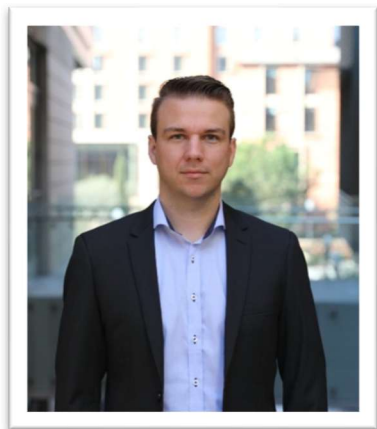




Green Steel: Design, Supply Chain, H₂ Storage and Dispatch Strategies

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Abstract: Hydrogen-based direct reduction (H₂-DRI) paired with electric arc furnaces can cut steelmaking emissions dramatically, but the path to reliable, affordable green steel hinges on how hydrogen is produced, stored, and dispatched at industrial scale. This seminar synthesizes recent results from our group and collaborators with an emphasis on energy efficiency and CO₂ emissions when shifting from natural gas-based DRI to H₂-DRI, and the resulting implications for the upstream H₂ supply chain.

First, the thermodynamic and practical energy requirements of NG-DRI versus H₂-DRI at the shaft furnace and EAF interface are compared, highlighting challenges and opportunities in balance-of-plant integration strategies. Building on these plant-level insights, the analysis connects process demands to upstream choices for hydrogen generation and storage: Renewable electricity generation, electricity storage, electrolyzer performance, hydrogen storage, and thermal integration.

A dispatch and sizing framework is presented for ~1 Mt/yr plants that co-optimizes wind/solar portfolios, batteries, electrolyzers (with realistic efficiency curves), and long-duration H₂ storage to maintain DRI uptime and minimize the levelized cost of steel. Case studies quantify how energy-efficiency improvements at the furnace propagate back to lower H₂ production and storage requirements, reducing CAPEX, curtailment, and balance-of-plant loads.

The takeaways are: a robust understanding of the technical and economic hurdles in H₂-DRI; a quantification of the dominant cost drivers—DRI efficiency, electrolyzer performance, and hydrogen storage/transport; and a prioritized research roadmap to de-risk and scale green-steel plants.

Bio: Fabian Rosner is an Assistant Professor of Civil and Environmental Engineering at UCLA and Assistant Director of the UCLA Institute for Carbon Management. He leads the Renewable Energy and Chemical Technologies Lab, where his group develops practical pathways for industrial decarbonization across carbon capture for point sources and direct air capture, CO₂ utilization, electrochemical conversion, and hydrogen systems for steelmaking through H₂-DRI and long-duration hydrogen storage. Prior to UCLA, he was a postdoctoral fellow at Lawrence Berkeley National Laboratory. Fabian holds a Ph.D. and M.S. in Mechanical and Aerospace Engineering from the University of California, Irvine, with a focus on thermal sciences. He also earned M.S. and B.S. degrees in Chemical Engineering, specializing in process engineering, from the Technical University of Munich. His work bridges rigorous process simulation and techno-economics with experimental research to deliver scalable engineering solutions for heavy industry.