QUANTITATIVE ANALYSIS OF GAS SUPPLY STRATEGIES FROM A GERMAN PLANT OPERATOR´S PERSPECTIVE

Andreas Henke, Department of Accounting & Management Control, TU Dortmund University,
Phone: +49-231-755 8203, Mail: andreas.henke@tu-dortmund.de
Nadja Löper, Department of Accounting & Management Control, TU Dortmund University,
Phone: +49-231-755 7918, Mail: nadja.loeper@tu-dortmund.de

Overview

Governmental regulations of energy network operators in Europe and in particular of German gas pipeline operators have been subject to profound changes within the last two decades. Regulators intend to overcome (regional) monopolistic structures and aim to stimulate competition in the energy distribution industry. At the same time, the ongoing liberalization of the gas market results in a broader choice of gas suppliers for industrial consumers. In addition to regulatory and market changes, technical advancements in production and transportation of gas has caused gas prices to decouple from oil prices.

Today, many of the traditional long-term gas supply contracts based on prices linked to oil and coal indices are about to expire and plant operators have to re-evaluate their natural gas supply strategies. Moreover, recent political commitments to an energy transition which favors more eco-friendly and renewable energy sources might induce energy providers to stock-up on new gas-fueled power plants. Those pose an ideal complementary solution for the difficult-to-anticipate and volatile energy supply of renewable energy sources.

There are basically two strategic options for plant operators to supply gas. The first way is to sign a ‘full supply contract’ with one single supplier. Traditional supply contracts containing prices linked to oil and coal price indices have been substituted by those that are directly linked to prices of natural gas, which has been traded at the European Energy Exchange (EEX) in Leipzig since July 2007. As a second option, the plant operator can satisfy demand by trading at wholesale markets.

The first option results in the gas consumer paying a fixed capacity charge and a unit rate for each MWh of consumed gas. The unit rate is linked to daily gas prices at wholesale markets at the day of consumption. Plant operators do not need to consider quantity risk and plan their demand accurately as they are free to consume as much gas as needed to operate the plant whenever the electricity produced can be sold. To compensate this quantity risk that is taken up by the gas supplier, their consumers are charged with a fixed premium per MWh.

The use of wholesale markets to supply fuel results in a fixed capacity charge, as well. This is quite similar to the first alternative. Moreover, this difference is not crucial for deciding which alternative to choose as these costs only represent a minor part of total supply costs. Fuel costs do not differ significantly between the two options either since unit rates in contractual supply are linked to wholesale gas prices. The plant operator, however, has to manage balancing discharged units and units being bought on an hourly and daily basis on his own. If there are differences in injected (bought) and discharged gas, the operator is fined with contractual penalties. This quantity risk referred to as ‘balancing costs’ remains at the plant operator’s expense. It represents the most important difference between the two supply sources.

Methods

To determine the (input-related) quantity risk that plant operators face by managing gas supply on their own, we derived a stochastic optimization model, which takes the uncertainty causing balancing costs into account by accepting different gas demand vectors as input variables. The optimization model was designed in *GAMS* and uses the solver *CPLEX*. It is able to consider gas storage facilities with its associated technical parameters (total capacity, hourly injection and discharging capacity) as well as combinations of both supply sources.

We generated different gas demand scenarios for a sample portfolio of a plant operator that is running two gas and steam cogeneration plants, two heating plants and a gas storage facility. As the announced demand of gas can be renominated and bought or sold in intraday-markets until three hours before discharging, only uncertainty about demand that occurs within these three hours has to be considered for generating different scenarios that affect bal-

ancing costs. Thus we generated a basis scenario by using an existing real options approach and added different simulated residuals. By conducting two interviews with operators of gas-fueled plants, we found that there are two particular events causing uncertainty in gas-demand within the relevant three hours: unscheduled outages and spontaneous electricity trades in the control power market.

We analyzed the plant operator´s historical data concerning both events for each of the four plants and generated 50 different scenarios based on this analysis with *Palisade´s @risk*. We simulated both events in two steps. First, a discrete distribution was used to determine whether an event occurs. In the second step, the amount of varying gas demand in each case was simulated.

The optimization model calculates (fuel and) balancing costs depending on uncertain gas demands represented by different vectors as it chooses a nomination binding for all scenarios and calculates the balancing costs incurred. We executed several calculations and sensitivity analyses varying storage facilities, supply contract specifications (take or pay conditions, make-up specifications) and observation periods.

Results

Our calculations clearly show that managing gas supply for a portfolio of gas-fueled power plants by using wholesale markets is the preferred choice of supply as the expected value of quantity risk is far lower than the premium in offered contracts. Even analyses of calculations without storage capacities show lower balancing costs per MWh than the quantity risk premium in full-supply-contracts. This result does not only apply to considerations of the expected value but also to the worst case of all gas demand scenarios. Proportionalized balancing costs do not exceed 18 ct/MWh in all calculations and scenarios, whereas supply contracts offered to the plant operator include a risk premium multiplied approximately by 10. However, a flexible gas supply contract having a very low take or pay quantity of only about 1% of total annual fuel demand can be added profitably to the supply strategy as it helps to reduce balancing costs for positive balancing energy in the event that the operator sells energy in control power market.

Conclusions

The results show that gas-fueled power plant operators should consider managing supply on their own by trading in wholesale markets as they do not rely on contractual gas supply offered by one single supplier anymore. Accordingly, they are able to reduce balancing costs. Gas suppliers selling full supply contracts will probably not be able to offer lower priced quantity risk premiums than those accruing by trading in wholesale markets as there is an information asymmetry between the operator and the supplier concerning actual gas demands of a plant.

A factor that should be kept in mind is that operators have to anticipate further costs incurred by additional expenditures for extra labor and enhanced IT system requirements to manage gas supply on their own before choosing an adequate supply strategy.

Furthermore, the calculations show that gas storage capacities lost value from a plant operator´s perspective as gas demand declined and intraday trading at EEX was established in March 2010. Moreover, the analysis of gas supply strategies shows that current efforts to regulate gas markets (e.g. reduced number of market areas, amendments to the balancing system) have been successful with regard to boosting competition between suppliers and establishing new markets.

References

Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen (2011): Bericht zum Ausgleichs-Regelenergiesystem Gas, (Report on gas balancing system of the Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway), http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Allgemeines/Bundesnetzagentur/Publikationen/Berichte/2011/BerichtAusgleichRegelEnergieSysGaspdf.pdf.

European Energy Exchange AG (2012): EEX Product Brochure Natural Gas (Release 0001D), http://cdn.eex.com/document/110633/20120614EEXProductBrochureNaturalGas.pdf.

Schmidt, Stefan (2012): Optimale Vertragsauswahl in der strategischen Gasbeschaffung (Optimal contract selection in strategic gas supply), Verlag Dr. Kovač.