Abstract: Our research group uses the principles of electrochemistry and chemical reaction engineering to advance new technologies for sustainable energy and chemical production. This presentation will summarize ongoing work in our lab directed at developing technologies that use renewable electricity to continuously regenerate commodity chemicals from waste products like CO₂. First, I will lay out the enormous challenge of reconfiguring the global chemical industry around the use of renewable resources rather than fossil fuels as well as the central role that hydrogen will play in this transformation. Next, I will focus on the production of hydrogen via water electrolysis and specifically our work to understand the precise, nanoscale composition of earth-abundant catalysts for next-generation water electrolyzers. Finally, I will summarize ongoing efforts to develop catalytic assemblies that use metal oxides to transport hydrogen between two completely different reactive environments, potentially enabling a new type of highly versatile hydrogenation reactor that runs on electricity and seawater.