German Economic Team

UZBEKISTAN

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Short-term forecasting of gas consumption by standard load profiles in Germany

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Financed by the Federal Ministry for Economics and Energy, the German Economic Team (GET) advises the governments of Moldova, Georgia, Ukraine, Belarus and Uzbekistan on economic policy matters. Furthermore, GET covers specific topics in other countries, such as Armenia. Berlin Economics has been commissioned with the implementation of the consultancy.

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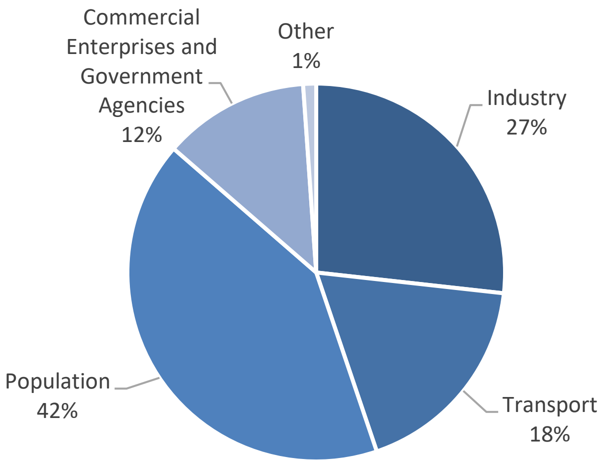
1 Introduction

Natural gas is currently by far the most important energy source for Uzbekistan amounting to 86% of total primary energy supply in 2020. Strong economic and population growth in past years led also to a strongly growing gas demand which faced an aging infrastructure. This resulted especially in winter in temporary supply interruptions. Despite the planned and already ongoing expansion of renewable energy as well as the development of higher energy efficiency, natural gas will remain an important energy source in Uzbekistan. We estimate only a slight decrease of gas demand by 6% in 2030 compared to 2019 as strong economic growth is projected to remain a key driver for growing energy demand. This would offset much of the planned fuel switching efforts away from natural gas and towards renewable and nuclear energy as well as improvements in energy efficiency.[1] One way to address these challenges and to secure a stable gas distribution is to improve the quality of gas consumption forecasts, especially in the short- and medium-term.

Figure 1

Final natural gas consumption in Uzbekistan in 2020



Source: Uzstat, own calculations

We want to contribute to this goal by describing the German approach of daily and yearly gas consumption forecasts. This technical note discusses how these forecasts are made in Germany. The focus lies on the forecasting methodology of gas demand of the population and small- to medium-sized enterprises. The methodology might be suitable to forecast the gas demand of the population of Uzbekistan, who accounts for 42% of the final energy consumption of natural gas (see figure 1). Additionally, the approach can be used to forecast the gas demand of medium-sized commercial enterprises or industries with low gas demand. The methodology is not designed to forecast gas demand of end-consumers with high energy consumption or the gas demand of the transport sector.

[1] Policy Briefing PB/05/2021: Projection of Uzbekistan's natural gas consumption in 2030

2 The Gas Demand Forecast Methodology in Germany

In Germany gas forecasts are estimated decentrally by distribution grid operators and are not done by the government. The German gas market is highly liberalized and around 900 regional and transregional distribution grid operators supply end-consumers with gas. These distribution grid operators estimate the yearly gas demand of end-consumers with a yearly gas consumption of less than 1.5 GWh through so-called standard load profiles (SLPs).

In this technical note, we describe the SLP methodology for forecasting gas demand and distinguish between the short-term forecasts for daily gas demand and the medium-term forecasts of up to one year.

2.1 Short-term daily forecast

Distribution grid operators use SLPs based on temperature as main indicator for gas demand forecasts. This is done for end-users with a yearly consumption of less than 1.5 GWh, which are standardised depending on the end-users characteristics. In general, end-users are differentiated in households and industry. They are further differentiated for different industry types and household characteristics. A standard load profile for gas consumption is defined as a load profile that forecasts the gas demand of a representative end-consumer with only yearly meter readings. End-consumers with a yearly consumption of more than 1.5 GWh have more frequent meter readings and their gas demand is negotiated directly with the distribution grid operator.

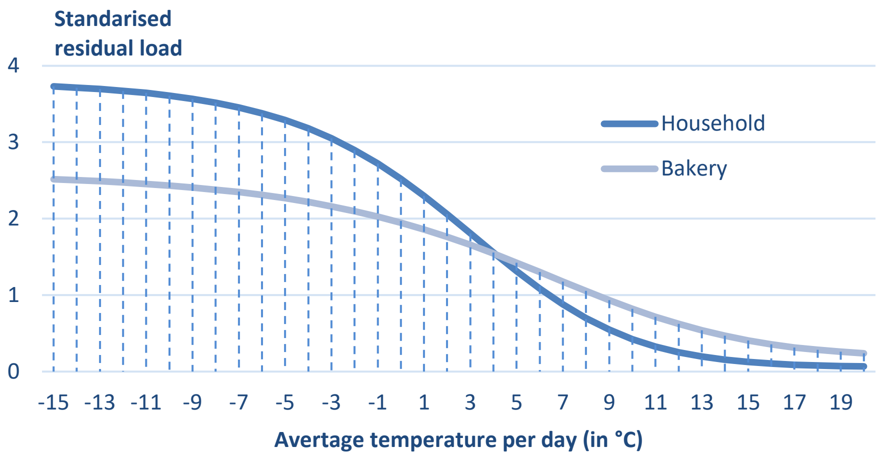
Technically gas demand is connected to the temperature forecast by a sigmoid function. An example of two different shaped sigmoid functions is provided in Figure 2 below. The function accounts for the fact that gas demand for heating is close to zero when temperatures are high (more than 20 °C) and that it raises when temperatures drop. The mathematical form of the function is explained in the appendix.

As a prerequisite past gas consumption of end-users must be analysed to categorise them into different SLP types. Furthermore, data about past gas consumption and respective temperatures are used to identify the specific form of the sigmoid function of the SLP.

Since the SLPs only use the temperature forecast as indicator of gas consumption, reliable temperature forecasts are necessary to apply SLPs. Additionally, it is crucial to use accurate and thorough data on past gas consumption to determine precise SLPs.

Figure 2

Example of standard load profiles in Germany



Source: Own calculations

2.2 Medium-term forecast for yearly gas demand

Past gas consumption and temperature dependent SLPs can also be used to estimate the yearly demand of gas. In order to do that the daily gas demand is estimated by the expected temperatures for every day of the following year. These daily forecasts are aggregated by each SLP to determine the medium-term gas demand for up to one year for each SLP.

To calculate the gas demand of all end-consumers in the market area the SLP forecasts are weighted by the number of end-consumers who are assigned to a SLP. In general, the more end-consumers belong to a SLP the more accurate the forecast will be.

In summary the SLP methodology uses the following steps to forecast gas demand:

1. Analysis of consumption and temperature data in order to group end-consumers by consumption characteristics.
2. Determine SLPs that fit these consumption characteristics.
3. Use temperature forecast to estimate gas demand of end-consumers by SLPs.
4. Aggregate daily gas demand forecast to determine yearly gas demand.

3 Discussion: Is the German approach useful for Uzbekistan?

The gas demand prediction by SLPs was developed in Germany in order to create a more accessible market for small- to medium-sized regional gas providers. It is a simplified procedure to obtain daily demand forecasts for end-consumers with only yearly meter readings. A prerequisite for successfully implementing the SLP methodology are thoroughly compiled consumption data and reliable temperature forecasts.

The method can be used to calculate yearly gas demand of end-consumers with a yearly gas consumption of less than 1.5 GWh. This methodology could be an interesting tool to estimate the gas demand of households and small enterprises in Uzbekistan differentiated by regions. However, we have no knowledge of the methodology currently used in Uzbekistan and it is therefore difficult to assess whether the approach could be useful for Uzbekistan. We suggest to use the SLP forecasts complementary to the established forecasting method to compare the predictive power of the methodology. The SLP methodology can be extended by including additional estimation parameters such as GDP growth or gas price development.

Forecasts of gas demand of end-consumers with a higher gas-consumption than 1.5 GWh is more intricate and involves frequent meter readings (up to hourly readings). For those consumers, which includes most commerce and industry, more sophisticated methods based on frequent meter readings and individual negotiations are used.

4 Appendix: Standard Load Profile (SLP) calculation

The sigmoid function used in SLPs is given by:

$$h_{day} = \frac{A}{1 + \left(\frac{B}{\vartheta - \vartheta_0}\right)^C} + D \; with \; \vartheta_0 = 40\ (°C)$$

- ϑ Temperature
- h gas demand
- A, B, C parameters of demand function
- D temperature-independent gas consumption (for hot water)

Graphically temperature is displayed on the abscissa and gas demand on the ordinate. By setting $\vartheta_0 = 40\ (°C)$ the discontinuity of the function is shifted to a temperature (40°C) that is not in the relevant temperature range. A and D are the upper and lower bound of gas demand respectively. A decrease of the negative coefficient B shifts the demand function in the negative direction (to the "left") on the abscissa. The coefficient C influences the steepness of the demand function and point of inflexion. An increase in C smoothes the demand function and shifts the inflexion point in the positive direction (to the "right") on the abscissa.

The approach described above under-allocates the gas demand for cold temperatures. Therefore, revised SLPs use a linearized continuation of the demand function for very cold temperatures.

An alternative to increase the predictive power of SLPs is to include econometric data like economic growth and inflation in the gas forecast or to account for different seasons. This can be done by adding an additional parameter to the equation or by adapting the parameters A, B, C and D frequently.

Based on a geometric temperature series and the SLP, the yearly consumption forecast (YCF) for each end-consumer can be estimated by:

$$YCF = \sum_{i=1}^{365} h_{SLP}(\vartheta_i)$$