A System Dynamics Study on Benefit Evaluation of Natural Gas Demand Response

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Abstract

In the current context of intensifying geopolitical conflicts and frequent extreme events, China, constrained by its limited domestic natural gas resources, faces a continuously expanding demand gap and increasing reliance on external sources. To address this challenge, it is imperative for the country to establish and strengthen demand-side management for natural gas and enhance its peak shaving capabilities. Based on a clear understanding of the participating entities and cost-benefit considerations in natural gas demand response, this paper employs a system dynamics approach to construct a benefit evaluation model for natural gas demand response from three perspectives: user benefits, gas distributor benefits, and pipeline company benefits. The model defines the stock-flow diagrams and key equations for each participating entity's benefit subsystem, and systematically analyzes the relationships between internal and external influencing factors through hierarchical modeling. Simulation examples are used to validate the rationality and effectiveness of the model. Research findings indicate that all participating entities benefit from and influence each other through the implementation of demand response. Enhanced natural gas demand response not only boosts recognition and support for demand response among these entities but also effectively plays a role in balancing supply and demand, mitigating peak demand pressures. This not only facilitates further research and widespread application of natural gas demand response but also provides strong support for achieving stable and efficient operation of the natural gas system.

Keywords

Natural Gas, Demand Response, Benefit Evaluation, System Dynamics, Peak Shaving