

Scientific Program Details for Day 3, Wednesday, 19 June 2024

PSE for Process Electrification

Chaired by Prof. Michael Baldea, U. of Texas at Austin

Session Synopsis:

The session focuses on the challenges posed by process electrification initiatives. We will cover the critical need for closer interaction and integration between manufacturers and the power grid at the level of system design and system operations. On the one hand, a paradigm shift will be needed on the manufacturing side regarding deviating from the steady-state operation mentality. On the other hand, the power grid will have to cope with a massive increase in load, but with the benefit of loads being increasingly flexible and controllable. The session will also cover environmental, economic, social, and workforce development aspects.

First Invited Talk

To What Extent Will Decarbonization Deepen the Conversation between Industry and the Grid?

Dr. Elaine Hale, Senior Research Engineer, National Renewable Energy Laboratory (NREL)

Abstract

Decarbonization—the transition away from un-mitigated fossil fuel combustion throughout the economy—requires big changes in both power and process systems. On the power system side, those changes are expected to include large increases in variable generation, e.g., from wind and solar, which have near-zero marginal costs and, at large shares, can produce infrequent but consequential energy droughts. On the process systems side, industries are investigating their options for direct and indirect electrification, the latter exemplified by replacing fossil fuel inputs with zero-carbon, energy-carrying chemicals like hydrogen and ammonia produced via electrochemical processes. The economic features of these changes within the larger context of power and process systems suggest that their realization could be accompanied by a paradigm shift in how industrial facilities interact with the grid. For example, the dominant type of demand participation in power markets could change from today's focus on load reductions at peak times to a new focus on shifting electricity use, enabled in part by large-scale product storage, to take advantage of renewable energy that would otherwise be curtailed and to avoid consumption during high-price energy droughts. This talk will describe these and other possible design and operational approaches from grid and industrial economic perspectives, culminating in an enumeration of open problems that lie at the interface of today and tomorrow's power and process systems.

Second Invited Talk

Decarbonization through Process Electrification: An Industrial Perspective on Challenges across Technologies and Scales

Dr. Elizabeth Endler, Chief Scientist for Energy, Shell Global

Abstract

Growth in renewable electricity from solar & wind is driving a paradigm change in how the world uses energy. It also presents an exciting opportunity to reimagine industrial process technologies for fuels and chemicals on a scale

not seen since the rapid expansion of the petrochemical industry more than 70 years ago. This talk will address 1) the roles of direct and indirect electrification in industrial decarbonization, 2) challenges associated with relevant technology development, adoption, and deployment from the kW to GW scale, and 3) the need to account for both product demand cycles and the inherent intermittency and variability of electricity produced from solar & wind over timescales ranging from sub-seconds to years.

Process systems engineering (PSE) approaches can play a significant role in supporting and accelerating decarbonization solutions, as there are a dizzying number of parameters to consider when evaluating and implementing these solutions. Large parameter spaces exist for 1) product portfolio selection, 2) identification of safe operation limits for devices as they scale up, 3) unit operation design and process synthesis, and 4) optimization of multiple units and utilities alongside dynamic feedstocks and energy inputs. PSE is also a key discipline central to the successful integration and commercialization of new, electrified technologies in the process industries, as it is where chemical engineering meets electrical engineering through the language of operability, control, and optimization.

In this talk, I will describe the characteristics of both traditional thermal and emerging electrical industrial loads, then compare & contrast them with other large & growing electrical loads. I will discuss case studies that highlight specific challenges associated with electrifying specific unit operations and utility services for manufacturing facilities, including technologies for electrolytic chemical conversions, electric heating, and energy storage. The role of familiar objective functions (e.g., cost minimization) and emerging constraints (e.g., emissions limits) will be discussed in the context of design, optimization, and planning. Finally, I will provide a view on key research challenges and priorities for the process systems engineering community.

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