Dr. Toni Marechaux, FASM
Vice President-Elect (2026-2027)

Dr. Toni Marechaux, FASM
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Dr. Toni Marechaux serves as a lead analyst at Booz Allen Hamilton, where she provides subject matter expertise to the U.S. Department of Energy. Previously, she was a senior analyst for the Defense Science Board and a science advisor at ZIN Technologies supporting space experiment design. Marechaux also directed more than 30 studies for the National Materials Advisory Board as well as the Board on Manufacturing and Engineering Design at the National Academies of Sciences, Engineering, and Medicine.

As a program manager for the Department of Energy and for NASA, Marechaux worked with industry to collaboratively develop technology vision and roadmap documents and tracked impacts of research and development programs. She directed programs for the mining and extractive metallurgy industry, the concrete industry materials for the automotive industry, and space nuclear power among others.

Finally, in her first professional position, she was a quality engineer at National Steel. Marechaux graduated from the University of Illinois with a B.S. in metallurgical engineering and from Case Western Reserve University with a Ph.D. in materials science and engineering.

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Abstract
Process Intensification, Circularity, and Hacking the Supply Chain

Technology development and sustained research funding are central to achieving a circular, resource-efficient economy, because they enable progress at every stage of the materials loop—from raw material extraction and processing, to manufacturing, product use, and end-of-life recovery. Advances in mining, refining, and materials engineering reduce energy and emissions at the front end, while innovations in product design—lightweighting, modularity, digital tracking, and durability—extend lifetimes and make reuse or disassembly far easier. Equally important are breakthroughs in recycling technologies, from automated sorting and chemical separation to closed-loop processes that can return high-purity materials back into production. Yet challenges remain: many processes were never designed for circularity, recovery rates vary widely, and certain critical materials are difficult or uneconomic to reclaim with today's methods. Still, the opportunities are significant. Strategic investment in R&D, coupled with supportive policy and industrial partnerships, can unlock new technologies that increase yields, lower costs, and enable true circular flows—reducing pressure on primary resources while strengthening supply-chain resilience and environmental sustainability.

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Abstract

Beyond Rare Earths: The Race to Discover Tomorrow's Magnets and Superconductors

Every motor, generator, and transformer runs on a hidden dependency: magnetic materials that concentrate and direct flux to make electrical-mechanical energy conversion possible. Superconductors offer an even bigger prize — zero-resistance current flow that could transform power transmission, fusion magnets, and MRI technology. The problem is that both technologies are hitting real walls. Today's best permanent magnets lean on rare-earth elements mined and processed in a handful of geopolitically fraught locations. Superconductors remain boxed in by stubborn temperature, current, and field thresholds that collapse their performance the moment you push too hard. This is where materials discovery gets interesting. Computational screening, machine learning–guided synthesis, and high-throughput experimentation are compressing what used to be decades of trial-and-error into rapid, targeted searches — for magnets that need little or no rare-earth content, and superconductors that operate at higher temperatures, carry more current, and can actually be manufactured at scale. This isn't a story about incremental gains. Better magnetic and superconducting materials could unlock entirely new categories of energy technology — from fusion power to next-generation grids — making materials discovery one of the highest-leverage bets in the energy transition.

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Abstract

Top 10 Challenges for Critical Materials in Energy Systems

Everyone assumes they know which materials will make or break our energy supply — lithium, cobalt, rare earths. This talk counts down through a different list. We start at the top of the countdown with the supply chain's least-discussed fault line: the divide between mining, metallization, and engineered materials, three industries that get lumped together in policy conversations but operate on entirely different timelines, capital structures, and failure modes. From there, the countdown moves through nickel, where battery-grade supply is quietly diverging from stainless-grade demand; electrical steel, the unglamorous alloy quietly gating every transformer and motor buildout; graphite, still overwhelmingly processed in one country regardless of where it's mined; magnesium, a lightweighting material whose supply chain has already collapsed once and could again; and magnets, where rare-earth headlines obscure a narrower, harder problem of processing and coercivity. Stay tuned for #1, arguably the challenge with the most leverage over the US energy system.