Assessment of vulnerability of natural gas supply in Serbia: State and perspective

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ABSTRACT

Ensuring security of supply for the domestic natural gas market is one of the priorities of Serbian energy sector development. In the natural gas sector, the Republic of Serbia is strongly dependent on Russian gas. Import dependency is almost 80% and gas is imported via a single supply route. In order to evaluate the security of the natural gas supply in Serbia and vulnerability to possible interruptions in international supply chains, three possible scenarios for natural gas infrastructure development and two scenarios of natural gas consumption by 2025, are discussed in this paper. This combination of infrastructure and demand scenarios projects six possible futures for the Serbian natural gas system, assessed by N-1 index. This paper presents a methodology for determining maximal daily consumption for households and district heating (with a probability of once in 20 years) based on degree-days. The possibilities of the Serbian gas system mitigating the consequence of a possible supply cut from Ukraine, for six analysed scenarios are discussed.

1. Introduction

Natural gas is the only fossil fuel whose share in the primary energy mix is expected to grow (WEC, 2016). It is the third most used energy source in the world, growing from 16% in 1974 to over 21% of total primary energy supply (TPES) nowadays (IEA, 2015). Due to its high energy content and lower emissions of harmful compounds at combustion compared to coal and oil, natural gas has the potential to play a significant role in the transition to a cleaner energy future.

In the Republic of Serbia, the share of natural gas in the total primary energy supply was 13.3% in 2016 (Statistical Office of the Republic of Serbia, 2017a). Out of the total yearly demand, approximately 18% (around 400 mcm) are supplied from indigenous production, while the rest is imported (AERS, 2017; Ministry of Mining and Energy, 2016), causing a natural gas import dependency of nearly 80% (Statistical Office of the Republic of Serbia, 2017b). Gas is imported predominantly from Russia, based on a long-term agreement (Ministry of Minning and Energy, 2013). The single supply route is the interconnection with neighbouring Hungary's cross-border transport system, directly connected with Ukraine.

The Ukrainian 2009 gas crisis demonstrated the vulnerability of natural gas supplies in Serbia, indicating a daily natural gas shortage of more than 75% in the winter period (Badea, 2010). Thus, providing a secure supply of natural gas for consumers in Serbia is recognized as an issue of high priority. Banatski Dvor underground natural gas storage facility (UGS) with a withdrawal capacity of 5 mcm per day was put into operation in 2011 (Ministry of Mining and Energy, 2013). Besides solving the problem of seasonal variation in consumption, UGS provides the possibility to deliver stored natural gas in emergency situations. However, single interconnection and dominant supply from one source make Serbia one of the most vulnerable countries in Europe regarding security of natural gas supply.

The availability of energy resource supply in a sustainable and timely manner represents the most dominant dimension of energy security (Kruyt et al., 2009); not just the physical presence of energy resources, but also the possibility of the community using these resources.

The availability of natural gas is usually described by System availability index (N-1) (Badea, 2010). It determines the ability of the gas pipeline system to respond to consumption requirements under extreme conditions. N-1 indicates the daily operational flexibility of natural gas infrastructure and measures its relative dependence on the most significant source of natural gas. Its calculations are based on the capacity of import gas pipelines, indigenous gas production, deliveries from the UGS or LNG terminals and maximal daily consumption (once in 20 years).

In order to evaluate the security of the natural gas supply in Serbia and its vulnerability to possible interruptions in international supply

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chains, three possible scenarios for natural gas infrastructure development and two scenarios of natural gas consumption by 2025, are discussed in this paper. Their combination makes provides six scenarios analysed and assessed by the N-1 index. Since in all analysed scenarios an increase in consumption is expected, a methodology for determination of maximal daily consumption (with a probability of once in 20 years) based on degree-days use was proposed and applied. The possibilities of the Serbian gas system mitigating consequences of a hypothetical supply cut from Ukraine are additionally discussed.

2. Natural gas sector in the Republic of Serbia

2.1. Current state overview

2.1.1. Indigenous production

Indigenous production meets 15–20% of natural gas demand in Serbia (AERS, 2017). Serbian gas fields are located in the northern part of the country, in the Pannonian Basin. The remaining reserves, with about 4.23 bcm of natural gas, are expected to have low quality exploitation (Ministry of Mining and Energy, 2013). The Oil Industry of Serbia - NIS-Gazprom Neft is the only producer in the country (Ministry of Mining and Energy, 2013). After a significant increase in indigenous production in 2011, production has been constantly decreasing since 2012 (AERS, 2017). Due to problems with compression, domestic production has difficulty in delivering gas to the network without external supplies (Kovacevic, 2009). Fig. 1 shows historical as well as expected production, until 2023 (Ministry of Mining and Energy of Republic of Serbia, 2017).

2.1.2. Infrastructure

Natural gas transmission system of the Republic of Serbia is a linear system with the single input from Hungary and the single output for transit for Bosnia and Herzegovina (Fig. 2) (Srbijagas, 2017a). Main gas pipeline system connects all domestic gas fields with consumers and enables gas import from Russia (Ministry of Mining and Energy, 2013). Main technical characteristics of transmission system are presented in Table 1.

Two transmission system operators are PE Srbijagas and Yugorosgas Transport LLC. PE Srbijagas is in charge of 95% of the transmission pipeline (AERS, 2017). The currant daily capacity of interconnections is 11 mcm with an interconnector utilisation rate of 90%. There is potential for an additional 2 mcm per day for transit to Bosnia and Herzegovina (Ivezić et al., 2012).

The Introduction of the Banatski Dvor underground gas storage increased the reliability of the natural gas supply in Serbia and mitigated problems of uneven consumption (4:1 winter/summer consumption ratio) (Ivezić et al., 2016). The current capacity of "Banatski Dvor" UGS is 450 mcm, and the maximal production was 4.95mcm per day in 2016 (nominal UGS production is 5 mcm per day) (AERS, 2017).

In 2017 there were 267,158 delivery points, with a tendency to increase. Annual growth rate of delivery points is between 1.5% and 2%
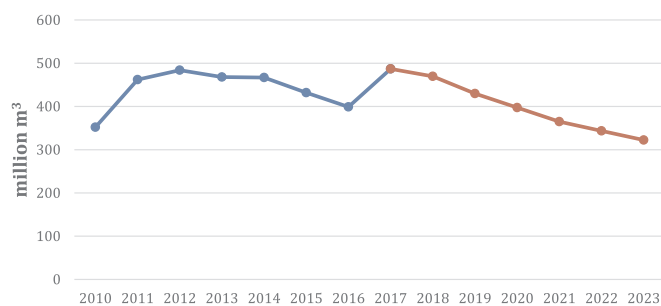
(4200–4900 new connections per year). The majority of deliveries (95.2%) from distribution systems are to households (Table 2). In total, approximately 10% of households in Serbia use natural gas (AERS, 2017).

It is important to notice that approximately 70% of Serbian inhabitants live in areas near the transmission network (AERS, 2017). Thus, there are technical prerequisites for gas utilisation in most parts of the country, as well as a potential for further development of distribution systems and increased natural gas consumption in households in the future.

2.1.3. Demand

According to the energy balance (Statistical Office of the Republic of Serbia, 2017b) the consumption of natural gas in 2016 was 2251 mcm. Table 3 presents supply and demand patterns for natural gas in Serbia for the last six years. The consumption pattern is presented in Fig. 3.

It is evident that the industrial sector is the main consumer of natural gas in Serbia. The share of natural gas in industry's fuel mix is 21% (Statistical Office of the Republic of Serbia, 2017b), while a significant additional amount of natural gas is used in chemical and petrochemical industries for non-energy purposes.

DH systems consume approximately 25% of natural gas in Serbia. In their fuel mix, natural gas comprises more than 75% (Ministry of Mining and Energy, 2016). The biggest DH systems in the country, in the most populated cities (Belgrade, Novi Sad, Niš) are almost completely dependent on natural gas, while connected households (dominantly multifamily housing), public, and commercial sectors do not have sustainable alternatives for their heat supply.

Unlike DH systems, households (single family housing) are usually able to switch to an alternative energy source (fire wood, LPG, heat pumps, electricity, etc.). Therefore, consumption in this sector had significant variations in previous years indicating dependence on natural gas price.

Gas import dependency in Serbia in 2016 was 82% (AERS, 2017). Analysis of consumption and the possibility of mitigating gas shortages clearly indicates that any interruption in supply, especially in winter, would have significant consequences for the Serbian economy and society.

2.2. Natural gas policy

In principle, the overall direction of Serbian energy policy is mostly determined by membership of the Energy Community and the process of accession to the European Union. The Community Treaty was the first contract between the Republic of Serbia and European Union, by which the Republic of Serbia undertook to implement EU regulations on energy, environment, competition and renewable energies, as well as to comply with certain general European standards relating to technical systems, for example on the subject of cross-border transportation or connection (EUR-Lex, 2017).

The Energy Law, adopted in 2014, mostly transposed the EU's Third Energy Package. The gas sector is governed by this Law and by secondary legislation adopted by the national regulatory authority. However, several important secondary acts have still not been updated in line with the Law. Moreover, the gap between the transposition of laws and their implementation in the gas sector is widening each year (Energy Community, 2017a). According to the Energy Community Secretariat (Energy Community, 2017b), the rate of EU Acquis implementation in the Serbian gas sector is around 45%.

Some additional critical issues relating to Serbian gas policy recognized by the Energy Community include, as follows (Thomson and Derrick, 2018):

– Non-achievement of the functional unbundling of PE Srbijagas (a state-owned company) and Jugorosgaz (ownership comprises Gazprom – 50%, PE Srbijagas - 25%, and Central ME Energy and Gas

Fig. 1. Indigenous production of natural gas – realization and forecast (Ministry of Mining and Energy of Republic of Serbia, 2017; AERS, 2013; AERS, 2014; AERS, 2015; AERS, 2016; AERS, 2017).