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Editorial: Integrated resource network optimization for sustainable development

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Editorial on the Research Topic
Integrated resource network optimization for sustainable development

To address modern challenges related to climate change, equality and access to resources, new ways of developing ever more efficient systems are necessary. Increasingly, portfolios of tightly integrated technologies and resource efficiency measures are required, in addition to the increasing use of renewable resources such as biomass. The Research Topic presents a collection of papers that develop an increase in our understanding and develop methods to systematically and synthesize as well as understand complex, highly integrated systems to take advantage of the properties of these new systems, helping to meet key sustainable development goals (SDGs).

The first paper, by Pérez-Uresti et al., is a collaborative work between researchers from the Instituto Tecnológico de Celaya, Mexico, and the University of Salamanca, Spain. The authors presented a stochastic two-stage mixed-integer linear programming (MILP) formulation including uncertainty in the availability of the renewable resources and on the utility demands for designing utility plants based on renewable energy. The used superstructure aims to integrate waste and biomass processing technologies, integrated with wind and solar. The authors concluded that the flexibility of the design is improved compared to designs obtained through deterministic formulations, but this flexibility comes at the expense of increasing investment costs. Works such as this are vital to find new ways of decarbonizing industry, contributing toward net-zero goals, and highlight the challenges of attaining the United Nation SDG 13 (Climate Action), 7 (Affordable and Clean Energy) and 9 (Industry, Innovation, and Infrastructure).

The second paper, by Pavão et al. is from the State University of Maringá, Brazil. The authors proposed a hybrid meta-heuristic method based on pinch insights for the synthesis of multiperiod heat exchanger networks (HENs), employing the "spaghetti" network concept to get single-period network initial estimates. These estimates are refined and merged into a solution that can operate across multiple operating conditions. This merged network is further refined *via* a multiperiod HEN formulation to achieve a final multiperiod HEN. The authors used a literature example which is one of the largest multiperiod case studies for HEN synthesis and obtained a solution that has

a total annual cost 3.5% lower than the literature solutions. New advances in heat integration can help to save resources, increasing efficiency and reducing energy consumption from fossil fuels, thus contributing to SDGs 7, 9, and 12 (Responsible Consumption and Production).

The third paper by Dokl et al. is from the Slovenian University of Maribor, whereby an organic Rankine cycle (ORC) formulation is presented that uses low-temperature waste heat from aluminum production with 2 low-temperature renewables in geothermal energy and solar thermal. Two separate ORC cycles are considered because geothermal energy is at lower temperatures compared to solar thermal and the process heat. A non-linear programming (NLP) model is presented that maximizes the economic and thermodynamic performance of the system. The results demonstrate that most of the power output can be generated from waste heat, with the smallest proportion coming from solar energy because of the low solar irradiance at the considered plant location. The authors concluded that the ORC system proposed using waste heat, solar thermal, and geothermal, can generate sustainable power, showing that more tightly integrated resource networks with a portfolio of technologies are more efficient and sustainable. Advances such as these also contribute to SDGs such as SDG 7, 9, and 11, and can help to achieve lower-carbon energy generation to contribute to net-zero, equitable future energy systems.

To achieve sustainable integrated resource networks, the economics and risks associated with the various options of process route and potential products must be understood. Making the right choice on what resources to include in the overall network is essential. In the fourth paper in this Research Topic, Trottier et al., from Polytechnique Montreal and Myers Consulting LLC, indicated that the aforementioned decision, which must be made at the early design stages of a process and/or product, is difficult to make in cases where technologies, and the associated cost data, have high level of uncertainties and risks. The authors therefore adopted the Large Block Analysis (LBA) to compare process and product options at the early design stage. To demonstrate their methodology, the case investigated involves the production of Xylitol using traditional chemical processes in conjunction with other biorefinery options. They were able to outline the relative costs and risks associated with the various process/product options. They found that furfural is a promising product but with high market risk while animal feed additive production has lower risks, lower capital cost and lower profit.

In the fifth paper in the Research Topic, Lange from BioEconomy, Research and Advisory in Denmark, discussed five business models which embeds higher value products for resource efficient bio-based industry. The first model entails upgrading of in-house industrial side streams to get value added product. This option has the potential to require relatively lower capital costs and maybe operating costs as well. The second entails biorefineries that make use of specialized biomass, e.g., isolating proteins from plants. The third involves multiple biorefineries pooling resources together to become cooperatively owned, while the fourth entails locating a biorefinery within an industrial zone for the purpose of resource sharing. The last model involves consortium-based ownership for the purpose of producing bio-based products. The author also presented potential viable business models that may be adopted in future considering new emerging technologies. Considering multi-stakeholder scenarios and various business models is also a key aspect of creating integrated research networks, and studies in this area are vital for creating ensuring sustainable long-term projects.

The final paper in the Research Topic was the study by Taneepanichskul et al. from University College London, where a detailed review of various potential sorting methods for compostable and bio-degradable plastics in the context of circular economy was presented. The authors indicate that for the sorting technologies to be viable, they must be integrated with existing waste management networks. The final three papers in this Topic show the potential risks and rewards associated with the diverse products of the bioeconomy and challenges in achieving circularity, which might contribute to meeting SDGs 9, 11, 12, and 13.

Together, these papers in the Research Topic of Integrated Resource Network Optimization for Sustainable Development have demonstrated the importance of considering portfolios of technologies in systematic ways to achieve more sustainable systems, contributing to net-zero goals and equitable future energy systems.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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