Sustainable Alternatives for Decarbonization

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Abstract

Decarbonization is a means to tackle the energy-water-environment-food-health challenge that we face on earth. Starting from carbon dioxide (CO2) capture technologies from dynamic and stationary emissions to their integration with utilization and/or sequestration technologies, to integrated networks to achieve zero-emission are opportunities worth considering for decarbonization. Techno-economic and sustainability evaluation of well-known technologies, such as direct air capture as well as capture from flue gas streams need to be performed to verify the conditions under which a net zero-emission of CO2 could be achieved through these technologies. However, as capture of CO2 alone will most likely not achieve the objectives of decarbonization, other options such as utilization and sequestration of captured CO2 also need to be considered. Both these options, however, have well-known limitations and are unlikely to provide sustainable alternatives. A promising option, particularly for energy intensive chemical, petrochemical, and related processes, is to consider a network of technologies that integrates the base process converting raw materials to desired products with technologies that supply energy, water, and other utilities, which the process demands together with technologies to capture CO2 for on-site utilization. A systems approach with a new class of methods and computer-aided tools are needed to tackle the complexity related to the mathematical representation of the problem and its efficient solution. The lecture will highlight different sustainable decarbonization alternatives together with known CO2 capture technologies ordered in terms of their ability to achieve net-zero or negative emissions. In addition, limitations of utilization and sequestration alternatives will be highlighted, and sustainable integrated networks that can achieve decarbonization objectives in the short-term and long-term will be presented.

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Short bio-data: Prof Gani is is currently the CEO of PSE for SPEED, a company he co-founded in 2018 and is also a distinguished adjunct professor at HKUST (Hong Kong University of Science & Technology) at Guangzhou (China) and a distinguished research professor at Széchenyi István University at Győr (Hungary). Starting from 1985, Prof Gani worked at the Department of Chemical & Biochemical Engineering, Technical University of Denmark, where he founded the CAPEC research center and industrial consortium. Prof Gani served as editor-in-chief of Computers and Chemical Engineering journal (2009-2015) and currently serves as editor for the Sustainable Production & Consumption journal and is a member of advisory boards for several peer-reviewed international journals. Prof Gani has been awarded five Doctor Honoris Causa degrees from University Politehnica Bucharest (Romania), University of Pannonia (Hungary), Babes-Bolyai University (Romania), University of Maribor (Slovenia) & Universidad Autonoma Metropolitana (Mexico). He is an ex-president of the European Federation of Chemical Engineering (2015-2018), a member of the Danish Academy of Science, a Fellow of AIChE and a Fellow of IChemE. He has received numerous awards, including the AIChE Computers in Chemical Engineering award in 2015, the EFCE Jacques Villermaux medal in 2019, the IChemE Sargent Medal in 2021 and the American Society for Engineering Education award for excellence in Chemical Engineering education in 2022. He has published more than 550 articles in peer reviewed international journals and proceedings plus 5 edited books and 1 text-book. His publications have given him an H-index of 78 in GoogleScholar, 67 in SCOPUS and 60 in Web of Science (January 2024). Prof Gani's current research includes development and application of computer aided methods and associated tools for modelling; property estimation; process and/or product synthesis, design & intensification; and process-tools integration with emphasis on energy, sustainability, decarbonization and application of a systems approach.