

**“Quantitative  
Insights for Rapid Improvement of  
Sustainable Energy  
and Chemical Technologies”**

**Wednesday  
September 21, 2022  
3:30 PM  
Wu and Chen Auditorium  
Levine Hall**



**Micah Ziegler**  
Postdoctoral Associate  
Massachusetts Institute of Technology

#### **Abstract**

A substantial and rapid transition to solar and wind energy resources can help society mitigate climate change. As reliance on these intermittent resources grows, additional technologies will be needed to ensure that energy demand is met reliably. Options include energy storage, backup generation, demand-side management, and transmission expansion. I will describe my recent research that identifies engineering strategies to improve technologies that can enable the utilization of renewable energy. First, using multi-decade weather data and parsimonious energy system models, we evaluate energy systems that combine renewable resources with storage. We identify key drivers of cost and features of storage technologies that can enable cost-competitive generation of electricity. We also study how these systems might produce excess energy, and we estimate its temporal and spatial characteristics. These results provide insight into how chemical technologies could be designed to effectively utilize this excess energy to produce fuels and materials. Second, we investigate the improvement of lithium-ion batteries to identify factors that enabled their success, as well as promising strategies for the future. We build extensive empirical datasets and develop models of technological change to elucidate the drivers of the rapid improvement that was observed for lithium-ion batteries. We then disentangle and quantify the contributions of low-level mechanisms of cost change, such as increases in cell charge density, and high-level mechanisms, such as economies of scale. We examine the contribution of advances in chemistry and materials science. These results can inform strategies for engineering research, as well as financial investments and public policies, to improve a range of sustainable technologies.

#### **Bio**

Dr. Micah S. Ziegler is a postdoctoral associate at the Institute for Data, Systems, and Society at the Massachusetts Institute of Technology. He evaluates sustainable energy and chemical technologies, their impacts, and their potential. Dr. Ziegler develops robust strategies to accelerate the improvement and deployment of these technologies in order to enable a global transition to sustainable and equitable energy systems. His approach relies on collecting and curating large datasets from multiple sources and building data-informed models. His recent research has focused on energy storage technologies, including how they can be improved rapidly and used to integrate solar and wind resources into reliable energy systems. His work informs engineering research and development, public policy, and financial investment. Dr. Ziegler earned a Ph.D. in Chemistry from the University of California, Berkeley and a B.S. in Chemistry, *summa cum laude*, from Yale University. Before graduate school, he researched international climate change negotiations and energy technology policy in the Climate and Energy Program at the World Resources Institute. He was also a Luce Scholar, advising companies on environmental sustainability at the Business Environment Council in Hong Kong.