Solar Energy to Fuels, Chemicals and Electricity

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In the long run, it is likely that all the basic human needs will be met by renewable sources like solar energy. However, there are several challenges associated with harness, storage and use of solar energy to meet our daily needs for food, chemicals, heat, electricity and transportation. In a sustainable future, all these usage must coexist.

We will first present some results from our energy systems modeling highlighting the synergistic interactions that exist for transportation sector and production of chemicals. This will be followed by a discussion and analysis of candidate processes to produce hydrogen from solar energy, our modeling results for energy storage at giga Watt-hour levels and uninterrupted around the clock electricity production using new solar thermal power cycles with internal hydrogen circulation. Such cycles have a potential to not only supply solar thermal electricity at an unprecedented efficiency during the period while solar energy is available but have a potential to supply around the clock electricity with efficiencies similar to that from batteries storage, however, here energy is stored at a much higher density. We will then discuss our vision of how to use solar thermal processes to meet demand for water, chemicals and food.

An exciting aspect of producing fuels and chemicals from biomass is learning to produce the array of molecules that we need with minimum process transformation steps and energy use while maximizing biomass carbon recovery. In this aspect, recent advancements at Purdue by a team of chemists, biologists and chemical engineers will be presented. We will show the new pathways along with the associated catalysts and reactors that have been developed for the production of fuel and chemicals from biomass. More importantly, we will showcase how modelling has been used to identify, design and guide the experiments.