A CAPABILITY-BASED MEASURE OF ECONOMIC WORKING GAS CAPACITY

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Overview

Because of the nature of gas storage facilities, dynamic measures are necessary to evaluate physically available and economically efficient storage capacity. The work reported here develops and applies dynamic or capability-based measures of working gas storage capacity. Referring to reports from the EIA (esp. September 2006), this work appears to add to the existing metrics for working gas capacity based on observed storage operations or technical limitations. Starting with a linear dynamic rate-inventory description of storage flows, I derive a solution for the long-run stable cycle that maximizes working gas capacity within the time allowed for a cycle and label it the "maximum cycling working gas" for a facility. The time spans used for the specific application here are the accepted winter-summer split of the natural gas industry for withdrawals (151 day) and injections (214 day). Within this context, the model reveals a feasible working gas window that may be less than the engineering or other purely space-defined working gas sizes for a facility. Depending on the nature of inputs for the facility, there may also be a limitation on capacity due to the response of marginal costs as the ends of flow seasons are reached. Extending the physical model with cost minimization and profit maximization analysis produces a capability-based measure of economically efficient working gas capacity.

Methods

The methods used are standard analytic solutions of a simplified gas-storage capability model. In particular, this work uses first-order linear difference equation system to model the dynamics of gas storage capability and capacity. Fixed time spans in the solutions defining the measure, maximum cycling working gas, are the conventional gas-industry injection (214 day) and withdrawal (151 day) semi-seasons. Extending the volumetric solutions, conventional analytic cost minimization and profit maximization analysis is used to consider the impact of flow costs and revenues on optimum capacity.

Results

An analytic solution for and dynamic measure of the maximum physically attainable long-run cycling working gas capacity, given the flow capability equations and cycle times. A demonstration of how this is likely to be less than working gas capacity from other size-based measures. Utilizing the physical solution, I solve a simplified the profit maximization problem and discuss the case where an operator would have an economically optimal maximum cycling capacity less than the maximum cycling working gas capacity of their facility. This profit optimization based on the dynamic capacity model therefore defines a measure of economically optimal long-run gas-storage cycling capacity.

Conclusions

Dynamic measures of gas storage physical and economically efficient storage capacity are derived and illustrated. This work offers a relatively simple modelling approach for determining physical storage capacity from the cycling capability of the facility. Extending the dynamic solution with simple optimization generates a capability-based measure of economically efficient working gas capacity.

References

EIA Report: "Estimates of Maximum Underground Working Gas Storage Capacity in the United States." (Sept. 2006)

(Full list on request)