Systems & Control Transactions

Extended Abstract
Foundations of Computer Aided Process Design (FOCAPD 2024)
Breckenridge, Colorado, USA. July 14-18, 2024
Not Peer Reviewed

Process Design for the Energy Transition: An Industrial Perspective

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Keywords: Energy Systems, Optimization, Process Design, Hydrogen, Ammonia

EXTENDED ABSTRACT

The United States' Inflation Reduction Act (IRA) of 2022 has established incentives to facilitate the energy transition. While these policies provide economic incentives that encourage investment and may reduce financial risk for the private sector on the supply side, transitioning to a lower carbon or net-zero economy by 2050 presents several challenges. These include designing flexible production systems that can interact with intermittent renewable energy resources, ensure process safety, redesigning existing energy infrastructure to support new energy carriers like hydrogen or ammonia, and making long-term investment decisions in an uncertain and evolving market. Addressing these challenges presents significant opportunities for the computer-aided design community to leverage techniques at the intersection of process design, AI/ML, data science, and optimization, which will play a key role in designing robust systems that can thrive during the energy transition.

This presentation aims to provide an overview of different technologies that are being considered and associated challenges faced by the industry at the ground level, particularly around hydrogen and ammonia production routes, as shown in Figure 1, in a post-IRA era. Specifically, the presentation will highlight the policy details in sections 45V and 45Q of the IRA and how these influence problem formulations and economic calculations. It will also demonstrate the importance of considering process design for hydrogen and ammonia production from a systems-level perspective that incorporates the interaction of tightly coupled, time-varying systems, and how conventional techno-economic designs need to consider emissions at the design stage given the incentive structures in the IRA are related to carbon intensity. In addition, this presentation will discuss how optimization-based end-to-end pipelines are deployed in production within a business environment while addressing challenges around comparison to pre-existing methods, data uncertainty, problem infeasibilities, and sustaining engagement with end users.

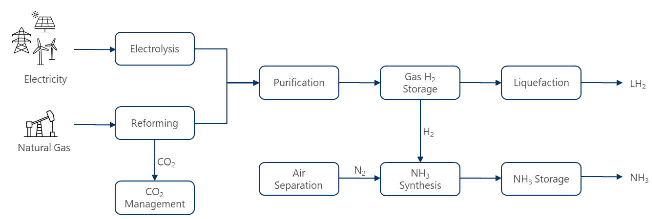

Figure 1: Potential production pathways from electricity and natural gas for H_2 and NH_3