A Mixed Integer Linear Programming Based Optimization Algorithm for Optimal Operation of an Integrated Natural Gas and Electricity Network in Presence of Demand Response Programs

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Abstract

The power companies try to reduce the power generation cost to satisfy the costumers and increase the profit. For this purpose, various acts including energy management strategies, power loss reduction plans, efficiency increasing of the gird components, etc. have been done in the past. Currently, the integration of natural gas and electricity networks for simultaneous operation is one of the most effective approach. In the integrated networks, the natural gas and electricity are managed simultaneously, making it more beneficial for both suppliers and customers. In this paper, the supplied and demanded natural gas and electricity are managed simultaneously to reach more benefits from both technical and economic perspectives. The studied integrated network includes power plants, gas supplier, gas storage, water electrolyzer, fuel cell units, wind energy and hydrogen vehicles. A comprehensive investigation is carried out to optimal energy management in a modern integrated energy systems, the hydrogen vehicles, as a new transportation vehicle, is included in the system. Both natural gas and electricity demands are supplied optimally using the proposed optimization algorithm. The demand response programs are considered as the flexible loads to increase the system profits. The optimal operation problem is modeled as a mixed integer linear programming problem and is optimized using GAMS programming software. The proposed methodology is simulated in various scenarios and its robustness and effectiveness are discussed.

Keywords
Natural gas networks, Integrated networks, Optimal operation, Demand response.

Biographies

Ali Ahmadian received his PhD Degree in Electrical Engineering in 2017. Currently, he is a Postdoctoral Research Fellow in the Department of Chemical Engineering at the University of Waterloo, Canada. He has been published more than 80 papers in journals and conference proceedings and one book in Springer. His main research interests include: transportation electrification, energy storage, energy and environment, smart cities, and machine learning applications in modern energy systems.

Ali Almansoori is Professor of Chemical Engineering at Khalifa University in Abu Dhabi. During his profession, Dr. Almansoori held several administrative positions including: the Coordinator of President's Duties, Dean of Engineering, and Chair and Deputy Chair of the Chemical Engineering Department. He also was the Interim Senior Vice President for Academic Affairs during the merge between PI, Masdar Institute, and Khalifa University of Science, Technology, and Research. His main research interest is in the area of Process Systems Engineering with the focus on energy systems design, simulation, modelling and optimization. He also conducts general research in the area of renewable energy and fuel cell technology with applications to the oil and gas industry. He has published numerous articles in renowned refereed journals and conference proceedings. He also delivered several presentations in international conferences and is the author of a few book chapters. Furthermore, he serves as a reviewer for reputable international journals in the area of energy and process systems.

Ali Elkamel is a Professor of Chemical Engineering. He is also cross appointed in Systems Design Engineering. Prof. Elkamel holds a BSc in Chemical Engineering and BSc in Mathematics from Colorado School of Mines, MS in Chemical Engineering from the University of Colorado-Boulder, and PhD in Chemical Engineering from Purdue University – West Lafayette, Indiana. His specific research interests are in computer-aided modelling, optimization and simulation with applications to energy production planning, carbon management, sustainable operations and product design. Professor Elkamel is currently focusing on research projects related to gas production and processing, integration of renewable energy in oil and gas operations, and the utilization of data analytics (Digitalization), machine learning, and Artificial Intelligence (AI) to improve process and enterprise-wide efficiency and profitability. Prof. Elkamel activities include supervising post doctorate and research associates, advising graduate/undergraduate students and participation in both university and professional societal activities.