173>
11. Dankevych, A., Perevozova, I., Nitsenko, V., Lozinska, L., & Nemish, Y. Effectiveness of Bioenergy Management and Investment Potential in Agriculture: The Case of Ukraine. In: Koval, V., Olczak, P. (eds), *Circular Economy for Renewable Energy. Green Energy and Technology*. Springer, Cham (2023). https://doi.org/10.1007/978-3-031-30800-0_6
12. Kovalchuk, S., Morokhova, V., Bondarenko, O., Mohylova, A., Dankevych, A., & Liu, J. Creative Economy and Value Creation through Marketing Analytics: New Approaches and Opportunities. *Pakistan Journal of Life and Social Sciences*. 22(2), 9812–9824 (2024). <https://doi.org/10.57239/PJLSS-2024-22.2.00741>
13. Horák, J., Bilan, Y., Dankevych, A., Nitsenko, V., Kucher, A., & Streimikiene, D. Bioenergy production from sunflower husk in Ukraine: potential and necessary investments. *Journal of Business Economics and Management*. 24(1), 1–19 (2023). <https://doi.org/10.3846/jbem.2023.17756>
14. Dankevych, A., Stoyanova-Koval, S., Polova, O., Los, Z., Burdeina, N., & Kazak, O. State of economic security and directions of restoration socio-economic development and food security in the conditions of war. *Financial and Credit Activity Problems of Theory and Practice*. 2(55), 441–460 (2024). <https://doi.org/10.55643/fcaptp.2.55.2024.4170>
15. Dankevych, V. Ye., Dankevych, A. Ye., & Navrotska, T. A. Creative management of the competitiveness of business structures in Ukraine's economy under conditions of war and recovery: Internet of Things and innovative solutions. *Aktualni Problemy Ekonomiky*. 9, 112–120 (2024). <https://doi.org/10.32752/1993-6788-2024-1-279-112-120>

16. Dankevych, A. Creative and digital economy as a strategic resource for innovation and value chains in the context of post-war recovery and European integration. In: Moderní aspekty vědy: LXVI. Díl mezinárodní kolektivní monografie. Mezinárodní Ekonomický Institut s.r.o., Czech Republic, pp. 290–319 (2026). <https://doi.org/10.52058/66-2026>
17. Dankevych A. Development of leased land relations in the conditions of corporatization // Zemlevporyadnyi visnyk. 2015. № 10. P. 34–39.
18. Dankevych A., Perevozova I., Nitsenko V., Lozinska L., Nemish Y. Effectiveness of bioenergy management and investment potential in agriculture: The case of Ukraine // Circular economy for renewable energy. Springer, 2023. P. 1–19. DOI: 10.1007/978-3-031-30800-0_6.
19. Dankevych A. Background and basic principles of agricultural holdings // Ekonomika APK. 2011. № 5. P. 139–147.
20. Dankevych A. Development of integrated structures in agriculture. Kyiv : NNTs “IAE”, 2011..
21. Dankevych A. E. Organizational and economic components of rational management // Economics of the Agricultural Industry. 2011. № 6. P. 22–27.
22. Dankevych A. E. Directions for improving leased land relations in the context of the development of agricultural holdings // Land Management and Cadastre. 2011. № 1. P. 21–28.
23. Dankevych A. E. Peculiarities of the development of land relations in conditions of concentration of land use // Land Management and Cadastre. 2011. № 2. P. 34–39.