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A multi-objective dynamic framework for design of energy hub by considering energy storage system, power-to-gas technology and integrated demand response program

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Abstract-

Since energy hubs meet the needs of customers for different energies, their construction rate has increased in recent years. The annual growth of load demand on the one hand and the declining efficiency of hub converters on the other hand have posed many challenges for hub designers. Therefore, this study develops a multi-objective model for the design of hub considering converters’ variable efficiency, degradation of equipment and annual growth of the load and energy prices. The proposed hub is equipped by a power-to-gas (P2G) technology and its consumers participate in an integrated demand response (IDR) program. The problem is formulated in mixed-integer non-linear programming (MINLP) format and is solved via DICOPT in GAMS environment. The simulation results substantiate that dynamic framework has led to the much more accurate determination of equipment capacity. Besides, the results indicate that the P2G technology reduces CO2 emissions by 9.89% through consuming CO2 emitted from the CHP and boiler. The results also illustrate that P2G increases the efficiency of gas-fired converters by injecting hydrogen into them, thus reducing losses by 9.2%.

Index Terms- Energy hub; Energy storage system; Power-to-Gas technology; Integrated demand response programs; Loss reduction; Emission

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