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Solar-driven carbon dioxide conversion at all scales

The opportunity to recycle and reuse carbon dioxide (CO₂) in the commodity chemical supply chain is a pathway through which the circular chemical economy can be achieved. However, given the high energy demands associated with CO₂ conversion and the projected demand for renewable electricity that is expected in the transition to a sustainable economy, using solar energy to drive CO₂ conversion reactions can provide an ideal pathway for the implementation of these technologies. This talk will discuss the opportunities and challenges associated with solar-driven CO₂ conversion from a number of scales. At the macro-scale, potential co-reactants and commodity chemical products that can be made from CO₂ will be reviewed. Following, using the example of photocatalytic dry reforming ($\text{CO}_2 + \text{CH}_4 \rightleftharpoons 2\text{CO} + 2\text{H}_2$), system design factors affecting process economics will be discussed and used to establish benchmarks for catalyst activity. Photocatalyst design and mechanisms of operation will be discussed, as well as the relative importance of these mechanisms as they relate to real-world implementation. Finally, remaining research questions and challenges in the field will be presented.