

ALICIA VALERO DELGADO

Full Professor of Thermal Engineering | Director, Industrial Ecology Group, Energaia Institute

Industrial Ecology • Thermoeconomics • Critical Raw Materials • Planetary Sustainability

PERSONAL DETAILS

Date of birth	31 March 1978	Place of birth	Zaragoza, Spain
Nationality	Spanish	ORCID	0000-0003-3330-1793
Current position	Full Professor, University of Zaragoza	Research profile	janovas.unizar.es/sideral/CV/alicia-valero-delgado

EDUCATION

2008	PhD in Renewable Energies and Energy Efficiency, University of Zaragoza. European Doctorate; Sobresaliente cum laude. Research stay at the British Geological Survey, United Kingdom (2007).
2005	MSc in Eco-efficiency, Energy Saving and Industrial Ecology, University of Zaragoza.
2002	Chemical Engineering, specialisation in Environmental Chemical Engineering, University of Zaragoza. Erasmus/traineeships at TU Berlin and Siemens Power Generation (Germany), and Université Paul Sabatier / INSA-CNRS Toulouse (France).

PROFESSIONAL EXPERIENCE

Apr. 2024–present	Full Professor of Thermal Engineering, University of Zaragoza, School of Engineering and Architecture.
2018–present	Director, Industrial Ecology Research Group, Energaia Institute; member of the Institute Steering Committee and Deputy Director of Energaia.
Apr. 2021–Mar. 2024	Associate Professor, Thermal Engineering, University of Zaragoza.
2003–2018	Fundación CIRCE: Director of the Industrial Ecology Area (2015–2018); researcher in energy sustainability (2003–2015).
2001–2002	Researcher-in-training, Siemens Power Generation (Berlin) and INSA-CNRS (Toulouse).

RESEARCH PROFILE AND LEADERSHIP

Research focus. Thermodynamic and exergy-based assessment of natural resources, mineral depletion, critical raw materials, circular economy, industrial ecology, soil fertility, and the material requirements of the energy transition.

Leadership and supervision. Director of a ten-member research group; principal investigator of European, national, regional, industrial and NGO projects; 8 completed doctoral theses co-supervised; more than 100 scientific publications and book chapters.

Selected scientific and policy service. Member of the ECOS “Second Law & Sustainability” Committee; coordinator of the THERSAURUS COST Action proposal (121 researchers, 34 countries); evaluator and project monitor for Horizon Europe, MSCA and other European and national programmes; contributor to the UN Digital Economy Report 2024 and Spain’s Roadmap for the Sustainable Management of Mineral Raw Materials.

SELECTED BOOKS AND SCIENTIFIC CONTRIBUTIONS

SELECTED BOOKS

1. Valero, A., Valero, A. & Calvo, G. (2021). The Material Limits of Energy Transition: Thanatia. Springer Nature. A comprehensive synthesis of the thermodynamic foundations of mineral scarcity and of the material constraints, bottlenecks and geopolitical implications of the energy transition.

2. Valero, A. & Valero, A. (2014). *Thanatia: The Destiny of the Earth’s Mineral Resources*. World Scientific / Imperial College Press. The foundational monograph presenting Thanatia as a thermodynamic reference state for evaluating the depletion of the Earth’s mineral capital.

SELECTED ARTICLES

- 3. Valero, A., Carpintero, Ó., Valero, A. & Calvo, G. (2014). “How to account for mineral depletion: the exergy and economic mineral balance of Spain.” *Ecological Indicators* 46, 548–559.** National-scale integration of thermodynamic mineral depletion and economic accounts; ECOS 2014 Best Paper Award.
- 4. Valero, A. & Valero, A. (2015). “Thermodynamic rarity and the loss of mineral wealth.” *Energies* 8, 821–836.** Introduced thermodynamic rarity as a physically grounded indicator of mineral scarcity.
- 5. Calvo, G., Valero, A. & Valero, A. (2018). “Thermodynamic approach to evaluate the criticality of raw materials and its application through a material flow analysis in Europe.” *Journal of Industrial Ecology* 22(4), 839–852.** Connected exergy-based scarcity, European material flows and raw-material criticality.
- 6. Valero, A. et al. (2018). “Global material requirements for the energy transition: An exergy flow analysis of decarbonisation pathways.” *Energy* 159, 1175–1184.** Quantified mineral-resource pressures and potential bottlenecks associated with decarbonisation.
- 7. Valero, A. et al. (2018). “Material bottlenecks in the future development of green technologies.” *Renewable and Sustainable Energy Reviews* 93, 178–200.** Widely cited synthesis of material constraints affecting renewable energy, mobility and digital technologies.
- 8. Valero, A., Palacino, B., Ascaso, S. & Valero, A. (2022). “Exergy assessment of topsoil fertility.” *Ecological Modelling* 464, 109802.** Extended exergy-based natural-capital accounting from mineral resources to fertile soils.
- 9. Torres, C., Valero, A., Valero, A. & Naredo, J. M. (2025). “Squaring the circle of the circular economy.” *Ecological Economics* 240, 108817.** Demonstrated the need to include resource quality and scarcity in circular-economy accounting.

SELECTED RESEARCH LEADERSHIP AND IMPACT

Research leadership. Principal investigator and scientific coordinator in European, national and regional projects on thermodynamic resource accounting, critical raw materials, circular economy, resource efficiency and the material requirements of the energy transition.

Methodological contributions. Co-developer of Thanatia and the Exergy Replacement Cost methodology; extension of exergy-based natural-capital accounting to soil fertility and regeneration; development of indicators linking resource quality, depletion, circularity and planetary sustainability.

Policy and standardisation. Scientific contributions to Spain’s Roadmap for the Sustainable Management of Mineral Raw Materials, the UN Digital Economy Report 2024 and CWA 17898:2022 on exergy-based assessment of agroecosystems and soil degradation.

Teaching and supervision. University teaching in thermodynamics, energy efficiency, renewable energies and sustainability; eight completed doctoral theses co-supervised; international teaching collaboration with TU Berlin.

SELECTED AWARDS AND RECOGNITION

2026	Nicholas Georgescu-Roegen Award for Best Paper and Presentation, 39th ECOS Conference.
2014	ECOS Best Paper Award for the work on the exergy and economic mineral balance of Spain.
2009	Best Paper Awards at SDEWES and SDIMI international conferences.
2009	Environmental award from Universidad Complutense de Madrid for the PhD thesis.

ADDITIONAL PROFESSIONAL RECOGNITION

Invited keynote speaker at international conferences in thermodynamics, materials science, corrosion, waste management and industrial ecology; invited presentations at the European Parliament and Spanish Parliament on critical raw materials, circularity and ecological transition.

Science communication. More than 20 invited outreach talks per year for industry, public administrations, NGOs, policymakers, students and citizens; active media engagement and development of open educational and thermoeconomic resources.