

# ANALYSIS AND CALCULATION OF MMRS AND PRIMARY GAS DISTRIBUTION NETWORK IN URBAN ENVIRONMENT - CASE STUDY KUČEVO

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# Natural gas – fuel and security tool

- The field of application of natural gas is very wide.
- As an energy source, it can be used for energy production in power plants, heating plants and cogeneration plants or for meeting various heat needs in industry and mass consumption.
- Gas can also be used as a raw material in the chemical and petrochemical industries, and during the last decades it has been used in traffic as a fuel in internal combustion engines.



# Natural gas – fuel and security tool

- Natural gas, in addition to environmental advantages, it also has significant technical and economic advantages over other conventional fuels.
- From a technical and economic point of view, the advantages of using gas are low investment costs and price, high degree of utilization, reliability and flexibility of use, easier and safer storage compared to other fossil fuels.
- This fuel is available throughout the year, and its quality is standardized and guaranteed.



# Natural gas Republic Serbia

- After coal and oil, natural gas is the third most used primary source of energy in the Republic of Serbia.
- Its share in total primary energy consumption in 2020 was 13.25%. The total consumption of natural gas in 2020 amounted to 2,481 million m<sup>3</sup>, which is 4% less than in 2019.
- The source of natural gas in Serbia is primarily represented by international gas pipelines from Russia, via Ukraine and Hungary, while only a small part (~ 10%) is obtained from own sources



# Natural gas Republic Serbia

- The Republic of Serbia has four interconnections with gas pipeline systems in other countries, and these are the points of interconnection:
- Hungary - Republic of Serbia (Kiskundorozhma) - entry point;
- Republic of Serbia - BiH (Zvornik) - exit point;
- Bulgaria - Republic of Serbia (near Zaječar) - entry point;
- Republic of Serbia - Hungary (under construction near Horgos) - exit point.



# Natural gas Republic Serbia

- In Republic of Serbia there is a trend of gasification of small places and urban availability of natural gas.
- According to AERS about 70% of the population of Serbia, i.e., about five million people live in areas close to the distribution network.
- Thus, there are technical preconditions for the use of gas in most of the country, as well as the potential for further development of distribution systems and increase in natural gas consumption in households in the future.



# Gasification of Kučevo

- The municipality of Kučevo is located in the northern part of eastern Serbia, within the Braničevo district.
- In its central part, it covers the Zviška valley and the Zviška mountains, through which the river Pek flows, in the south the slopes of the Homolje mountains, while in the north there is a gradual transition to the Stiška plain and the Braničevo area.
- The territory of the municipality covers an area of 721 km<sup>2</sup>. It consists of 26 settlements, and the city of Kučevo is the economic, administrative and cultural center of the municipality.



# Gasification of Kučevo

- Since Kučevo does not have a city heating plant, the satisfaction of heat needs is currently done from individual fireplaces in all existing facilities.
- The dominant energy sources, with a share of 77%, are coal and wood. In the public utility sector, coal-fired boilers of different capacities are primarily represented, depending on the size and purpose of the facility.
- Most households use wood as an energy source (66%), pellet heating 7%, while electricity construction is present in 11% of households.





# Gasification of Kučevo

- It can be concluded that the use of solid fuels is by far the most common type of meeting the heat needs in Kučevo.
- This, along with the fact that almost all fireboxes are of an individual character, leads to a relatively high content of pollutants in the air during the winter months.
- Outside the heating season, the air quality index is in the good area, in the range of 51-100.



# Gasification of Kučevo

- During the winter months, this index is significantly higher, and the reason for that is the increased concentration of PM 10 (particles smaller than 10 microns) and PM 2.5 (particles smaller than 2.5 microns).
- During the summer, the concentration of PM 10 is about  $2.5 \mu\text{g}/\text{m}^3$ , and the concentration of PM 2.5 is about  $2 \mu\text{g}/\text{m}^3$ . These values during the heating season exceed  $100 \mu\text{g}/\text{m}^3$ , which puts the air in the category of moderately polluted.
- The main causes of this situation are energy inefficient individual boiler rooms and the use of energy sources with high emission factors



# Gasification of Kučevo

- Priority zones for gasification in the city would be industrial zones within which the company "FIC" and the number of small entrepreneurs, the route to the company "Limekiln", as a consumer with the greatest needs, and then the city center as the area with the most densely populated population and the largest by the number of communal - public facilities.
- The mentioned consumers would have the advantage of connecting to the gas pipeline network, while the rest of the city settlement and facilities would be gradually connected.



# Gasification of Kučevo

- The existence of a reliable and efficient gas pipeline system on the territory of Kučevo would represent a great progress in the technical and ecological sphere, and the option of using natural gas as an energy source would be suitable for both the population and industrial consumers.
- These facts are good reasons for gasification of the city.



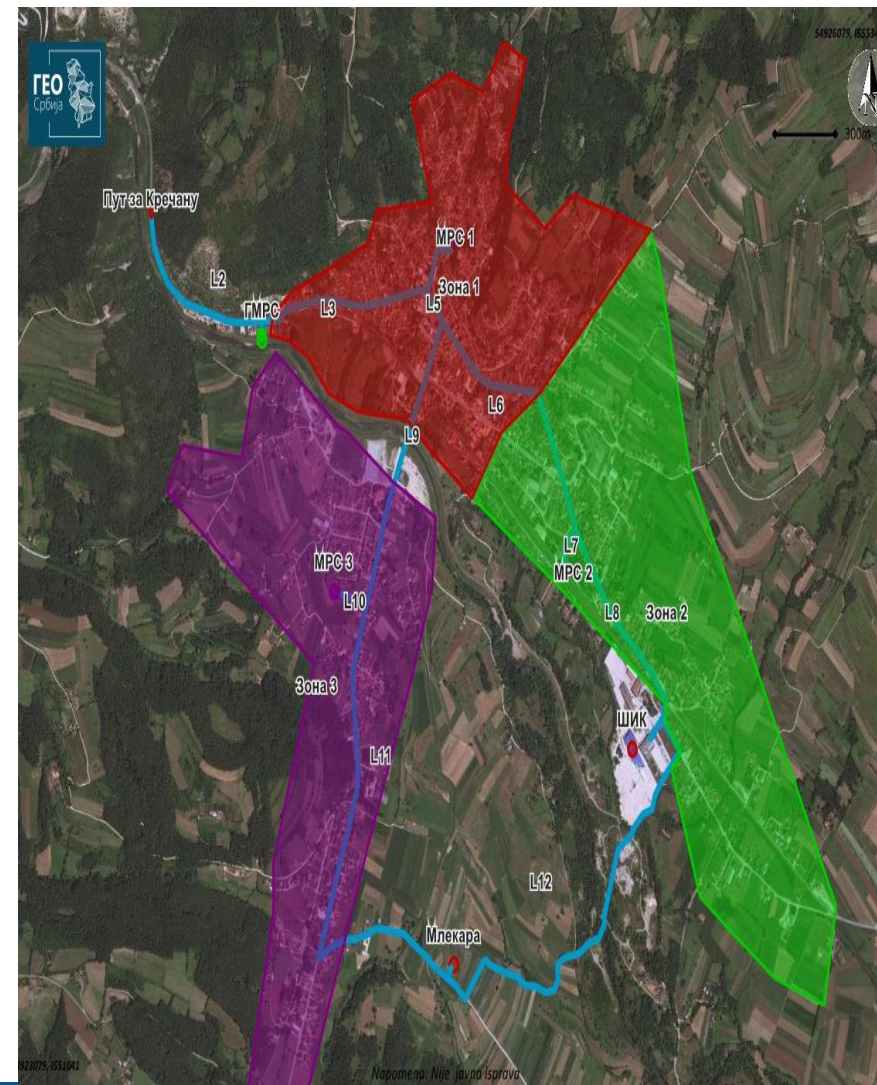
# Distribution network of Kučevo

- Consumers in the urban settlement of Kučevo are divided into three zones, in such a way that in each of them there is approximately the same number of consumers and that the levels of consumption are uniform.
- Each of the three units would be covered by one MRS, whose task would be to deliver gas to all individual consumers in those zones. Industrial consumers would be supplied with gas directly through the primary gas network.



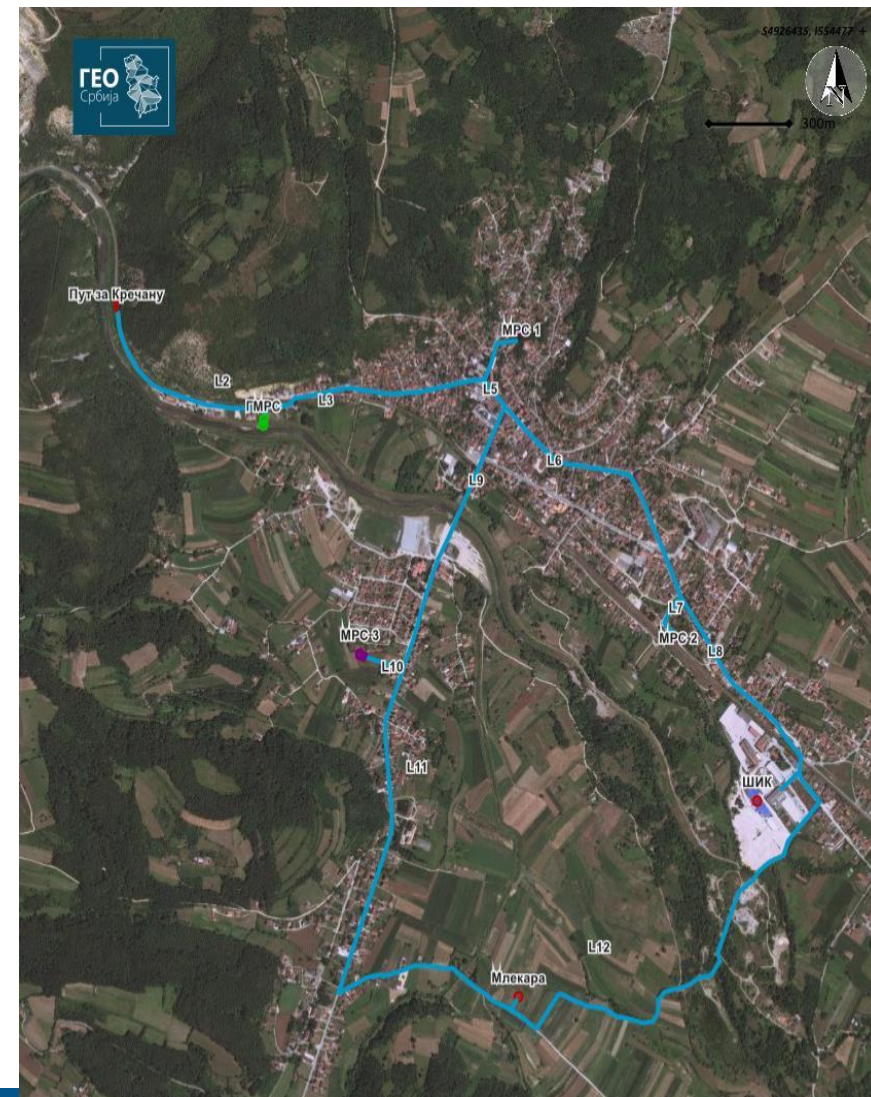
# Distribution network of Kučevo

Supplier	Number of consumers	Hourly consumption
		[m <sup>3</sup> /h]
Zone 1 - MRS Center	606	900.00
Zone 2 - MRS Peck	604	900.00
Zone 3 - MRS Colony	552	794.98
Limekiln	1	4,571.28
FIC	1	489.48
Dairy	1	191.78
<b>Total</b>	<b>1,765</b>	<b>7,847.51</b>



# Distribution network of Kučevo

Section	Consumer	Section length	Flow	
			By Consumer	Total
		km	m <sup>3</sup> /h	m <sup>3</sup> /h
L1		0.022		7,847.510
L2	Limekiln	3.3	4,571.278	4,571.278
L3		0,825		3,276.232
L4	MRS Center	0,247	900,000	900.000
L5		0.112		2,376.232
L6		0.956		1,381.100
L7	MRS PEK	0.151	900.000	900.000
L8	FIC	0.807	507.600	481.100
L9		0.906		995.132
L10	MRS Colony	0.139	794.980	794.980
L11	Dairy	1.8	191.776	218.276
L12		1.73	934.100	934.100
		10.995		



# Distribution network of Kučevo

- It should be noted that section L12 represents the backup section of the pipeline. To ensure the optimal pressure, drop at the node points, it is planned to always deliver 26,5 m<sup>3</sup> of gas to the company Limekiln through section L12.
- The section itself is designed so that with this flow, it can transfer the amount of gas needed to cover the needs of companies from the second branch of the primary network and part of the gas needs of the zone where the MRS is located from the other branch.
- The reason for this sizing of the section is to ensure security of supply and reserves in the event of a breakdown in one of the operational sections of the pipeline





# Distribution network of Kučevo

Section	Flow	Diameter (standard)	v
		<b>inner</b>	
	m <sup>3</sup> /h	mm	m/s
L1	7,847.510	441.2	14.26556
L2	4,571.278	339.8	14.00937
L3	3,276.232	339.8	10.04051
L4	900.000	159.5	12.51840
L5	2,376.232	261.9	12.25874
L6	1,377.600	261.9	7.10690
L7	900.000	159.5	12.51840
L8	477.600	105.5	15.18404
L9	998.632	159.5	13.89031
L10	794.980	159.5	11.05765
L11	221.776	105.5	7.05078
L12	937.600	159.5	13.04140



# Distribution network of Kučevo

- Based on the results shown in the tables of the distribution pipeline sizing procedure, it can be concluded that the designed pipeline route and adopted diameters meet all requirements regarding final distribution pressure and gas velocity through the system, since none of the sections exceeded the values defined as inappropriate.
- The annular structure of the gas pipeline was also successfully performed, considering that the appropriate values of pressure drop at the node points were achieved.



# Distribution network of Kučevo

- To perform the presented conceptual pressing of the gas pipeline network, it would be necessary to procure the following pipes: 2,600 m pipes with a diameter of 114.3 mm, 3,173 m with a diameter of 168.3 mm, 1,068 m with a diameter of 273.1 mm, 4,125 m with a diameter of 355.6 mm and 22 m with a diameter 455.7 mm.
- There is still place for corrections of savings, but in such a situation, the impact of these changes on key parameters must be monitored.



# Distribution network of Kučevo

- This paper presents the conceptual solution for the gasification of the city of Kučevo. Determining the optimal route of the primary gas network and dimensioning it was done with the aim of minimizing investment costs and investments.
- Hourly and annual gas needs of all existing consumers have been defined, and potential future consumers are also foreseen.
- The positions and capacities of MMRS and MRS were determined, with the accompanying equipment adopted. In this process, all requirements regarding security of supply and security were monitored and complied with.



# Distribution network of Kučevo

- The realization of the gasification project requires large financial resources, and in the case of Kučevo it would be justified only if there would be further development of the industrial sector and the emergence of new plants as planned, or if most of the consumer sector would be connected to the gas network.
- The relief in this process is that the company "Limekiln" has expressed its intention to use only natural gas as an energy source for its needs soon, and the process of procuring the necessary equipment has already begun.



# Distribution network of Kučevo

- A survey was conducted on the territory of the city for the purposes of this paper.
- The aim of the survey is to gain insight into the attitudes and commitment of the public to the gasification of the city. In a sample of one hundred and fifty respondents, ninety-two said they would use the natural gas heating system, when it was available to them.
- As this represents 57% of the sample, it is possible to establish the existence of certain difficulties related to the gasification process.



# Distribution network of Kučevo

- As potential obstacles or reasons why, they would not use natural gas, the respondents point out the high price of connection to the gas network (40%) and the costs related to the purchase of heaters, boilers, and furnaces (38%).
- Also, 11% of respondents said they would not use natural gas because they have their own energy sources, primarily wood.
- Twenty-two expressed concerns for the safety and security of the installation as a potential obstacle to the introduction of natural gas heating.



# Distribution network of Kučevo

- As a conclusion of the examination, one can get the impression that the financial aspect is the main reason for the relatively low public interest in gas heating, and it would be necessary to find an adequate solution to overcome this obstacle.
- The advantages of performing gasification on the territory of the city are reflected in the existence of a reliable heating system and the reduction of air pollution.
- Reducing the emission of harmful particles would be achieved by more rational use and reduction of the amount of consumed solid energy sources, as well as a gradual decline in the number of individual combustion plants.

