Adv Syst Sci Appl 2018; **02**; 59-62
Published online at http://ijassa.ipu.ru/index.php/ijassa/article/view/578.

Specifics of Long-Term Forecasting for Global Gas Markets

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Abstract*:* The article presents a methodology for developing long-term forecasts for global gas markets using optimization modeling. This approach can be effectively used for an integrated analysis of the global gas market conjuncture, and assessment of management decisions in the gas industry in both the short and long term.

Keywords: gas market; modeling; forecast; demand; production; prices

1. INTRODUCTION

The article covers the specifics of forecasting for global markets employing optimization models. These models are based on the principle of the Monge-Kantorovich problem of large dimension, in which the world's total costs of satisfying the global gas demand are minimized:

$$f(x) \rightarrow min$$

where $f(x)$ stands for the total global costs of gas production, including taxes, global transportation costs, gas storage, as well as liquefaction and regasification in the case of LNG transportation.

2. INPUT AND OUTPUT PARAMETERS IN FORECASTING OF WORLD GAS MARKETS DEVELOPMENT

The main results of calculations in regarded optimization models are the optimal volumes of global gas trade by route, production by countries and gas prices.

The key modeling input parameters and assumptions are as follows:

- Volumes of gas supply with corresponding production costs;
- Gas demand volumes;
- Capacity of the existing and planned infrastructure for piped gas and LNG, including corresponding transportation costs;
- Volumes and pricing conditions of the concluded contracts for piped gas and LNG supply;
- Prices of alternative energy resources, taking into account prices of CO2 emissions and the extent of demand switching for such energy resources.

The level of detail in the global supply curve presentation, which contains information on the opportunities for gas production by fields and groups of fields per each forecast year, including corresponding costs, largely determines whether the model reflects the real market with due accuracy. A number of market factors and assumptions about future production volumes and costs (for instance, the rate of decline in gas production in Europe, the cost of extracting shale gas and coalbed methane in Asia, the prospects of gas production in East

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Africa, etc.) greatly affect the relative competitiveness of gas producers. Thus, when the development of individual national or regional gas markets, it is necessary to incorporate changes in the balance of supply and demand across all the global markets, even without any need for receiving such a detailed forecast. Gas production costs are not a fixed parameter, either: in particular, they are influenced by the development of technologies for the production of conventional and unconventional gas, devaluation/revaluation of currencies, changes in oil and gas market prices and tax burden. Thus, since H2 2014, the costs of hydrocarbon production have significantly decreased (Fig. 1).

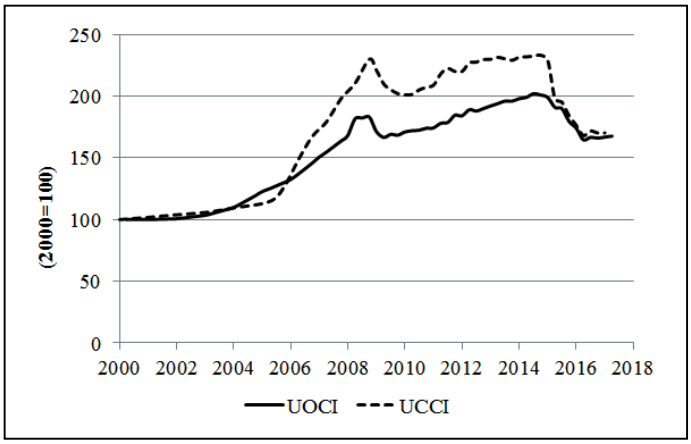

Fig. 1. Indices of operational (UOCI) and capital (UCCI) costs in the oil and gas production sector. Source: IHS CERA [1].

In this regard, an important assumption in plotting the gas supply forecast curve, which directly influences the forecast level of gas prices, is the rate of production cost escalation.

The global gas demand drivers have an impact on modeling results that is no less important than that of the assumptions for gas supply. The demand for gas, as part of energy demand, shall be determined by both the level of domestic energy consumption (as a whole and by sectors) and the conditions of inter-fuel competition. Forecasting energy consumption of countries (nodes) by types of energy resources shall be carried out separately and shall not be deemed the subject-matter of the study described. But the demand for gas in the model shall be refined further - in order to consider inter-fuel competition, the opportunities for switching the demand for alternative energy resources are added when certain threshold levels of prices are reached in the process of calculations. Here, the coefficients reflecting the assumptions for CO2 emission prices are added to the prices of carbon fuels.

Countries (more precisely, nodes, since in the detailed analysis of certain countries, especially big ones, it is expedient to allocate several nodes within a single country) with the given production capacities and the volume of gas demand in the models under consideration are connected with one another by gas transportation and storage infrastructure. This includes gas pipelines, gas storage facilities, LNG plants and LNG regasification terminals. The main parameters of gas transportation infrastructure are capacity, transportation costs, their escalation rates, expected service life, and directions of routes (dispatch nodes and destination nodes). Thus, the possibilities of gas transportation between the nodes with surpluses and deficit of supply are formed.

In view of a large share of transportation costs in the market price of gas, manipulating the possibilities can significantly distort simulated conditions of competition. In particular, in the short run, when analyzing a volatile market environment with price wars, scenarios can become realistic in which only operational costs for gas production and transportation are considered while the correct option for long-term forecasts is to incorporate long-term marginal costs.

A part of supply and demand for gas is withdrawn from the free competition environment through the introduction of gas supply contracts (piped gas and LNG). Gas supplies under contracts can differ from optimum competition alternatives by volumes, routes and price. In the real market swap deals take place, and it is possible to overestimate future demand when signing the long-term contracts.

However, long-term contracts, first and foremost, ensure the security of supply through the guarantee of supply and demand and reduction of transaction costs. The increased flexibility of gas supply conditions under long-term contracts also contributes to their role in gas markets. However, on the background of market development the volume of gas supplies under short- and medium-term contracts has markedly increased: in 2016, almost 30 % of global LNG supplies were made under contracts valid for up to 4 years [2]. In the models, the input parameters characterizing gas supplies under long-term contracts include annual volumes of supplies, contract duration, gas price formula, level of quarterly and annual minimum volumes. Gas prices in contracts can be directly indexed to oil prices, the price of the Japanese crude cocktail (JCC), prices of petroleum products (gasoil, fuel oil), as well as to spot prices (for example, Henry Hub, Gaspool, NBP, TTF). Accordingly, the projected oil prices and spot gas prices to be indexed in contracts are exogenous variables. These prices are also used to calculate the cost of the fuel required to transport LNG.

The optimization results are the volumes of gas supplies in all directions (can be grouped into import and export forecasts by countries), the gas production required for these supplies (in the same level of detail as gas supply input in the model), gas storage volumes, gas prices as long-term marginal costs of supplying gas to each node and refinement of gas consumption volumes, with consideration of the switching of part of the demand for alternative fuels. Based on the calculation results per each node, the following condition is fulfilled:

Gas production + Piped gas and LNG import + Withdrawal from gas storage - Gas consumption - Piped gas and LNG export - Injection into gas storage = 0. □□□

In general, the scheme of input parameters and assumptions and output data appears as follows (Fig. 2).

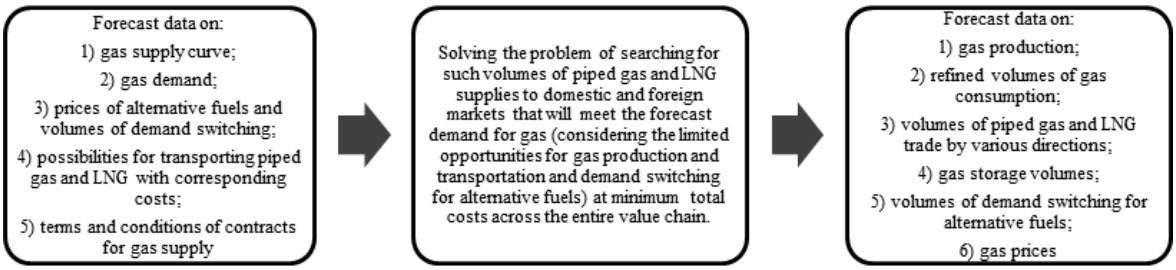

Fig. 2. Inputs and outputs in optimization models of global gas market development. Source: ERI RAS.

3. SENSITIVITY ANALYSIS AND RESULTS

As the studies and results of the calculations show [3, 4], currently, gas prices are more influenced by oil prices in the Asian and European markets, but in the long term, the role of gas-on-gas competition and hence the role of gas production and transportation costs will increase in all key global markets.

In the US market, gas production costs already directly affect market gas prices.The prospects for changing directions and the level of global gas trade in the next 25 years will largely be determined by the demand in Asia. Russian exports to the east will mainly depend on the opportunities for production, the projects implemented and contracts signed. In the European and the CIS market the dynamics of demand and the possibilities of competition will

play a key role, while the production and transportation capacities will have sufficient reserves for increasing supplies when needed.

The considered approach allows for the shaping of complex scenarios, exploring interactions between market participants and analyzing the sensitivity of national gas markets to various local and global factors (for example, to changes in global or regional demand, the costs and volumes of supply of conventional and unconventional gas, changes in taxation, terms of supply contracts), as well as assessing the competitiveness of projects for gas production and transportation under various conditions.

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