**Optimal Synthesis and Planning of Sustainable Chemical Processes**

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In this presentation we show how mathematical programming techniques can offer a general modeling framework for including environmental concerns in the synthesis and planning of chemical processes. In the area of process synthesis we address first the synthesis of integrated water process networks which involves the global optimization of an MINLP model. We next address the energy and water optimization of biofuel plants. We present an optimization framework based on superstructure optimization that effectively accounts for energy and water integration, and illustrate its application to corn-based and ligno-cellulosic ethanol. In the area of supply chain optimization we consider the design of an integrated infrastructure for gasoline and ethanol that can deliver a variety of blends. We also describe a model for the design and planning of hydrogen supply chains for vehicle use using a multiobjective optimization approach coupled with the Eco-indicator 99 to assess the effect on human health. Finally, we describe recent work in the area of shale gas in which we address the design of supply chains, including water management for hydraulic fracturing in well pads.