

# **Towards a Sustainable Energy-Materials Transition Nexus**

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The transition toward low-carbon energy systems faces numerous challenges, including the management of energy storage for intermittent renewable sources, the accounting of emissions across diverse sectors, and the coordination of technology shifts for applications such as power generation, transportation, and dense energy carrier (DEC) production. Achieving these goals sustainably requires significant material resources, as clean energy technologies often demand additional materials than fossil-fuel-based systems, as for example for energy storage, electric vehicle production, grid infrastructure, and construction of wind and solar power systems, among others. As the production and procurement of these materials generate emissions and introduce additional supply chain costs and constraints, the consideration of the energy and materials transition nexus becomes essential to fully address sustainable energy challenges. We will present some of these challenges, propose an energy systems engineering framework for the energy-materials transition nexus, and highlight examples, including solar photovoltaics, wind farms, and electric vehicles, which rely on energy- and emission-intensive materials such as rare earth metals, polymers, and concrete.

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Professor Pistikopoulos is the Director of the Texas A&M Energy Institute and holds the Dow Chemical Chair Professorship in the Artie McFerrin Department of Chemical Engineering at Texas A&M University. He was a Professor of Chemical Engineering at Imperial College London, UK (1991-2015) and a former Director of its Centre for Process Systems Engineering. He holds a Ph.D. degree from Carnegie Mellon University and worked with Shell Chemicals in Amsterdam before joining Imperial. He has authored or co-authored over 650 major research publications in the areas of modelling, data analysis, control and optimization of energy, process and systems engineering & automation applications, 17 books, 5 patents, and various software tools. A co-founder of Process Systems Enterprise (PSE) Ltd (now part of Siemens), he is a Fellow of AIChE and IChemE and the Editor-in-Chief of *Computers & Chemical Engineering*. Prof. Pistikopoulos was a co-recipient of the prestigious Mac Robert Award from the Royal Academy of Engineering in 2007, the recipient of the Computing in Chemical Engineering Award of CAST/AIChE in 2013, the IChemE's Sargent Medal in 2020, and the AIChE's Sustainable Engineering Forum Award in 2021. At Texas A&M, he received The Association of Former Students Distinguished Achievement Award for Research in 2021 and was named a University Distinguished Professor in 2023. He is a Fellow of the Royal Academy of Engineering in the UK, and a Member of the Texas Academy of Medicine, Engineering, Science and Technology.