Three Seas Initiative Natural Gas North-South Corridor Market Integration Study

Eastern Europe Natural Gas Partnership (EENGP)
Cooperative Agreement: AID-OAA-12-00036

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ABBREVIATIONS

In alphabetical order

ACER	- Agency for the Cooperation of Energy Regulators
bcm	- billion cubic meters
CAPEX	- Capital expenditures
CBA	- Cost-Benefit Analysis
CCGT	- Combined Cycle Gas Turbine
CHP	- Combined Heat and Power Generation
CS	- Compressor Station
EC	- European Commission
EE-NGP	- Eastern Europe Natural Gas Partnership
EIHP	- Energy Institute Hrvoje Požar
EMI	- Electricity Market Initiative
ENTSO-E	- European Network Transmission System Operators for Electricity
ENTSO-G	- European Network Transmission System Operators for Gas
FSRU	- Floating Storage Regasification Unit
GDP	- Gross Domestic Product
HDD	- Heating Degree Days
IAP	- Ionian Adriatic Pipeline
IBS	- Interconnector Bulgaria-Serbia
IEA	- International Energy Agency
IGB	- Interconnector Greece-Bulgaria
IGU	- International Gas Union
IRR	- Internal Rate of Return
ITB	- Interconnector Turkey-Bulgaria
ktoe	- thousand tonnes of oil equivalent
LDC	- Load duration curves
LNG	- Liquefied Natural Gas
MAED	- Model for Analysis of Energy Demand
mcm	- million cubic meters
MTPA	- Million Tonnes Per Annum
NPV	- net present value
NRA	- National Regulatory Authority
OPEX	- Operating expenses
PCI	- Project of Common Interest
PECI	- Project of Energy Community Interest

RES	- Renewable Energy Sources
SEE	- South East Europe
SIMONE	- Simulation and Optimization Software
TANAP	- Trans-Anatolian Natural Gas Pipeline
TAP	- Trans Adriatic Pipeline
TPP	- Thermal Power Plant
TSO	- Transmission System Operator
UGS	- Underground Gas Storage
USAID	- United States Agency for International Development
USEA	- United States Energy Association
WDI	- World Development Indicators

EXECUTIVE SUMMARY

New gas supply routes to the Southeast European region including the Southern Gas Corridor, TurkStream pipeline, and new LNG supplies provide an opportunity to diversify gas supply and enhance energy security. To take advantage of the supply diversification potential, investment in new gas infrastructure is required.

Members of the Eastern Europe Natural Gas Partnership (EE-NGP) including the transmission system operators and ministries of Albania, Bosnia Herzegovina, Bulgaria, Croatia, Greece, Kosovo, Montenegro, North Macedonia, Romania, Slovakia, and Serbia conducted this study to evaluate the resilience of the current and proposed natural gas infrastructure in the North-South/South-North gas transmission corridor proposed to connect the Baltic Sea and Poland and countries with coastlines on the Adriatic, Aegean, and Black Seas, notably Croatia, Greece, and Romania. Specifically, the study examines the potential to connect Poland's LNG terminal at Świnoujście with Croatia's LNG terminal, Romanian new gas production in the Black Sea, the LNG terminals in Greece, and the Southern Gas Corridor.

To perform this evaluation, the EE-NGP members updated the Max 2040 Eastern Europe Regional Gas Network Planning model developed in a previous work phase, re-calculated and verified demand forecasts and optimized the model's existing and planned infrastructure through 2040.

The model was updated to include data on all of the relevant gas infrastructure projects in the region that are either part of the national network development plans or are part of the regional gas infrastructure development initiatives including Projects of the Energy Community Interest (PECI), Projects of Common Interest (PCI) and Projects of Mutual Interest (PMI). Pertinent information on all of these projects have been compiled into the EE-NGP "*Catalog of Potential Eastern European Natural Gas Investment Projects in Support of the Three Seas Initiative",* which is a companion publication to this study.

Key findings from the study include the following:

- Overall gas demand in the region is forecast to increase by 2.4% by 2040 and peak demand is forecasted to increase by 8.2% compared to 2020. Gas demand for power generation is forecast to increase by 31% by 2040 and peak gas demand for power generation by 74%. Gas demand for all other purposes is forecast to decrease by 5% and peak demand to decrease by 5.5% by 2040

- Total existing storage capacities are 29.3 bcm, with planned expansion to 33.5 bcm by 2030. No additional gas storage facilities are planned to be constructed after 2030 at this time. These quantities are sufficient to cover approximately 43% of the forecasted demand in 2040. If we consider EE NGP member countries only, total existing storage capacities are 12.8 bcm, with planned expansion to near 17 bcm by 2030 which could cover up to 32% of the forecasted gas demand in 2040.

- LNG supplies to the region are sufficient to cover approximately 19% of the demand in 2020 and could cover up to 43% of the forecasted gas demand by 2040. Taking into account EE-NGP member countries only, up to 65% of the forecasted demand could be covered by LNG supplies by 2040.

- Domestic production and the planned expansion in the storage capacities are crucial to provide security of supply during the peak demand. Romania's plan to develop offshore gas resources will contribute to the region's security of supply and the diversification of gas supply.

- A critical bottleneck to gas flows along the corridor occurs at the borders in Poland. There is a lack of interconnections with its southern neighbors, the Czech Republic and Slovakia. The Poland-Slovakia Interconnection is currently the only envisaged option to connect Poland with other countries on the North-South Corridor route and according to Gaz System this project is indefinitely on hold. One of the infrastructure projects that should be implemented to enable the North-South gas throughput is the Poland-Czech Republic Interconnection (STORK 2).

- Most of the infrastructure further south to Croatia's LNG facility is in place. The interconnections Slovakia-Hungary and Hungary-Croatia constitute the southern backbone of a North-South transmission corridor. In the Croatia to Hungary gas flow mode, this interconnection plays an important role for gas delivery from Croatia's LNG terminal towards the north. An important component for gas infrastructure on this segment of the corridor is the Croatian compressor station, commissioned at the end of 2019. The interconnections Hungary-Romania and Hungary-Serbia are also in place.

- The Krk LNG terminal was commissioned on January 1st, 2021. The initial capacity is 2.6 bcm/y, with plans to provide up to 7 bcm/y in the second phase sometime by 2030. The planned Zlobin-Bosiljevo-Sisak-Kozarac-Slobodnica pipeline is an integral part of the overall Croatian LNG project and an integral part of the North-South Gas Corridor, as an extension of the Hungary-Croatia Interconnection. It is also being designed to connect with the Ionian Adriatic Pipeline.

- In the south, the development of new pipelines to connect the Southern Gas Corridor, and with LNG facilities in the Aegean Sea, should be prioritized to enable gas connections throughout the Balkans.

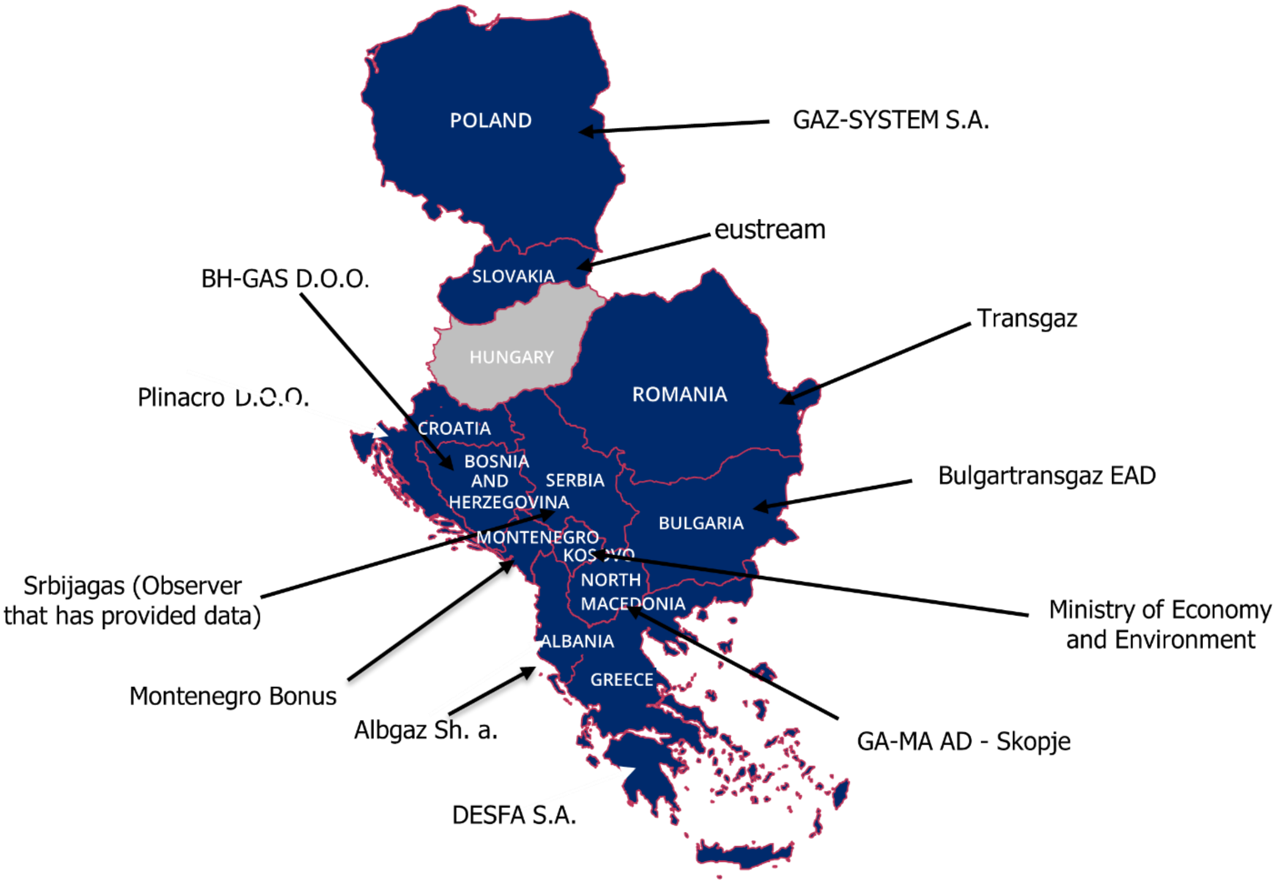
- Since most of the interconnection pipeline projects planned are in the final development phase or already under construction, what should be "pushed" are the bigger pipelines that enable higher gas flows towards the north. One of these projects is the Ionian Adriatic Pipeline (IAP) that connects the Trans Adriatic Pipeline (TAP) in Albania with the Croatian gas transmission system, and the other one is the Eastring pipeline, which connects Turkey and Slovakia, via Bulgaria, Romania, and Hungary, which could bring Caspian gas to the north and transport gas from European gas hubs to Southeast Europe.

The findings from this study are based upon a hydraulic analysis of current and future gas flows along the north-south corridor. The next phase of work for the EE-NGP will focus on the development of a market-based simulation planning model and an examination of the impact on transmission tariffs associated with the development of the infrastructure necessary to complete the North/South-South/North corridor.

1 INTRODUCTION

The Eastern Europe Natural Gas Partnership (EE-NGP) was established by the United States Agency for International Development (USAID), the United States Energy Association (USEA), Ministries and Natural Gas Transmission System Operators (TSOs) of Eastern Europe to build sustainable institutional capacity to develop and utilize the region's first common transmission planning models. The models are used to analyze regional internal pipeline infrastructure, interconnections, and regional storage capacity necessary to accelerate the gasification process in Eastern Europe.

USAID/USEA Eastern Europe Natural Gas Partnership (EE-NGP) Members



Each member organization was provided a license of the SIMONE gas network planning software and receives ongoing training on its use. The members utilized the software to create national gas network models and the EE-NGP national models were consolidated into Eastern Europe's first regional gas network planning model. The EE-NGP Max 2040 Natural Gas Transmission Network Planning Model includes all the existing and potential future (planned) gas infrastructure in the region. The EE-NGP's studies employ the regional model to optimize the regional network by the target year 2040, considering forecast demand scenarios and all potential supplies of natural gas to the region.

The Three Seas Initiative was launched in 2015 as a flexible political platform at the presidential level. The Initiative includes 12 European Union (EU) Member States located between the Adriatic, Baltic, and Black Seas: Austria, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.

The overarching pillars of the Three Seas Initiative are threefold: economic development, European cohesion and transatlantic ties. The Initiative aims to boost interconnectivity among the Member States, with a special focus on the energy, infrastructure, and digital sectors. Setting new dynamics of cooperation among the countries at the Eastern and Southern borders of the EU and on the North-South Axis will advance economic growth and help to bridge the East-West economic gap. The initiative emphasizes strengthening transatlantic ties in the energy sphere. The U.S. economic presence in the region provides a catalyst for an enhanced transatlantic partnership.

The EE-NGP region is a major supply route for the transmission of Russian gas into Europe. New Russian gas supply routes will be realized with the development of Nord Stream 2 and Turk Stream, circumventing the EE-NGP region. The combined capacity of Nord Stream 2 and Turk Stream will add 140 billion m^3/year, replacing the existing traditional East-West supply route through Belarus, Ukraine and the following EE-NGP countries: Poland, Slovakia, Romania, Bulgaria and to a smaller extent Hungary.

The purpose of this study is to evaluate the natural gas infrastructure strength of the Three Seas Initiative members, as well as, all of the EE-NGP members.

The Study is structured into the following four major components:

1.1 Task One: Update Gas Demand Forecasts

The goal of this task was to re-evaluate EE-NGP's total and current gas peak demand forecasts based upon those developed by ENTSO-G and, where available, analyze newer national scenarios and to incorporate these forecasts into the EE-NGP Max 2040 Regional Natural Gas Transmission Network Planning Model.

The analysis of forecasts includes final gas consumption and power generation consumption. Numerous data sources have been examined and validated including official national strategies, TSO strategies, ENTSO-G data, EUROSTAT, etc., all of which serve to better evaluate future demand.

The main result of this task is a new EE-NGP Gas Demand Database which includes the following outputs for each of the target countries:

- Five-year forecasts for the period up to 2040 (20 year period);
- Analysis of key energy consumption sectors: final consumption sector and power generation (transformation sector);
- Delivery of at least three scenarios: 1 national trend and 2 EU policy driven scenarios;
- Statistics on annual natural gas demand data;
- Estimates for normal and peak demand (m^3/h);
- Estimates of normal daily duration curve.

All national data are integrated into the database using a common structure which enables comparability of data and trends in the past and monitoring the achievements of defined scenarios.

1.2 Task Two: Evaluation of supply and gas system development options

The product of this task is the "*EE-NGP Catalog of Potential Eastern European Natural Gas Investment Projects in Support of the Three Seas Initiative*". This catalog identifies all relevant gas infrastructure projects in EE-NGP member countries. Relevant projects are considered to be those projects that are either part of the national network development plans or are part of the regional gas infrastructure development initiatives including Projects of the Energy Community Interest (PECI), Projects of Common Interest (PCI) and Projects of Mutual Interest.

Each project in the catalog includes information to the smallest obtainable detail (including, but not limited to: CAPEX, OPEX, promoter, length, capacity, origin, pathing…). This catalogue serves a two-fold purpose. First, it allows non-technical personnel to quickly get project information from a central reliable source. Second, it provides information on relevant projects for any given intent or purpose; in this study it pertains to projects which aid in North-South/South-North natural gas throughput.

1.3 Task Three: Update of the EE-NGP Max 2040 Eastern Europe Natural Gas Transmission Network Planning Model

The tool for performing the technical analyses in this study is the EE-NGP Max 2040 Regional Natural Gas Network Transmission Planning Model. In order to perform the analyses, all of the natural gas infrastructure detailed in the "*Catalog of Potential Eastern European Natural Gas Investment Projects in Support of the Three Seas Initiative*" was entered into the model.

The updated model now encompasses 15 countries (all EE-NGP members + Austria, Hungary, and Slovenia). Eight countries (Albania, Bosnia & Herzegovina, Bulgaria, Croatia, Kosovo, Montenegro, North Macedonia and Serbia) were the inaugural members of the EE-NGP and their national models were previously consolidated into the regional model during the first phase of the Partnership. Four members – Greece, Romania, Poland and Slovakia have since joined the EE-NGP. Simplified, but detailed networks from Greece and Romania were incorporated into the regional model. Networks from Austria, Slovenia, Hungary, Slovakia and Poland were also added, but in a more simplified manner to aid in necessary study calculations.

The update to the model added 1,278 nodes (113 supply nodes) and 1,062 elements (514 pipes).

1.4 Task Four: Optimization of technical development options

The goal of this task was to utilize the updated EE-NGP Max 2040 Natural Gas Transmission Network Planning model to optimize the network and identify the most crucial current and future infrastructure to enable North-South/South-North gas transmission. Historical development of the gas pipeline infrastructure in the European Union was east-west oriented, which lead to a lack of North-South connections. New gas supply routes to the SEE region, Southern Gas Corridor, and the TurkStream pipeline, as well as new LNG supplies, provide the ability to ensure a radical diversification of European gas supply. To utilize all of the supply diversification potential, a planned new gas infrastructure needs to be in place.

This study is a baseline for further market optimization which could include tariff optimization, gas price formation, RES impact, EU policy impact, etc.

2 TASK ONE: FUTURE GAS DEMAND

2.1 Purpose and scope of the activity

The purpose of this task was to re-evaluate and update EE-NGP's gas peak demand forecasts and design new forecasts. The objective was to provide quality input data to apply to the regional model to perform technical optimization of the future natural gas system development options.

The target countries in this analysis are the EE-NGP members (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Kosovo, North Macedonia, Montenegro, Romania, Slovakia, Greece, Poland, Romania) and Austria, Slovenia, and Hungary.

The main result of this activity is the creation of a new EE-NGP Gas Demand Database which includes the following outputs for each of the target countries:

- Five-year forecasts for the period up to 2040 (20 year period);
- Analysis of key energy consumption sectors: final consumption sector and power generation (transformation sector);
- Delivery of at least three scenarios: 1 national trend and 2 EU policy driven scenarios;
- Statistics on annual natural gas demand data;
- Estimates for normal and peak demand (m^3/h);
- Estimates of normal daily duration curve.

The specific contribution of this task is the analysis of the sensitivity of gas demand to weather conditions. The peak consumption is calculated for normal winter conditions and for the 1 in 20 winter conditions - which means the coldest winter conditions in the last 20 years.

2.2 Input data and methodology

2.2.1 Methodology, data sources and models applied

The methodology to assess natural gas demand scenarios is based on the availability of data by the target countries.

The first data set, historical energy statistics, was collected for the period 1990-2018 and enables analysis of the historical natural gas trends in a country for different energy flows: energy production (domestic production at national territory), import (entry into the national territory for national purposes), export (exit out of the national territory), transformations (use for electricity and/or heat production in TPP, CHP and HP), losses (technical and commercial losses in the transportation and distribution networks), final energy consumptions (final consumption in manufacturing industry, transport, service sector, agriculture, households and others). ENTSO's scenarios and newer national scenarios estimate future consumption up to 2040.

The procedures applied to design the databases are detailed below.

1. <u>Collection of time series of annual data and national scenarios options</u>

The collection of time series data and statistics on natural gas flows for the targeted countries are taken from reports on national energy balances. The key flows which are included in this database are: primary energy productions, imports, exports, changes in stock (underground gas storage), gross available consumption, transformation input, energy sector use and natural gas available for final consumption by sectors (non-energy use, industry, transport, households, commercial and public services and agriculture and forestry). The key source for this analysis is the EUROSTAT's energy statistics database which has available data for all of the target countries.

Natural gas scenarios options analysis takes into consideration the following inputs: ENTSO's and available national estimates. There are two identified sources for the collection of national estimates: national gas transmission system operators (TSOs) and National Energy and Climate Action Plans (NECPs) or other strategic documents. In cases when national partners did not respond to a request for the newer scenario options, the same are analyzed in the NECPs and compared with ENTSO's scenarios. The NECPs for the target countries, except Romania, Kosovo, North Macedonia, Albania, and Bosnia and Herzegovina, are available on the official web pages of the European Commission.

In addition to natural gas data, we collected data on weather conditions from EUROSTAT in the form of Heating Degree Days (HDD) and Cooling Degree Days (CDD) (www.degree-days.net), and a macroeconomic indicator - Gross Domestic Product (GDP).

In addition to the above, data on power generation loads for 2000, 2025, and 2030 were collected from the USAID/USEA Electricity Market Initiative (EMI). The EMI was established in July 2018 by the United States Agency for International Development (USAID) and the United States Energy Association (USEA) to enhance the integration and operation of power markets in Southeast Europe. Under EMI, USEA works closely with electric transmission system operators, market operators and electricity regulators in the region to anticipate and quantify the benefits that could emerge from a more integrated power market.

It is important to note that there is a small discrepancy in ENTSO-G's methodology approach for some countries when interpreting natural gas use in the transformation sector. ENTSO's and EMI's methodology considers natural gas use for power production in thermal power plants and in combined heat and power plants as a transformation process. But, when considering the entire energy flow of natural gas, transformation processes also include natural gas use in district heating plants, small industrial power plants, and heat plants, refineries, and other transformations. Therefore, natural gas consumption which is not used for power transformations is considered in this study as final energy consumption although it includes consumption in the energy sector, losses, non-energy consumption, and transformations which do not belong to power generation.

2. Collection of monthly time series data on natural gas flows and weather impact analysis

Monthly natural gas time series data are used for a twofold purpose. First, it enables analysis of weather and outdoor impacts on final energy consumption. These impacts are analyzed by using EIHP's original methodology and a tool named PROG12. It enables the creation of tailor-made analysis and identification of drivers and their impacts on energy consumption using the multiple linear regression method. The outcome of PROG12 is a formula that can calculate the dependent variable (consumption) based on selected and tested independent variables.

For this study, a targeted variable is natural gas consumption and independent variables are heating degree days (HDDs), gross domestic product (GDP), and season - months in the year (M1-M12). PROG12 requires the availability of data for at least 5-8 years. The monthly time series data are also taken from the EUROSTAT's energy statistics portal, as well as HDD indices and quarterly GDP values.

The impact of weather conditions on gas demand is usually based on outdoor temperatures. Energy planning approaches recognize HDDs as a more appropriate parameter. The HDD index shows the severity of the cold in a specific time period i.e. day, month, year taking into consideration outdoor temperature and average room temperature. The calculation of the HDD index relies on the base temperature, defined as the lowest daily mean air temperature not leading to indoor heating.

The value of the base temperature depends in principle on several factors associated with the building and the surrounding environment. By using a general climatological approach, the base temperature is set to a constant value of 15°C in the HDD index calculation in this study. The following simple example shows how HDDs are calculated. If the daily mean air temperature is 12°C, for that day the value of the HDD index is 6 (18°C-12°C). If the daily mean air temperature is 16°C, for that day the HDD index is 0[1].

The impact of the COVID19 pandemic on natural gas consumption particularly in 2020 and 2021 was also analyzed and estimated for the countries with the highest decline in GDP in 2020.

The main results of PROG12 are:

- Scenarios for natural gas consumption in years Y-0, Y+1,...,Y+5 using average HDDs and the highest HDDs in the last 20 years;
- Scenarios for monthly natural gas consumption for years Y-0, Y+1,...,Y+5 using average HDDs and the highest HDDs in the last 20 years;
- Scenarios for daily natural gas consumption (where available) for years Y-0, Y+1,...,Y+5 years using average HDDs and the highest HDDs in the last 20 years.

The first group results in this project are used for the analysis of annual forecasts based on GDP growth and in the framework of this project, for the analysis of COVID19 impact. The last two results are used for identifying monthly and daily peak loads for the average year, and for the coldest weather conditions.

3. Peak demand and load duration curves

Load duration curves in the target countries are forecast where appropriate data is available. The main input for modelling and forecasting future loads are hourly loads in a typical "average" year when considering weather conditions and economic growth, and annual consumptions in the future, planned period. The methodology requires splitting final energy consumption into two groups: consumption in the manufacturing industry which is not sensitive to the outdoor temperature and other final energy consumption (households, services) which has a significantly seasonal character. Modelling of hourly loads in the final energy consumption sector is done by using the PROG 365 model but loads for the power sector are based on the data received from the EMI working group.

4. Databases by countries

All of the collected and modelled data have been compiled in common structured databases which provide insight into detailed historical time series on natural gas flows in each country and different natural gas development scenarios. The databases are designed in a way that they can be easily upgraded and renewed with the most recent data from monitoring achieved results and can serve for planning follow-up strategies and related activities.

[1] https://ec.europa.eu/eurostat/cache/metadata/en/nrg_chdd_esms.htm

2.2.2 Review of collected data

The following table shows the structure of the data that were available and collected for this project by country. Most of the countries provided the input which was used either for the entire modelling of the national natural gas system or for calibrating results in models that simulate national systems.

Table 1. Summary of collected data

	AL	BA	BG	HR	XS	N.M.	ME	RS	SLO	GR	RO	PL	AT	SI	HU
Feedback/Responses from Partners	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	-	-
Available ENTSO's scenarios		✓	✓	✓		✓			✓	✓	✓	✓			
New national scenarios (NECP or other)		✓	✓	✓	-	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Power sector		✓	✓	✓	-	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Final consumption		✓	✓	✓	-	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Total		✓	✓	✓	-	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Energy Balances (official national statistics)	✓	✓	✓	✓	-	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Monthly statistics (official national statistics)	-	-	✓	✓	-	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
HDDs averages (official national statistics)	-	-	✓	✓	-	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Hourly loads (TSOs)	-	✓	-	-	-	-	-	-	-	✓	✓	-	-	-	-
System capacities Nm^3/day (TSOs)	✓		-	-	-	✓	-	-	-	-	-	-	-	-	-
Measured temperatures (TSOs)	-	✓	-	-	-	✓	-	-	-	✓	✓	-	-	-	-
Load forecasts (TSOs)	✓		-	-	-	✓	-	-	✓	-	-	-	-	-	-
Electricity generation forecasts (EMI)	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	-	-	✓	✓

2.3 Summary of ENTSO 2020 - National trends scenario options

ENTSO 2020's National trends scenario options have been selected as the first step towards final modelling and comparison with newer scenarios provided by national TSOs and national authorities. The focus in the analysis is put on ENTSO's National trends scenarios which are considered as the most relevant for the optimization of the gas transmission network. The following table and figure explain consumption trends by countries and total.

The main conclusion is that the total consumption in the region will remain stable with significant changes in only a few countries.

Table 2. Peak gas demand forecasts in ENTSO 2020 National trends scenario, m³/h

	2020	2025	2030	2035	2040	2040/2020
Albania	-	-	-	-	-	-
Austria	2.275.156	2.244.732	2.447.430	2.314.327	2.181.225	0,96
Bosnia and Herzegovina	27.025	36.020	96.262	107.340	118.419	4,38
Bulgaria	669.910	686.661	759.346	815.027	870.708	1,30
Croatia	824.001	839.759	686.307	657.495	628.683	0,76
Greece	1.005.150	1.202.382	1.139.738	1.158.347	1.176.956	1,17
Hungary	3.427.181	3.299.649	2.207.944	1.902.301	1.596.658	0,47
Kosovo	-	-	-	-	-	-
Montenegro	-	-	-	-	-	-
North Macedonia	76.791	75.339	135.709	231.172	326.636	4,25
Poland	4.307.009	4.562.287	4.834.327	5.579.097	6.323.867	1,47
Romania	2.624.611	2.704.332	2.659.657	2.725.360	2.791.063	1,06
Serbia	662.237	784.961	925.818	926.131	926.444	1,40
Slovakia	1.191.338	1.477.323	1.363.236	1.343.313	1.323.390	1,11
Slovenia	223.910	299.939	305.296	305.551	305.807	1,37
Total	**17.314.318**	**18.213.384**	**17.561.068**	**18.065.461**	**18.569.854**	**1,07**

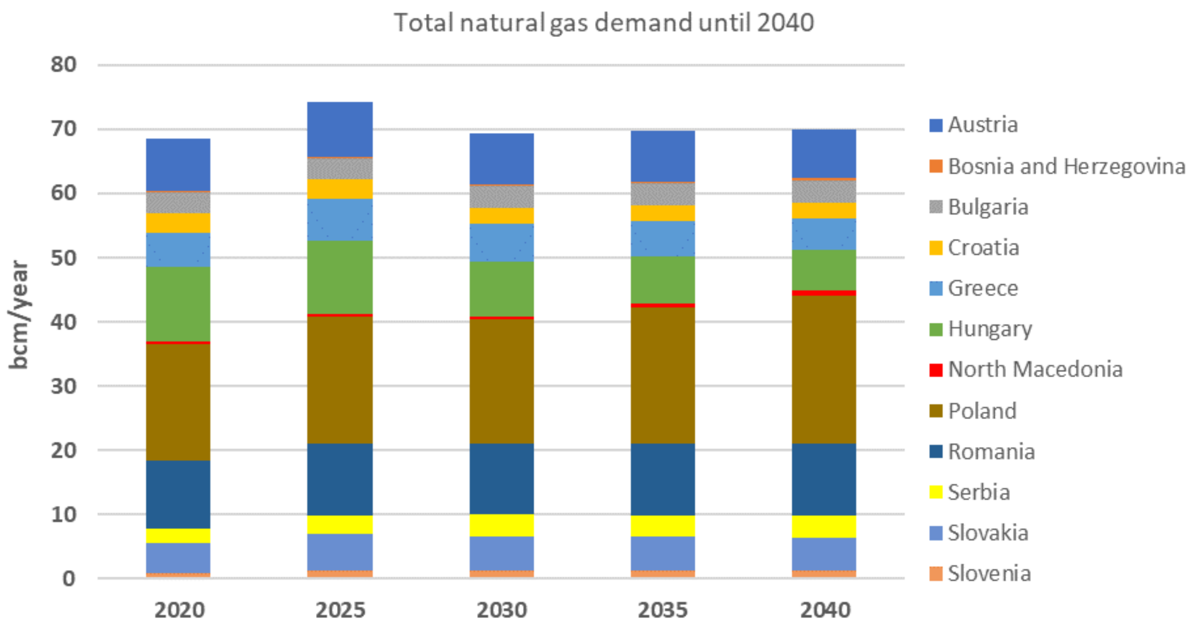


Figure 1. Total natural gas demand forecasts in ENTSO 2020 National trends scenario, bcm/y

Consumption trends for power generation and final consumption are based on national specificities and are presented in Annex 1 of this report.

2.4 Assessment of the COVID-19 pandemic impact on gas consumption in 2020

The specific challenge during the assessment of various gas scenario options was to identify the impact of the COVID-19 pandemic on gas consumption. The first step was to identify quarterly GDP changes and national assumptions for 2019-2021. The European Commission launches a quarterly publication under the name European Economic Forecast[2], and for this study, the summer 2020 edition was used. The largest change in economic activity in 2020 is identified in Croatia. According to estimates, GDP fell by 11% in 2020 while recovery is expected in 2021 with a growth of 8%.

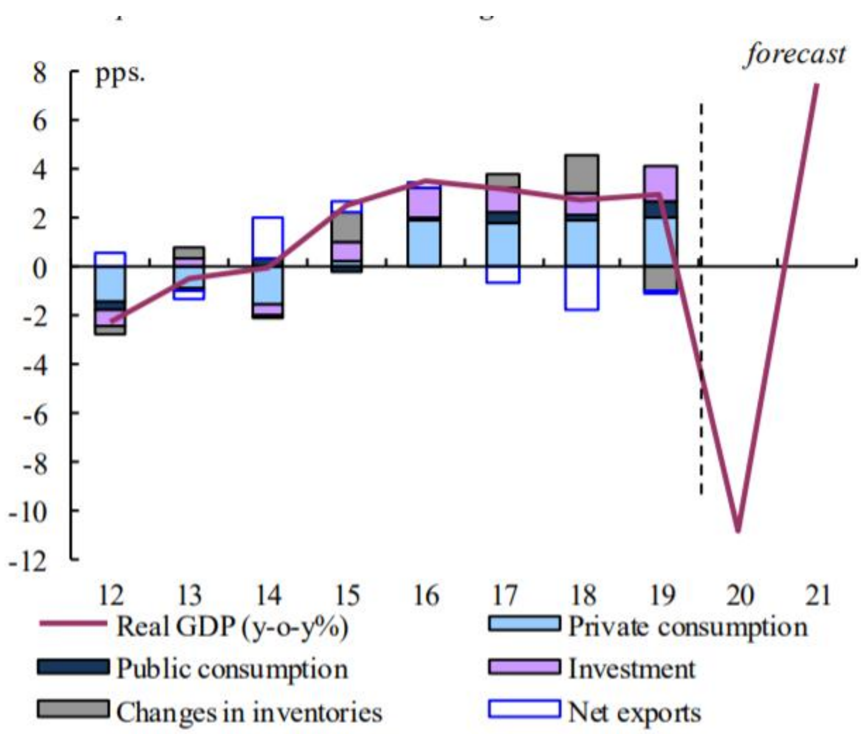


Figure 2. Assessment of GDP growth in Croatia 2020-2021

Using monthly statistics and EIHP's model PROG12, gross inland consumption estimates for the period July 2020 - December 2021 are calculated for two scenarios: average weather circumstances and extremely cold weather conditions. The results show a low impact of GDP on consumption in Croatia and a continuous consumption trend without irregularities. A similar analysis was repeated for Romania, Bulgaria, Romania, and Hungary and the results were similar.

The following figure shows model results for Croatia and the impact of outdoor air temperatures, GDP, and seasonal consumption as well as the monthly forecast for the period July 2020 - December 2021 for two scenarios.

[2] *https://ec.europa.eu/info/business-economy-euro/economic-performance-and-forecasts/economic-forecasts/summer-2020-economic-forecast-deeper-recession-wider-divergences_en*

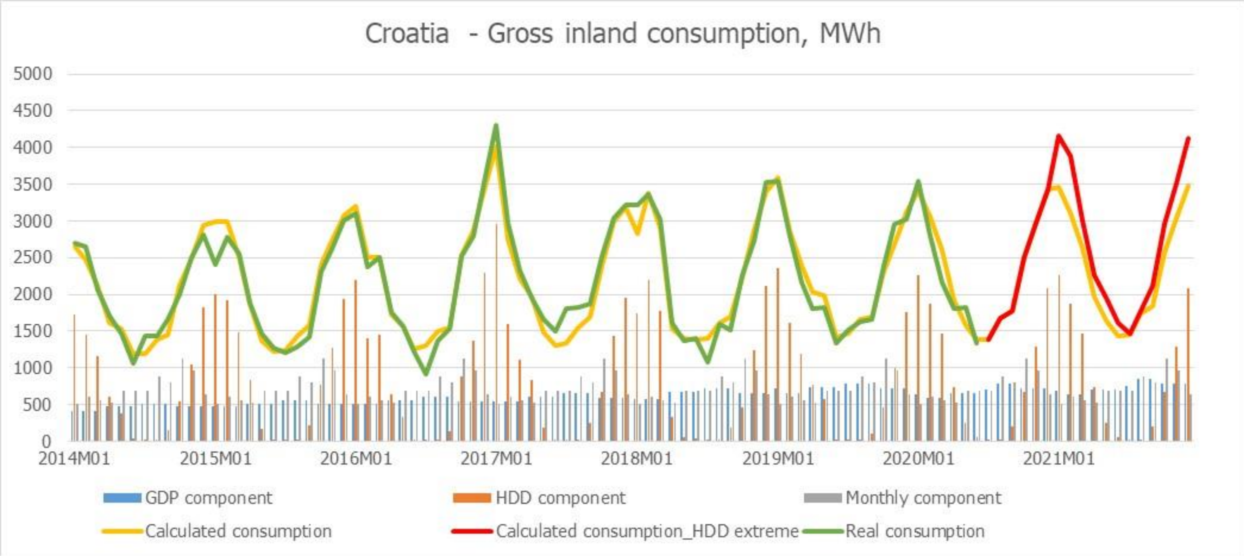


Figure 3. Estimates of monthly gross inland natural gas consumption in Croatia, MWh

Additional analysis in selected project countries was performed in December 2020 using the recent EUROSTAT data on monthly gross inland natural gas supply which enabled comparison of consumption in the period January - September in 2020 with the same period in 2019. The results show that the total gross inland supply in the defined period is 5% lower in 2020 compared to the forecasted period in 2021. The first complete annual data for 2020 will be available in March 2021 when analysis of change for the entire 2020 will be available. A review of results by countries is presented in the diagram below.

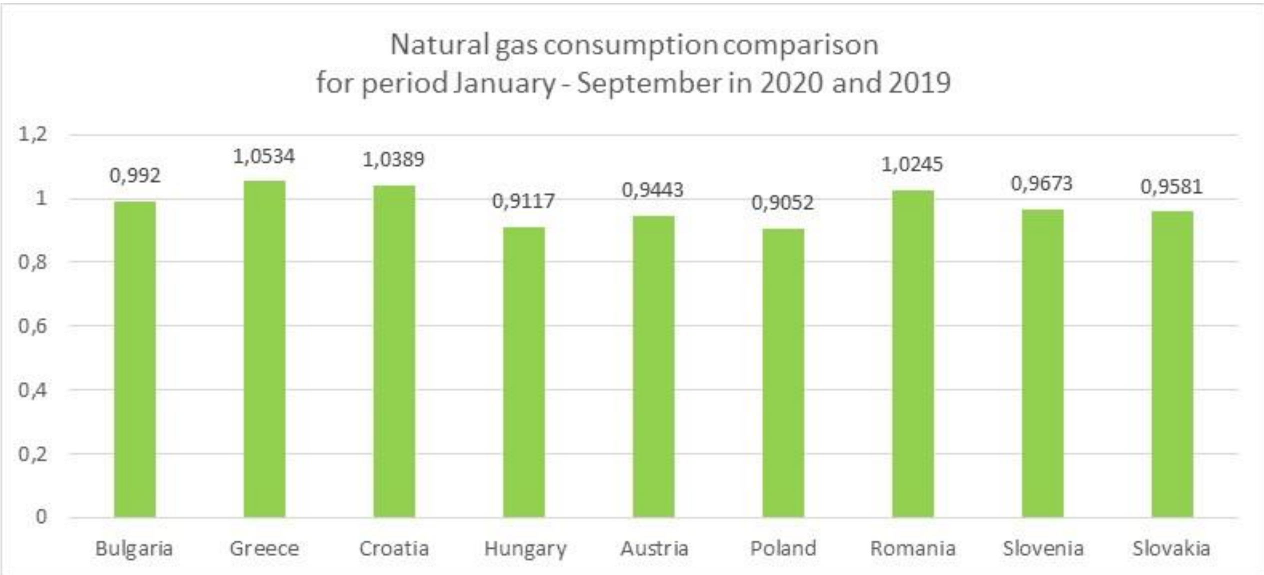


Figure 4. Comparison of gross inland gas consumption in period January - September in 2019 and 2020

2.5 Review of newer scenarios and analysis of weather impacts

The databases and analyses developed for this study provide the ground for continuous and harmonized monitoring of natural gas system development in the EE-NGP countries. This approach enables comparability of indicators and trends between the countries and can explain differences between targets and achievements.

The databases are designed in a simple, user-friendly format in MS Excel. Also, their structure enables updating with recent monthly and annual data from EUROSTAT, IEA, ENTSO, the EMI working group, and other sources. The analysis of the impact of weather on consumption, peaks, and daily loads was performed using a uniform approach for all of the countries. This approach is based on the EIHP model which has previously been applied and tested in many similar studies. The methodology first requires splitting total natural gas consumption (or gross final consumption according to EUROSTAT methodology and definitions) into power sector use and final energy consumption. Final energy consumption includes all other consumption in the system which is not used for power and CHP production. After disaggregation, the analysis of power sector loads is based on EMI inputs. At the time of completion of this task, however, not all of the necessary data were available since EMI only forecasts to 2030 and the data for time horizon 2030-2040 were not modelled..

As data availability for all of the target countries is not of the same quality, the final modelling results also have a different accuracy level. Countries with a developed natural gas system generally were able to provide adequate data, but countries such as Albania, Kosovo and Montenegro have available only estimates for one or two national scenarios.

The data which is calculated and obtained for this study present results of the analysis of possible situations in the cases of extremely cold weather circumstances. It is clear from the analysis that extremely low winter temperatures have different impacts on natural gas consumption in the target countries. The model used for this analysis is based on the identification of the "temperature sensitive consumption" for consumption in households and the service sector. It enables simulation of the consumption in cases of temperature changes and analysis of peak load change compared to average winter conditions. The final peak loads which are used for the optimization of technical development options of the transmission system have been agreed with the national TSOs and are slightly modified based on each TSO's experiences and ENTSO's recommendations.

ENTSO 2020 scenarios were developed in late 2019 and this process was almost parallel with the development of the National Energy and Climate Plans. This was likely the reason why national scenarios in a few cases are not entirely compliant. For this study we Modelled future demand by comparing ENTSO data with newer data delivered by national TSOs and/or published in NECPs, analyzing discrepancies where such exist, and preparing proposals for future improvements.

National Trends (NT) is the central bottom-up scenario in line with the NECPs in accordance with EU governance and climate action rules, as well as with further national policies and climate targets already stated by the EU member states. Following its fundamental principles, NT is compliant with the EU's 2030 Climate and Energy Framework (32 % renewables, 32.5 % energy efficiency) and EC 2050 Long-Term Strategy with an agreed climate target of 80–95 % CO_2 reduction compared to 1990 levels.

Global Ambition (GA) is a scenario compliant with the 1.5°C target of the Paris Agreement also considering the EU's climate targets for 2030. It looks at a future that is led by development in centralized generation. Economies of scale lead to significant cost reductions in emerging technologies such as offshore wind, but also imports of energy from competitive sources are considered as a viable option.

Distributed Energy (DE) is a scenario compliant with the 1.5°C target of the Paris Agreement also considering the EU's climate targets for 2030. It embraces a de-centralized approach to the energy transition. A key feature of this scenario is the role of the energy consumer (prosumer), who actively participates in the energy market and helps to drive the system's decarbonization by investing in small-scale solutions and circular approaches. Based on stakeholders' feedback on the Draft Scenario Report, a part of biomass usage has been transferred to both P2L and direct electricity consumption resulting in an updated Storyline Central Matrix. The updated scenario comes very close to the 1.5 TECH/LIFE scenario of the European Commission for most of the parameters.

Additional data for modelling impact of weather on consumption were collected from EE-NGP members partners and since these data are linked with recent national estimates, the newer scenarios are used as a base for the development of the model and for modelling the impacts of extreme weather conditions on daily and hourly peak demand. This was done for Bosnia and Herzegovina, Romania, and Greece. These countries can serve as an example of good practices and for demonstration of the entire modelling process and analysis of impact of weather conditions on consumption, analysis of peak demand in normal weather circumstances and under extreme conditions. Their results served partially for modelling in other countries. Modelling for Croatia is also performed in full because of the number of models and estimates available at EIHP. In addition to the analysis of peak demand, load duration curves are analyzed and designed for these four countries and presented in the study. Other countries also prepared inputs for the modelling processes used for calibrating or controlling the results.

Specific analysis has been done for a group of countries that are non-EE-NGP members (at the moment) - Austria, Slovenia, and Hungary. Because of poor data availability for these countries, the final results are less reliable.

2.5.1 Albania

Albania belongs to the group of countries where intensive development of the natural gas system is expected in the next few years. Older national estimates and scenarios options are available in the *Gas Master Plan for Albania* (Demand and Supply Assessment Report, June 2016). The document specifies consumption potentials for households, services, industries, and the power sector up to 2040 in the amount of 2.1 mil.m^3. New consumption assessments have been done recently, in the framework of EE-NGP's earlier study *Optimization of the Regional Gas System to Reach Lowest Costs Maximum Diversification of Gas Supply for Target Year 2040* where total consumption in 2040 amounts to 1.467 mil. m^3. This study is used as a reference for analyzing the impact of weather on consumption.

Table 3. Comparison of national natural gas consumption scenarios in Albania, GWh

GWh	2020	2025	2030	2035	2040
National scenario 1	0,0	5.381,6	8.662,0	11.465,9	16.140,5
National scenario 2	NA	NA	NA	NA	NA

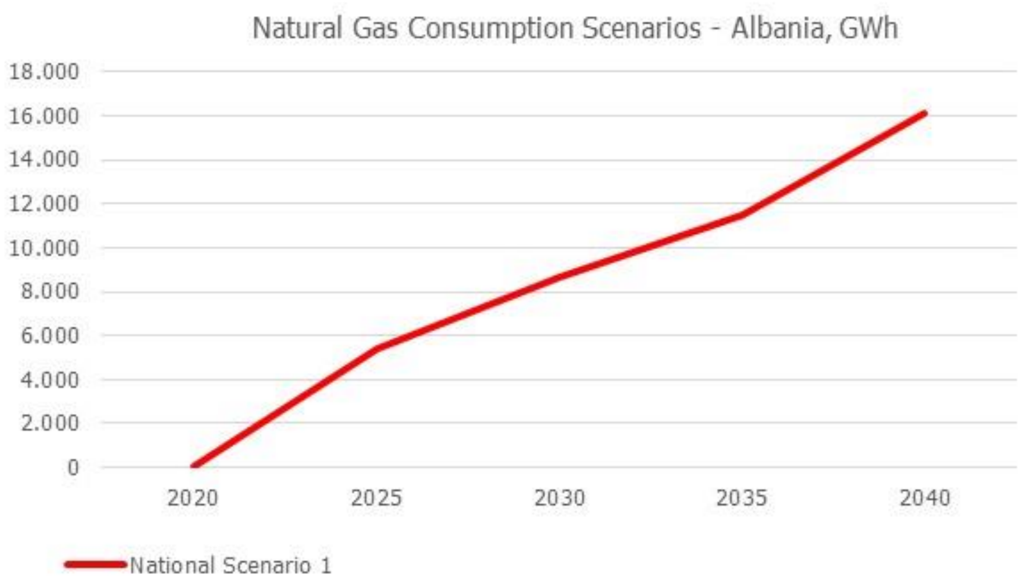


Figure 5. National natural gas consumption scenarios in Albania

The *Optimization of the Regional Gas System Study* provides details on the structure of final energy consumption and enables identification of consumption in the manufacturing industry and in other consumption sectors (households, services) for which the loads, based on the air temperature component, are modelled. Data on hourly loads in the power sector provided by the EMI group are not aligned with the new scenario. According to EMI sources, natural gas use in the power sector in 2030 is significantly lower than in the *Optimization of the Regional Gas System Study*. Due to differences in planning of the natural gas development in the power sector, daily loads in the power sector are not included in the model, and results are shown based on hourly loads identified for final energy consumption.

Modelling daily loads in the final energy consumption sector in Albania is based on the 20-year daily and monthly temperature averages and on the statistics on extreme temperature which can appear in a certain period of the year. In Albania it is mostly January - the lowest temperature was measured on January7, 2017 (www.degree-days.net).

Table 4. Annual and average daily natural gas use by sectors in Albania

Annual natural gas consumption, GWh	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0	5.381,6	8.662,0	11.465,9	16.140,5
(1) Power generation	0	1.639,0	3.410,0	3.454,0	4.807,0
(2) Final energy consumption	0	3.742,6	5.252,0	8.011,9	11.333,5

Average daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,00	8,94	24,01	32,10	43,76
(1) Power generation	0,00	4,47	9,29	9,41	13,10
(2) Final energy consumption	0,00	10,25	14,39	22,69	31,00

Table 5. Peak daily natural gas use in Albania, average weather circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,0	24,88	40,0	*55,1*	70,2
(1) Power generation	0,0	9,38	18,49	18,73	26,07
(2) Final energy consumption	0,0	14,88	20,9	*32,9*	45,0

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,0	2,8	1,7	1,7	1,6
(1) Power generation	0,0	2,1	2,0	2,0	2,0
(2) Final energy consumption	0,0	1,5	1,5	1,5	1,5

Table 6. Peak daily natural gas use in Albania, extremely cold circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,0	29,2	46,9	66,0	85,0
(1) Power generation	0,0	9,38	18,49	18,73	26,07
(2) Final energy consumption	0,0	19,9	27,9	44,0	60,2

Table 7. Ratio between peak daily use in extremely cold circumstances and average consumption

Peak daily/average daily use	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,0	1,9	1,9	2,1	1,9
(1) Power generation	0,0	2,1	2,0	2,0	2,0
(2) Final energy consumption	0,0	1,9	1,9	1,9	1,9

Table 8. Peak daily natural gas consumption in final energy consumption, 1000 m^3/h

Peak hourly use in final cons., 1000 m^3/h					
Average weather conditions	0	74,46	149,81	209,83	269,84
Extremely cold day – average hourly	**0**	**87,61**	**176,28**	**251,61**	**326,95**
Extremely cold day – real peak hour	0	128,12	205,23	289,97	373,76

The ratio between peak load in extreme weather conditions and average daily consumption calculated from national estimates forecasts is not high as in countries with less favorable winters. It ranges from 1,9-2,1.

2.5.2 Bosnia and Herzegovina

The analysis of demand forecasts in Bosnia and Herzegovina includes analysis of ENTSO's scenarios and scenarios submitted by BH-Gas, the national TSO. The reference scenario is based on the use of natural gas in sectors other than the power sector, while additional scenarios consider gradual use of natural gas in combined cycle gas turbine (CCGT) plants (Zenica and Mostar). BH-Gas recommends using a Reference scenario and this scenario overlaps with ENTSO's 2020 national trends scenario. It is important to note that the scenarios presented here include gas consumption for the Federation of Bosnia and Herzegovina only, while the network model includes gas system development in other parts of Bosnia and Herzegovina as well.

Table 9. Comparison of national natural gas consumption scenarios in Bosnia and Herzegovina, GWh

GWh	2020	2025	2030	2035	2040
ENTSO 2020 - National trends	1.810	2.413	3.030	3.542	4.055
ENTSO 2020 - Distributed energy	1.810	2.413	3.030	#N/A	#N/A
ENTSO 2020 - Global ambition	1.810	2.413	#N/A	#N/A	#N/A
BH gas - Reference	1.811	2.722	3.343	3.989	4.498
BH gas - Optimal C	1.811	2.722	6.569	7.215	7.724

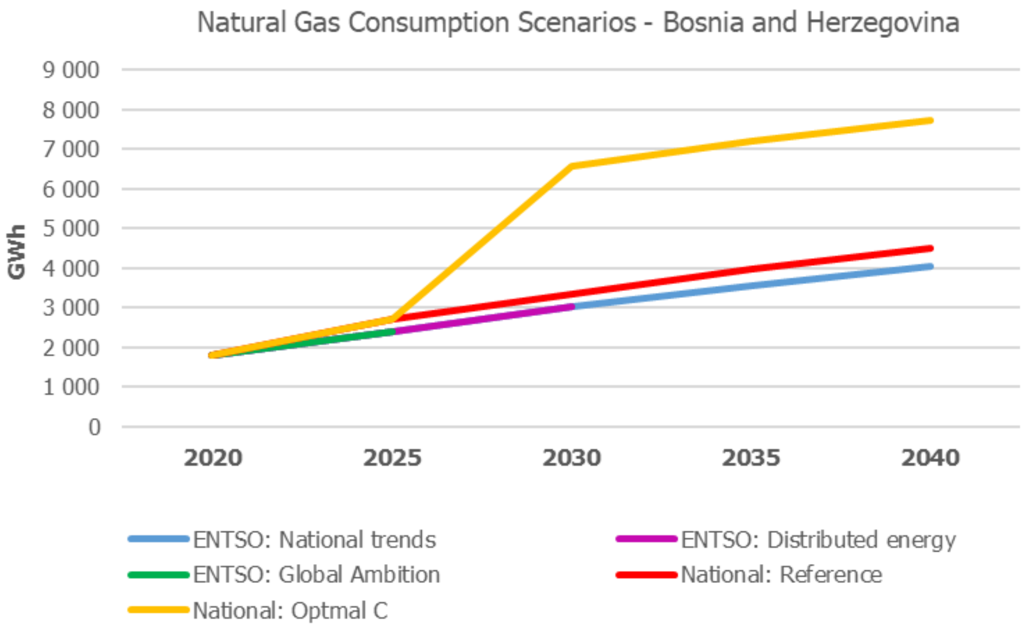


Figure 6. Natural gas consumption scenarios in Bosnia and Herzegovina, GWh

After 2019, ENTSO applies changes in structuring consumption data between the power sector and final consumption. Before 2019, natural gas use in heat plants was in some cases considered as inputs for "Power generation" but after 2019, in scenarios, ENTSO 2020 appropriate allocation between end-uses is applied. For the purposes of analysis of the load duration curve and peak demands, original BH-Gas data are used: hourly delivery of natural gas to the distribution system and other large consumers in 2018 (industry sector). Besides natural gas data, BH-Gas submitted daily outdoor temperatures which are used for calculation of HDDs. It is worth mentioning here that 2018 can be considered as the average colder year. The temperature in February 2018 reached -13 °C (or 27 degree-days) and these temperatures appeared at the end of the month. But the highest peak in the last 20 years was 35 degree-days and is noted in January 2017.

It should be noted that the former EE NGP study used peak load of 77.500 m^3/day as it was the official peak measured capacity of the current interconnection point Zvornik.

Table 10. Annual and average daily natural gas use in Bosnia and Herzegovina

Annual natural gas consumption, GWh	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	1.810,6	2.721,6	3.343,3	3.989,3	4.498,4
(1) Power generation	0,0	0,0	0,0	0,0	0,0
(2) Final energy consumption	1.810,6	2.721,6	3.343,3	3.989,3	4.498,4

Average daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	4,96	7,06	9,16	10,74	12,32
(1) Power generation	0,00	0,00	0,00	0,00	0,00
(2) Final energy consumption	4,96	7,06	9,16	10,74	12,32

Table 11. Peak daily natural gas use in Bosnia and Herzegovina, average weather circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	11,4	*15,3*	19,3	*22,4*	25,6
(1) Power generation	0,00	0,00	0,00	0,00	0,00
(2) Final energy consumption	11,4	*15,3*	19,3	*22,4*	25,6

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	2,3	2,2	2,1	2,1	2,1
(1) Power generation	-	-	-	-	-
(2) Final energy consumption	1,9	1,9	1,8	1,8	1,8

Table 12. Peak daily natural gas use in Bosnia and Herzegovina, extremely cold circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	20,4	*27,0*	33,5	*38,7*	44,0
(1) Power generation	0,00	0,00	0,00	0,00	0,00
(2) Final energy consumption	20,4	*27,0*	33,5	*38,7*	44,0

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	4,1	3,8	3,7	3,6	3,6
(1) Power generation	-	-	-	-	-
(2) Final energy consumption	4,1	3,8	3,7	3,6	3,6

Table 13. Peak hourly natural gas consumption

Peak hourly use, 1000 m^3/h	*2020*	*2025*	*2030*	*2035*	*2040*
Average weather conditions	45,41	61,35	77,29	89,77	102,25
Extremely cold day – average hourly	**81,73**	**107,89**	**134,05**	**154,95**	**175,85**
Extremely cold day – real peak hour	114,39	147,84	183,66	211,51	239,89

The ratio between peak load in extreme weather conditions and average conditions calculated from national data is different compared to ENTSO 2020 scenarios and ranges from 4,1 in 2020 to 3,6 in 2040. Data from BH-Gas show a peak of 79.750 m^3/day in 2018, and considering that 2018 was a moderate year, it can be concluded that peaks in the system might be even higher. The load duration curve for power generation, final consumption, and total consumption is presented in Annex 2 of this report.

2.5.3 Bulgaria

Comparisons of natural gas consumption scenarios until 2040 do not show significant differences between projections prepared by ENTSO and the Bulgarian Ministry of Energy and Ministry of the Environment and Water (National Energy and Climate Plan 2020-2030[3], pg. 201). Overall consumption in Bulgaria by year 2040 will increase steadily and will amount to between 33 and 35 TWh in 2040. Compared to NECP data, this amount is about 20 percent higher than consumption in 2018.

Table 14. Comparison of national natural gas consumption scenarios in Bulgaria, GWh

GWh	2020	2025	2030	2035	2040
ENTSO 2020 - National trends	34.829	35.009	36.354	35.915	35.476
ENTSO 2020 - Distributed energy	34.829	35.009	31.337	32.453	33.569
ENTSO 2020 - Global ambition	34.829	35.009	31.887	32.589	33.291
National estimates - NECP	31.866	32.157	39.437	39.286	35.495
National estimates - no data	-	-	-	-	-

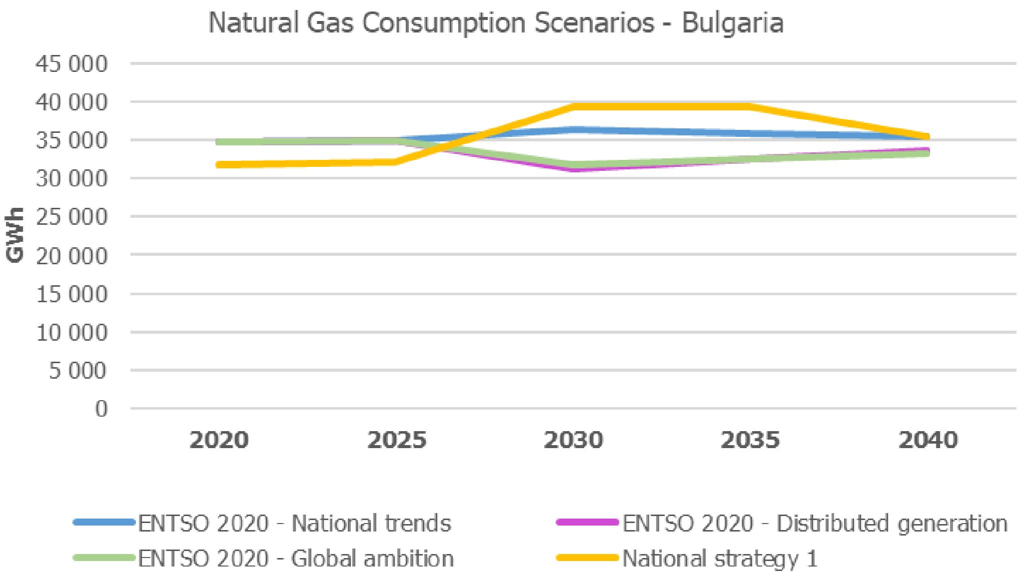


Figure 7. National natural gas consumption scenarios in Bulgaria

Today, the power and heat transformation sector consume a significant share in gross final natural gas consumption in Bulgaria and it is expected that consumption will continue to increase from 1,107 TWh in 2018 to 1,504 TWh in 2040. Contrary to the power sector, consumption in households, manufacturing industry, transportation, and the commercial sector will remain steady at a level of 1,5 TWh. The manufacturing industry, transportation, and energy sectors also consume a significant share of total final consumption, 87 percent. It is estimated that approximately 50 percent of gross final consumption has seasonal behavior.

Bulgaria has moderate weather conditions when compared with other target countries - the intensity of cold during wintertime is 23,03 degree-days. The average daily maximum HDD index during wintertime is 19,65. The coldest day in the last 20 years was 13 February 2004, with 32,10 degree-days. To model daily and hourly consumption, comparison with surrounding countries (Croatia, North Macedonia) is applied.

[3] https://ec.europa.eu/energy/sites/ener/files/documents/bg_final_necp_main_en.pdf

Table 15. Annual and average daily natural gas use by sectors in Bulgaria

Average natural gas consumption, GWh	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	31.866,2	32.157,0	39.437,3	39.286,1	35.494,8
(1) Power generation	7.440,6	7.515,0	8.547,0	10.439,0	7.993,4
(2) Final energy consumption	24.425,6	24.642,0	30.890,3	28.847,1	27.501,4

Average daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	87,2	*98,2*	109,3	*103,2*	97,1
(1) Power generation	20,3	20,5	23,3	28,4	21,8
(2) Final energy consumption	66,9	75,8	84,6	80,0	75,3

Table 16. Peak daily natural gas use in Bulgaria, average weather circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	126,2	*143,2*	160,2	*154,6*	148,9
(1) Power generation	37,6	37,9	43,2	52,7	40,4
(2) Final energy consumption	90,9	*103,6*	116,3	*112,9*	109,6

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	1,4	1,5	1,5	1,5	1,5
(1) Power generation	1,9	1,9	1,9	1,9	1,9
(2) Final energy consumption	1,4	1,4	1,4	1,4	1,5

Table 17. Peak daily natural gas use in Bulgaria, extremely cold circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	150,6	*172,5*	194,4	*191,5*	188,6
(1) Power generation	37,6	37,9	43,2	52,7	40,4
(2) Final energy consumption	120,8	*139,1*	157,5	*154,8*	152,1

Table 18. Ratio between peak daily use in extremely cold circumstances and average consumption

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	1,7	1,8	1,8	1,9	1,9
(1) Power generation	1,9	1,9	1,9	1,9	1,9
(2) Final energy consumption	1,8	1,8	1,9	1,9	2,0

Table 19. Peak hourly natural gas consumption in Bulgaria

Peak hourly use, 1000 m^3/h	*2020*	*2025*	*2030*	*2035*	*2040*
Average winter conditions	504,67	572,83	640,98	618,21	595,44
Extremely cold day – average hourly	**645,26**	**739,23**	**833,21**	**820,77**	**808,33**
Extremely cold day – real peak hour	737,55	846,25	978,46	954,85	950,28

The analysis of consumption shows that approximately 25-30% percent of gross natural gas consumption is dependent on weather circumstances. This causes differences in peak loads in extremely cold and in average weather conditions in the range of 20-25%.

2.5.4 Croatia

Future natural gas demand and use in Croatia in the last two years has been thoroughly analyzed when developing the following strategic studies and documents: *Energy Development Strategy of the Republic of Croatia, Integrated National Energy and Climate Plan for the Republic of Croatia,* and *Development of New Scenarios for the Decrease of Emissions up to 2030 and Climate Neutrality up to 2050 for the Energy Sector.* Two scenarios which were developed in the framework of this study are used for comparison with ENTSO 2020 estimates. The selected scenarios are the following: (1) S1 scenario from the *Energy Development Strategy* which simulates faster transition towards the achievement of the Paris Agreement goal, and which is used also as the base for NECP; (2) Zero-emission scenario (ZES) from the Climate-Neutral Strategy up to 2050.

Table 20. Comparison of ENTSO and national natural gas use scenarios in Croatia, GWh

GWh	2020	2025	2030	2035	2040
ENTSO 2020 - National trends	32.221	33.564	27.378	26.905	26.432
ENTSO 2020 - Distributed energy	32.221	33.564	20.316	19.083	17.851
ENTSO 2020 - Global ambition	32.221	33.564	20.935	20.459	19.983
New national - NECP 2019 - 2030	27.464	26.090	24.715	22.466	20.218
New national - ZES 2020 - 2050	27.464	26.797	24.603	23.394	22.185

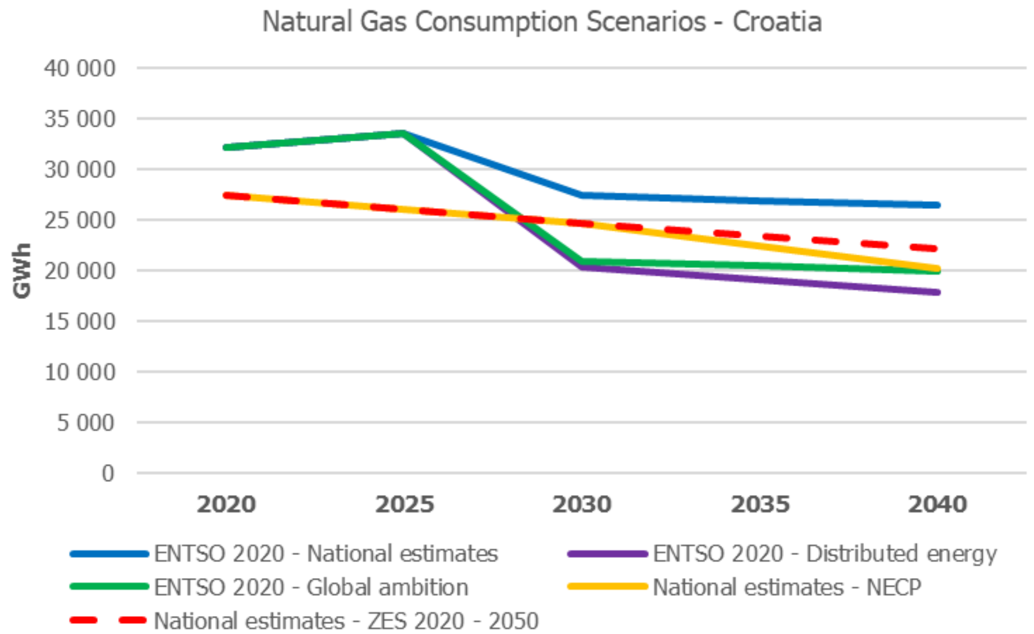


Figure 8. Natural gas consumption scenarios in Croatia, GWh

Total natural gas use as estimated by national scenarios will amount to between 20 and 22 TWh in 2040. The ENTSO 2020 - Climate Scenario in 2040 is forecasting almost the same use as the national NECP scenario. Other ENTSO scenarios differ from national scenarios, but the difference is less than 30 percent compared to national estimates.

The S1 scenario parameters are used for further developing and analyzing the impact of extremely cold weather on natural gas consumption and for calculation of peak loads which can appear in normal weather conditions, and in extremely cold circumstances. The main data inputs for the calculation of the list of additional parameters are EIHP's models (PROG 12 and PROG 365) which were developed in the framework of various projects conducted for natural gas companies. The results of the model are presented in the following tables.

Table 21. Annual and average daily natural gas use by sectors in Croatia

Annual natural gas consumption, GWh	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	27.464,4	26.089,8	24.715,2	22.466,4	20.217,7
(1) Power generation	6.012,3	5.142,5	4.272,7	3.578,5	2.884,3
(2) Final energy consumption	21.452,1	20.947,3	20.442,5	18.887,9	17.333,4

Average daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	75,11	71,40	68,36	61,50	68,36
(1) Power generation	16,38	14,01	11,64	9,75	7,86
(2) Final energy consumption	58,77	57,39	56,01	51,75	47,49

Table 22. Peak daily natural gas use in Croatia, average winter circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	136,5	132,0	127,4	111,8	96,3
(1) Power generation	38,36	37,07	35,49	29,73	23,96
(2) Final energy consumption	101,8	98,6	95,5	85,7	75,9

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	1,8	1,8	1,9	1,8	1,4
(1) Power generation	2,3	2,6	3,0	3,0	3,0
(2) Final energy consumption	1,7	1,7	1,7	1,7	1,6

Table 23. Peak daily natural gas use in Croatia, extremely cold circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	184,7	176,6	168,6	147,7	126,7
(1) Power generation	38,36	37,07	35,49	29,73	23,96
(2) Final energy consumption	150,4	148,2	146,0	130,0	113,9

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	2,5	2,5	2,5	2,4	1,9
(1) Power generation	2,3	2,6	3,0	3,0	3,0
(2) Final energy consumption	2,7	2,6	2,6	2,5	2,4

Table 24. Peak hourly natural gas consumption

Peak hourly use, 1000 m^3/h	*2020*	*2025*	*2030*	*2035*	*2040*
Average weather conditions	330,49	314,17	300,80	270,59	300,80
Extremely cold day – peak	**738,84**	**706,59**	**674,35**	**590,67**	**506,99**
Extremely cold day – real peak hour	857,38	824,47	791,28	689,49	587,96

Air temperatures have a significant impact on gas consumption in Croatia, and some earlier analyses show that differences between monthly consumption in extremely cold and extremely warm circumstances can achieve 60 percent in the final energy consumption sector. The ratio between peak load in extreme weather conditions and average hourly consumption calculated from national estimates is the same as in the ENTSO 2020 scenario. The load is overlapping in the base year and is slightly lower in 2040. Newer scenarios include a strong impact of energy efficiency measures in the building sector which will significantly reduce the temperature impact on energy consumption.

2.5.5 Kosovo

Similar to Albania, , the development of the natural gas system in Kosovo is expected to occur after 2025. Currently, there are no estimates in ENTSO 2020 scenarios on future consumption and peak loads in this country. The analysis below has been performed based on forecasts published in EE-NGP's "*Optimization of the Regional Gas System to Reach Lowest Cost Maximum Diversification of Gas Supply for Target Year 2040"* where consumption of 33,68 GWh in 2040 is envisaged.

Table 25. Comparison of national natural gas consumption scenarios in Kosovo, GWh

GWh	2020	2025	2030	2035	2040
National estimates	-	-	1.132,6	2.069,9	3.654,3

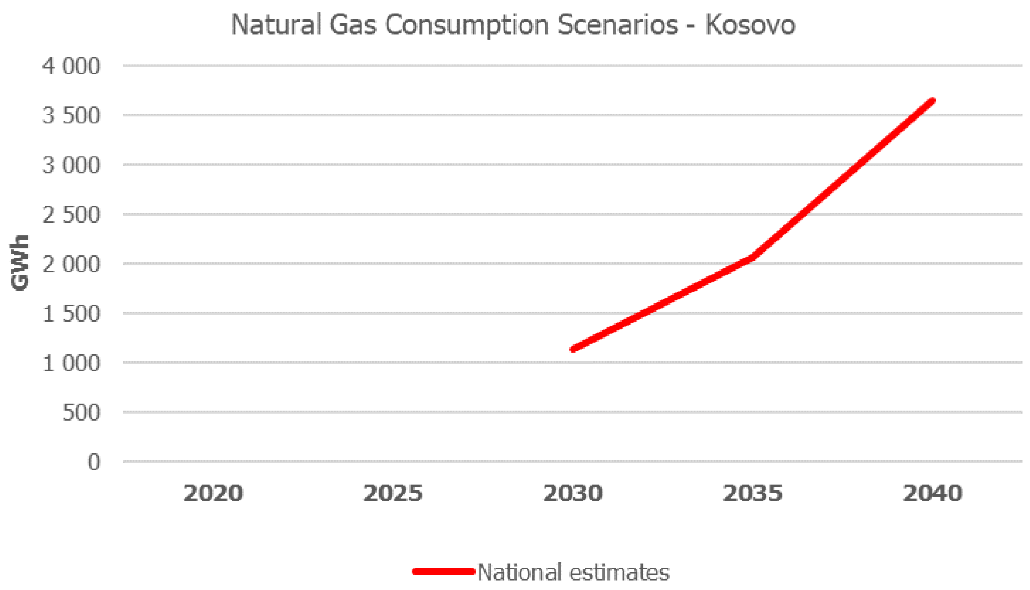


Figure 9. National natural gas consumption scenarios in Kosovo

The focus of the consumption in the next decade will be final energy consumption and consumption in the manufacturing industry which is forecast to be 67 percent in final energy consumption in 2040. It is expected that such a large share of consumption in the manufacturing industry will cause a decrease of sensitivity of weather impact on total gross final natural gas consumption in Kosovo. Due to the lack of data, daily loads in final energy consumption sectors are simulated based on the principles applied in Bosnia and Herzegovina.

The analysis of weather conditions in Kosovo showed that the highest HDD index appeared on 8th January 2017 and amounted to 30,7 degree-days. Average annual HDDs amount to 21,77, and the average daily HDD index in the winter period are 17,97.

Table 26. Annual and average daily natural gas use by sectors in Kosovo

Annual natural gas consumption, GWh	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,0	0,0	1.132,6	2.069,9	3.654,3
(1) Power generation	0,0	0,0	0,0	0,0	0,0
(2) Final energy consumption	0,0	0,0	1.132,6	2.069,9	3.654,3

Average daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,0	0,0	3,1	6,6	10,0
(1) Power generation	0,0	0,0	0,0	0,0	0,0
(2) Final energy consumption	0,0	0,0	3,1	6,6	10,0

Table 27. Peak daily natural gas use in Kosovo, average weather circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,0	0,0	3,9	8,8	13,7
(1) Power generation	0,0	0,0	0,0	0,0	0,0
(2) Final energy consumption	0,0	0,0	3,9	8,8	13,7

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,0	0,0	1,3	1,3	1,4
(1) Power generation	0,0	0,0	0,0	0,0	0,0
(2) Final energy consumption	0,0	0,0	1,3	1,3	1,4

Table 28. Peak daily natural gas use in Kosovo, extremely cold circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,0	0,0	3,8	10,8	17,7
(1) Power generation	0,0	0,0	0,0	0,0	0,0
(2) Final energy consumption	0,0	0,0	3,8	10,8	17,7

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,0	0,0	1,2	1,6	1,8
(1) Power generation	0,0	0,0	0,0	0,0	0,0
(2) Final energy consumption	0,0	0,0	1,2	1,6	1,8

Table 29. Peak hourly natural gas consumption in Kosovo

Peak hourly use, 1000 m³/h	*2020*	*2025*	*2030*	*2035*	*2040*
Average winter conditions	0	0	12.580	26.585	40.589
Extremely cold day – average hourly	0	0	15,484	35,545	55,606
Extremely cold day – real peak hour	0	0	16,022	43,839	71,656

The ratio between peak load in extreme weather conditions and average daily consumption calculated from national estimates forecasts is not high as in countries with less favorable winters. It ranges from 1,2-1,8.

2.5.6 Greece

Overall consumption in Greece until 2040 will decrease steadily, according to the recent scenarios developed by ENTSO and the Ministry of Environment and Energy (National Energy and Climate Plan 2020-2030). Total natural gas consumption in Greece will amount to between 40,2 and 53,3 TWh in 2040. The newer national scenario presented in the NECP has foreseen consumption of 49,9 TWh in 2040, which is 18 percent less compared to 2020. It also includes different trends of natural gas use in the power sector and final consumption compared to ENTSO. Final consumption is growing at a higher rate, while consumption in the power sector at a slower rate.

Table 30. Comparison of national natural gas consumption scenarios in Greece, GWh

GWh	2020	2025	2030	2035	2040
ENTSO 2020 - National trends	56.824	69.395	62.708	58.120	53.533
ENTSO 2020 - Distributed energy	56.824	69.395	63.574	51.892	40.210
ENTSO 2020 - Global ambition	56.824	69.395	48.622	47.658	46.693
National estimates - NECP 2019-2030	61.057	56.196	56.568	50.032	49.939

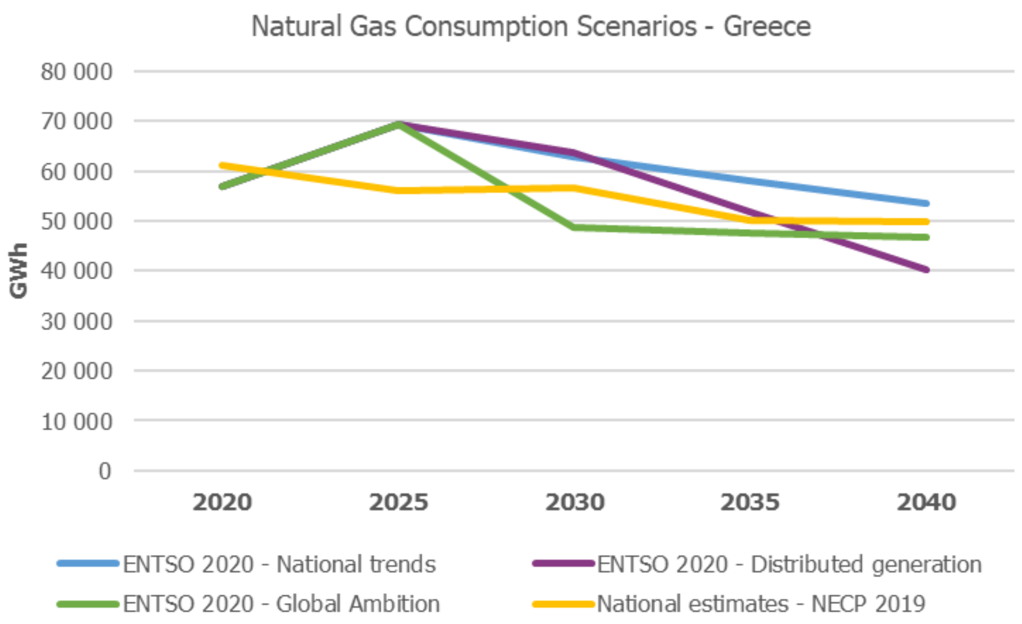


Figure 10. National natural gas consumption scenarios in Greece

Today, the power sector has the largest share in gross natural gas consumption in Greece and it is expected that the largest drop by 2040 will occur in this category. Contrary to the power sector, consumption in households, manufacturing industry, transport, and the tertiary sector will continue to rise. This change will shift the intensity of loads toward a more seasonal pattern.

Greece has the most favorable weather circumstances among the target countries - the intensity of cold during wintertime is approximately 2,5 times smaller than in other countries and amounts to 740 HDDs. The average daily maximum HDD index during wintertime is 12.08. The coldest day in the last 20 years was 13th February 2004 when 19,8 HDD index were noted. The analysis of hourly loads for specific distribution areas, e.g. Athens area, enabled setting up national relations between outdoor temperature and natural gas consumption in the distribution area. It is worth mentioning that some distribution areas have a very specific annual mode of operations which significantly differs from regular seasonal consumption. The analysis shows that 40 percent of consumption in distribution areas has seasonal characters. Hourly loads in power generation are modelled based on national data received by TSO and EMI data for 2025 and 2030.

Table 31. Annual and average daily natural gas use by sectors in Greece

Annual natural gas consumption, GWh	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	61.057,5	56.196,2	56.568,3	50.032,3	49.939,2
(1) Power generation	41.961,0	32.750,1	31.005,6	22.434,3	20.503,7
(2) Final energy consumption	19.096,5	23.446,1	25.562,7	27.598,0	29.435,5

Average daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	167,2	161,1	155,0	145,9	136,8
(1) Power generation	114,6	89,5	84,7	61,3	56,0
(2) Final energy consumption	52,3	61,2	70,0	75,3	80,6

Table 32. Peak daily natural gas use in Greece, average weather conditions

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	326,9	*309,5*	292,0	*272,8*	253,5
(1) Power generation	244,2	190,6	180,4	130,5	119,3
(2) Final energy consumption	86,9	*101,0*	115,1	*125,7*	136,4

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	2,0	1,9	1,9	1,9	1,9
(1) Power generation	2,1	2,1	2,1	2,1	2,1
(2) Final energy consumption	1,7	1,7	1,6	1,7	1,7

Table 33. Peak daily natural gas use in Greece, extremely cold circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	373,3	*362,7*	352,2	*340,4*	328,6
(1) Power generation	244,2	190,6	180,4	130,5	119,3
(2) Final energy consumption	132,9	*153,7*	174,6	*192,9*	211,2

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	2,2	2,3	2,3	2,3	2,4
(1) Power generation	2,1	2,1	2,1	2,1	2,1
(2) Final energy consumption	2,5	2,5	2,5	2,6	2,6

Table 34. Peak hourly natural gas consumption in Greece

Peak hourly use, 1000 m^3/h	*2020*	*2025*	*2030*	*2035*	*2040*
Average winter conditions	669,1	644,5	619,9	583,6	547,3
Extremely cold day – average hourly	**1.493,2**	**1.450,9**	**1.408,6**	**1.361,6**	**1.314,6**
Extremely cold day – real peak hour	1.734,7	1.720,2	1.680,5	1.667,6	1.632,7

The measured peak load in Greece in 2019, according to TSO data, is 1.493,2 thousand cubic meters. It is considered to be a year with average weather circumstances and peak load appeared on January 8th, 2019 and its intensity was 14,1 degree-days. This value is modelled for peak load on an extremely cold day. Results of modelling show the estimates for extreme weather circumstances. The load duration curve for power generation, final and total consumption is presented in Annex 2.

2.5.7 North Macedonia

Future natural gas demand and use in North Macedonia includes intensive development of power and heat generation facilities. According to national estimates, total natural gas consumption in 2040 will amount to 6.061 GWh, out of which 4.509 GWh will be used by the power and heat generation sector and 1.551 GWh in the final energy consumption sectors.

The new scenario provided by GA-MA, the national TSO for North Macedonia, for the purpose of this study shows significant differences compared to *ENTSO 2020 - national trends* scenario - it is much more compliant with the distributed generation scenario. It is also noted that smaller discrepancies exist in the base 2020 year. It is assumed that new GA-MA's scenarios include more recent estimates for this year.

Table 35. Comparison of ENTSO and national natural gas use scenarios in North Macedonia, GWh

GWh	2020	2025	2030	2035	2040
ENTSO 2020 - National trends	3.449	3.611	4.555	6.928	9.300
ENTSO 2020 - Distributed energy	3.449	3.611	5.263	5.322	5.380
ENTSO 2020 - Global ambition	3.449	3.611	4.683	4.704	4.725
New TSO scenario - 2020 - 2040	2.806	3.390	4.634	5.951	6.061

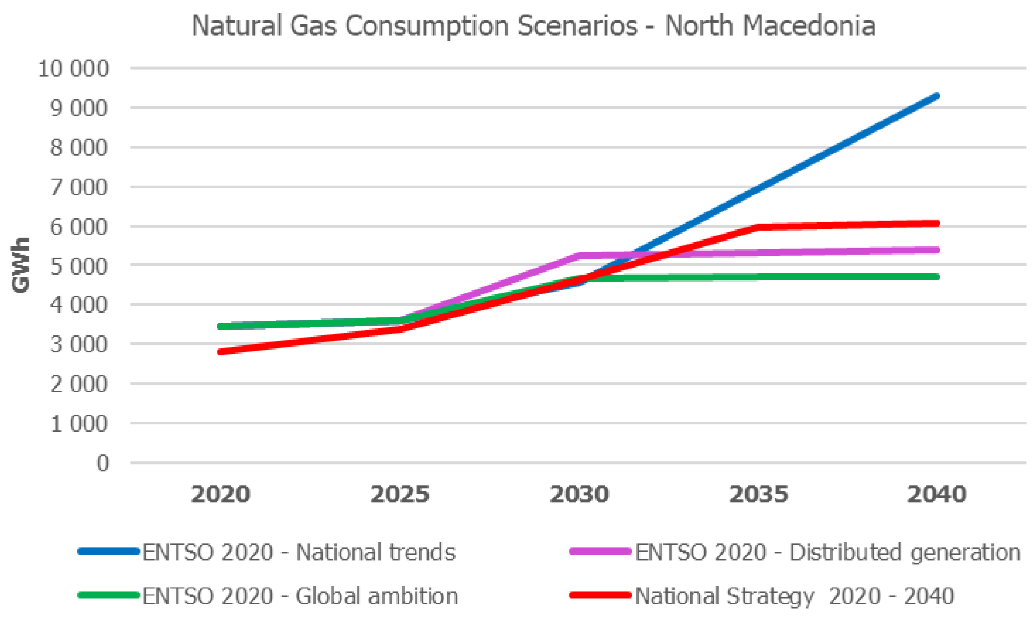


Figure 11. Natural gas consumption scenarios in North Macedonia, GWh

According to the national gas strategy and intensive development of the combined power and heat sector, it is expected that the impact of weather conditions will be similar in power and heat and the final energy consumption sector characterized by seasonal consumption and use during the year. The average annual HDDs amount to 2038, while the average daily HDD index is 17,2. The highest HDD index - 33,1 is noted on 21st December 2001, and the average daily HDDs in December are approximately 17.

Hourly loads for power and heat generation sectors are modelled based on similar cases in neighboring countries as inputs received from the EMI group do not reflect the real state in 2020 and expected changes in 2025 and 2030.

Table 36. Annual and average natural gas use by sectors in North Macedonia

Annual natural gas consumption, GWh	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	2.806,0	3.389,8	4.633,9	5.951,0	6.060,5
(1) Power generation	1.878,9	2.254,6	3.381,9	4.509,3	4.509,3
(2) Final energy consumption	927,1	1.135,2	1.252,0	1.441,8	1.551,3

Average daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	7,65	9,13	13,16	16,13	16,50
(1) Power generation	5,12	6,14	9,22	12,29	12,29
(2) Final energy consumption	2,54	2,99	3,43	3,84	4,25

Table 37. Peak daily natural gas use in North Macedonia, average weather circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	17,4	*24,4*	31,4	*35,4*	39,5
(1) Power generation	14,36	17,23	25,85	34,46	34,46
(2) Final energy consumption	3,9	*4,6*	5,4	*6,0*	6,5

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	2,3	2,7	2,4	2,2	2,4
(1) Power generation	2,8	2,8	2,8	2,8	2,8
(2) Final energy consumption	1,5	1,6	1,6	1,6	1,5

Table 38. Peak daily natural gas use in North Macedonia, extremely cold circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	18,0	*25,2*	32,4	*36,5*	40,6
(1) Power generation	14,36	17,23	25,85	34,46	34,46
(2) Final energy consumption	5,4	*6,5*	7,6	*8,4*	9,2

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	2,3	2,8	2,5	2,3	2,5
(1) Power generation	2,8	2,8	2,8	2,8	2,8
(2) Final energy consumption	2,1	2,2	2,2	2,2	2,2

Table 39. Peak daily natural gas consumption in North Macedonia

Peak hourly use, 1000 m^3/h	*2020*	*2025*	*2030*	*2035*	*2040*
Average winter conditions	82,98	116,58	150,19	169,47	188,75
Extremely cold day – peak	**86,14**	**120,49**	**154,85**	**174,53**	**194,21**
Extremely **cold day** – **real peak**	86,14	133,99	171,55	192,87	214,81

Assumptions of peak demand during extreme weather conditions correspond to the peaks in the power sector and for final demand as estimated by GA-MA. It is obvious that there is no significant impact of outdoor temperature on overall consumption because weather-sensitive consumption participates with very small shares in gross final energy consumption. In North Macedonia, dominant consumption sectors are the combined power and heat (CHP) sector and the manufacturing industry.

2.5.8 Montenegro

Similar to Albania and Kosovo, the development of the natural gas system in Montenegro is expected after 2020. Currently, there are no estimates of future consumption and peak loads in this country in the ENTSO 2020 scenarios. The analysis below was performed based on forecasts published in the EE-NGP *Optimization of Regional Gas System Study* from 2018 where consumption of 3,9 TWh in 2040 is envisaged. The results of the study are modelled on EIHP models for the analysis of weather impacts and similar results are achieved.

Table 40. Comparison of national natural gas consumption scenarios in Montenegro, GWh

GWh	2020	2025	2030	2035	2040
National estimates 1	0,0	69,7	1.358,0	2.903,5	3.833,5

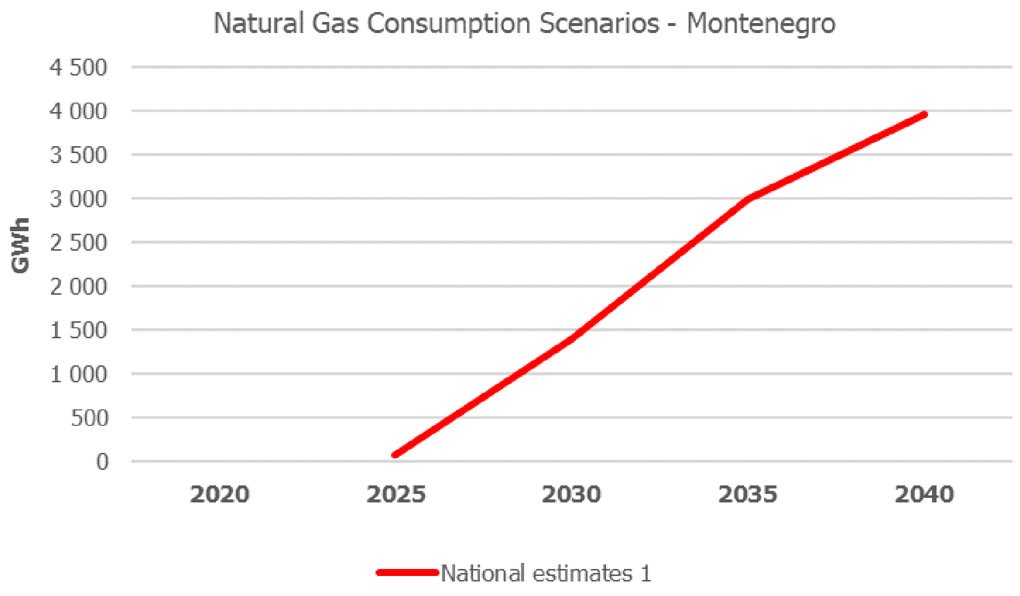


Figure 12. National natural gas consumption scenarios in Montenegro

The development of the national gas system includes different trends of final energy consumption and power generation. Consumption will be first introduced in final energy sectors, particularly in the manufacturing industry and it is expected that after 2030 new power plants will be put into operation. In 2040, the share of natural gas use for power generation is estimated at 37 percent, while 63 percent belongs to the final energy consumption sectors. The manufacturing industry will remain the dominant consumer in the final energy consumption sector.

The average annual cold intensity in Montenegro is 1224 degree-days, the coldest day is estimated to be 7th, January 2017, cold amounted to 20,9 degree-days, and the average daily cold during the wintertime amounts to 11,57 degree-days.

During the period of development of this study, the EMI group did not have available estimates for natural gas use scenarios in the power sector, so overall consumption and related loads are roughly modelled using similar cases in neighboring countries.

Table 41. Annual and average natural gas use by sectors in Montenegro

Annual natural gas consumption, GWh	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,0	69,7	1.358,0	2.903,5	3.833,5
(1) Power generation	0,0	0,0	687,1	1.288,3	1.503,0
(2) Final energy consumption	0,0	69,7	670,9	1.615,3	2.330,5

Average daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,0	0,2	3,8	7,6	10,5
(1) Power generation	0,0	0,0	1,9	3,5	4,1
(2) Final energy consumption	0,0	0,2	1,8	4,1	6,4

Table 42. Peak daily natural gas use in Montenegro, average weather conditions

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,0	0,3	6,7	12,2	17,8
(1) Power generation	0,0	0,0	3,7	7,0	8,2
(2) Final energy consumption	0,0	0,3	2,8	6,4	10,1

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,0	0,1	1,7	1,6	1,7
(1) Power generation	0,0	0,0	2,0	2,0	2,0
(2) Final energy consumption	0,0	1,5	1,5	1,6	1,6

Table 43. Peak daily natural gas use in Montenegro, extremely cold circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,0	0,4	8,0	15,5	22,9
(1) Power generation	0,0	0,0	3,7	7,0	8,2
(2) Final energy consumption	0,0	0,4	4,1	9,4	14,8

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	0,0	1,8	2,1	2,0	2,2
(1) Power generation	0,0	0,0	2,0	2,0	2,0
(2) Final energy consumption	0,0	1,8	2,2	2,3	2,3

Table 44. Peak hourly natural gas consumption in Montenegro

Peak hourly use, 1000 m^3/h	*2020*	*2025*	*2030*	*2035*	*2040*
Average winter conditions	0,00	1,42	29,58	54,81	79,08
Extremely cold conditions – average	**0,00**	**1,61**	**31,73**	**62,31**	**92,88**
Extremely cold conditions - real	0,00	1,71	35,76	69,36	101,74

2.5.9 Serbia

Gross natural gas consumption in Serbia will sharply grow until 2035, however, after that period it is expected that consumption will be stabilized. According to the ENTSO's scenarios it is estimated that in 2040 consumption will range from 33 to 37 TWh per year. There are no newer natural gas scenarios, and Serbia is currently preparing grounds for launching the NECPs.

Table 45. Comparison of national natural gas consumption scenarios in Serbia, GWh

GWh	2020	2025	2030	2035	2040
ENTSO 2020 - National trends	24.631	30.668	36.745	36.862	36.979
ENTSO 2020 - Distributed energy	24.631	30.668	34.140	33.968	33.796
ENTSO 2020 - Global ambition	24.631	30.668	33.854	33.722	33.590

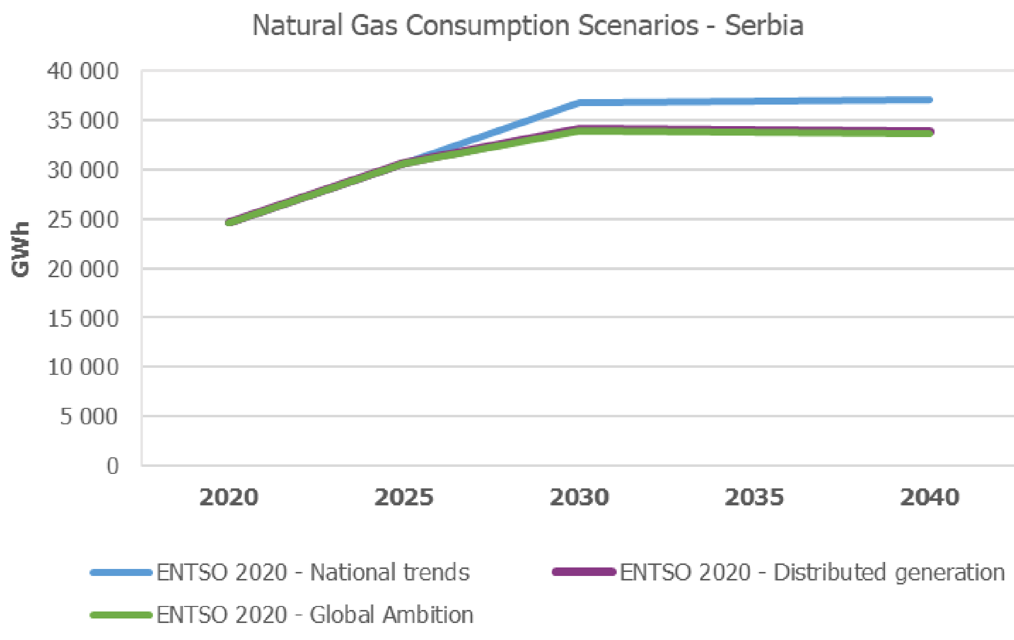


Figure 13. National natural gas consumption scenarios in Serbia

Natural gas scenarios are characterized by a significant increase in natural gas consumption for power generation. It is estimated that in 2040 natural gas use for electricity and heat generation will be almost 1,5 times higher than in 2020 and will amount to about 5 TWh. The largest share of natural gas use in transformation processes belongs to heat plants. This type of transformation process in this study is considered as final consumption.

The manufacturing industry, non-energy consumption, distribution, and losses have a significant share in total final energy consumption which amounts to about 50 percent.

Serbia belongs to a group of countries with medium climate conditions during wintertime. Average HDDs are 1761, the average HDD index on a typical winter day is 13,2, while the maximum HDD index amounts to 27,7 and is noted on 23rd January 2006.

Except for data from ENTSO's reports, national statistics, EUROSTAT, and draft inputs from the EMI group, there were no other data available and overall analysis in Serbia is based on the simulation of consumption based on expert experience.

Table 46. Annual and average daily natural gas use by sectors in Serbia

Annual natural gas consumption, GWh	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	24.793,8	30.668,1	36.745,0	36.862,0	36.979,0
(1) Power generation	1.074,0	2.045,4	2.822,6	3.895,2	5.375,4
(2) Final energy consumption	23.719,8	28.622,8	33.922,4	32.966,8	31.603,7

Average daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	66,5	81,6	96,8	95,4	93,9
(1) Power generation	1,5	2,8	3,9	5,3	7,4
(2) Final energy consumption	65,0	79,0	92,9	89,8	86,6

Table 47. Peak daily natural gas use in Serbia, average weather conditions

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	118,0	149,0	180,1	172,6	165,0
(1) Power generation	2,8	4,9	6,7	9,3	12,8
(2) Final energy consumption	116,3	146,4	176,4	166,7	157,0

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	1,8	1,8	1,9	1,8	1,8
(1) Power generation	1,9	1,7	1,7	1,7	1,7
(2) Final energy consumption	1,8	1,9	1,9	1,9	1,8

Table 48. Peak daily natural gas use in Serbia, extremely cold circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	179,2	231,3	283,5	267,6	251,8
(1) Power generation	2,8	4,9	6,7	9,3	12,8
(2) Final energy consumption	177,0	227,4	277,8	259,4	241,0

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	2,7	2,8	2,9	2,8	2,7
(1) Power generation	1,9	1,7	1,7	1,7	1,7
(2) Final energy consumption	2,7	2,9	3,0	2,9	2,8

Table 49. Peak hourly natural gas consumption in Serbia

Peak hourly use, 1000 m³/h	*2020*	*2025*	*2030*	*2035*	*2040*
Average winter conditions	636,2	803,6	971,0	930,4	889,8
Extremely cold day – peak	726,4	937,9	1.149,3	1.085,0	1.020,8
Extremely **cold day** – real peak hour	966,1	1.247,4	1.528,6	1.443,1	1.357,6

The ratio between peak load in extreme weather conditions and average daily consumption will increase in the future mostly due to changes in power sector operation but also due to the increase of consumption in final energy consumption. The ratio between the peak daily consumption in average weather (winter) circumstances and extremely cold weather circumstances is around 40 percent.

2.5.10 Poland

Gross natural gas consumption scenarios in Poland show two trends: the first trend represents a continuous and steady growth until 2035. The other trend is based on a more intensive natural gas decrease which will in 2040 amount to about 27 percent. The ENTSO 2020 national estimates scenario is overlaps with newer national scenarios which are elaborated in the National Energy and Climate Plan for 2020 - 2030 adopted by the Ministry of Energy. In addition to NECP, Gaz System, the national TSO, provided three additional national scenarios: moderate growth, optimal development, and market saturation scenario.

Table 50. Comparison of national natural gas consumption scenarios in Poland, GWh

GWh	2020	2025	2030	2035	2040
ENTSO 2020 - National trends	193.618	211.958	206.771	226.430	246.089
ENTSO 2020 - Distributed energy	193.618	211.958	319.900	333.170	346.440
ENTSO 2020 - Global ambition	193.618	211.958	303.486	319.988	336.489
National estimates 1 - NECP	189.960	198.489	208.029	225.892	237.200
National estimates 2 – Moderate growth	191.119	209.384	220.841	260.401	287.758

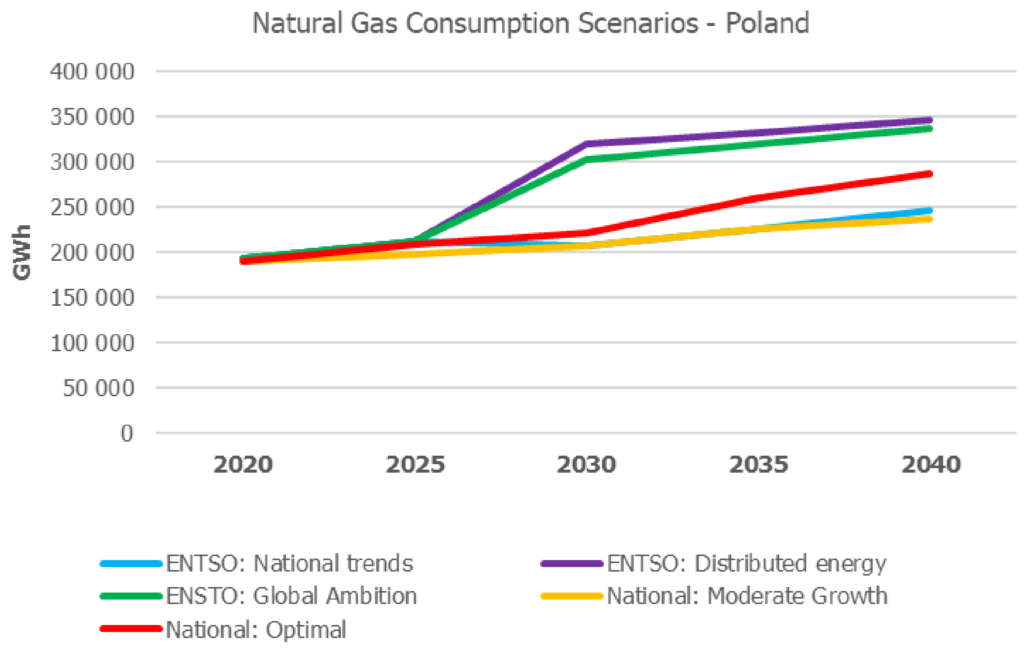


Figure 14. National natural gas consumption scenarios in Poland

According to NECP, most of the consumption in the transformation sector is allocated to combined power and heat generation and it is expected that consumption in this category will increase 2,78 times until 2040. Total final energy consumption will remain steady until 2040. The manufacturing industry, non-energy consumption, distribution, and losses have a significant share in total final energy consumption which amounts to about 50 percent. This consumption structure makes Poland's natural gas system less sensitive to outdoor temperature changes.

Poland belongs to a group of countries with less favorable climate conditions during wintertime. Average annual cold intensity amounts to 2724 degree-days, the average HDD index on a typical winter day is 20,68, while the maximum HDD index amounts to 34,8 and is noted on 23rd January 2006.

Table 51. Annual and average daily natural gas use by sectors in Poland

Annual natural gas consumption, GWh	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	189.959,6	198.489,2	208.029,1	225.892,0	237.199,8
(1) Power generation	26.272,2	31.982,5	41.740,1	60.115,5	73.222,5
(2) Final energy consumption	163.687,4	166.506,7	166.289,0	165.776,5	163.977,3

Average daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	519,97	539,17	576,34	616,22	576,34
(1) Power generation	71,59	87,15	113,73	163,80	199,52
(2) Final energy consumption	448,46	452,02	455,59	452,42	449,25

Table 52. Peak daily natural gas use in Poland, average winter conditions

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	757,8	*797,9*	838,0	*893,0*	947,9
(1) Power generation	108,63	158,56	199,10	286,76	349,28
(2) Final energy consumption	681,1	*674,4*	667,7	*656,8*	645,8

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	1,5	1,5	1,5	1,4	1,6
(1) Power generation	1,5	1,8	1,8	1,8	1,8
(2) Final energy consumption	1,5	1,5	1,5	1,5	1,4

Table 53. Peak daily natural gas use in Poland, extremely cold circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	1151,3	*1169,7*	1188,1	*1217,9*	1247,6
(1) Power generation	108,63	158,56	199,10	286,76	349,28
(2) Final energy consumption	1083,7	*1058,9*	1034,0	*1009,3*	984,5

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	2,2	2,2	2,1	2,0	2,2
(1) Power generation	1,5	1,8	1,8	1,8	1,8
(2) Final energy consumption	2,4	2,3	2,3	2,2	2,2

Table 54. Peak hourly natural gas consumption in Poland

Peak hourly use, 1000 m^3/h	*2020*	*2025*	*2030*	*2035*	*2040*
Average winter conditions	3.685,03	3.851,31	4.009,27	4.241,98	4.478,77
Extremely cold day – peak	5.065,79	5.146,72	5.227,64	5.358,57	5.489,49
Extremely cold day – real peak hour	5.598,70	5.645,94	5.684,13	5.785,36	5.894,82

The estimated peak load for extreme weather circumstances is 5.065 thousand m^3/h in 2020 and it is estimated that it will slightly increase until 2040. These estimates are also aligned with the data provided by Gaz System.

2.5.11 Slovakia

Overall consumption in Slovakia will increase steadily until 2040. According to the recent scenarios developed by ENTSO and by the Slovak Ministry of Economy (National Energy and Climate Plan 2020-2030[4]), total natural gas consumption in Slovakia will amount to between 47 and 56 TWh in 2040. The newer national scenario estimates consumption of 56 GWh in 2040, and compared to 2020 it is around 10 percent higher consumption.

Table 55. Comparison of national natural gas consumption scenarios in Slovakia, GWh

GWh	2020	2025	2030	2035	2040
ENTSO 2020 - National trends	49.800	60.643	57.259	55.240	53.220
ENTSO 2020 - Distributed energy	49.800	60.643	49.239	48.192	47.144
ENTSO 2020 - Global ambition	49.800	60.643	51.596	50.912	50.228
National estimates 1 - NECP 2019-2030	51.050	58.232	57.284	55.202	56.126

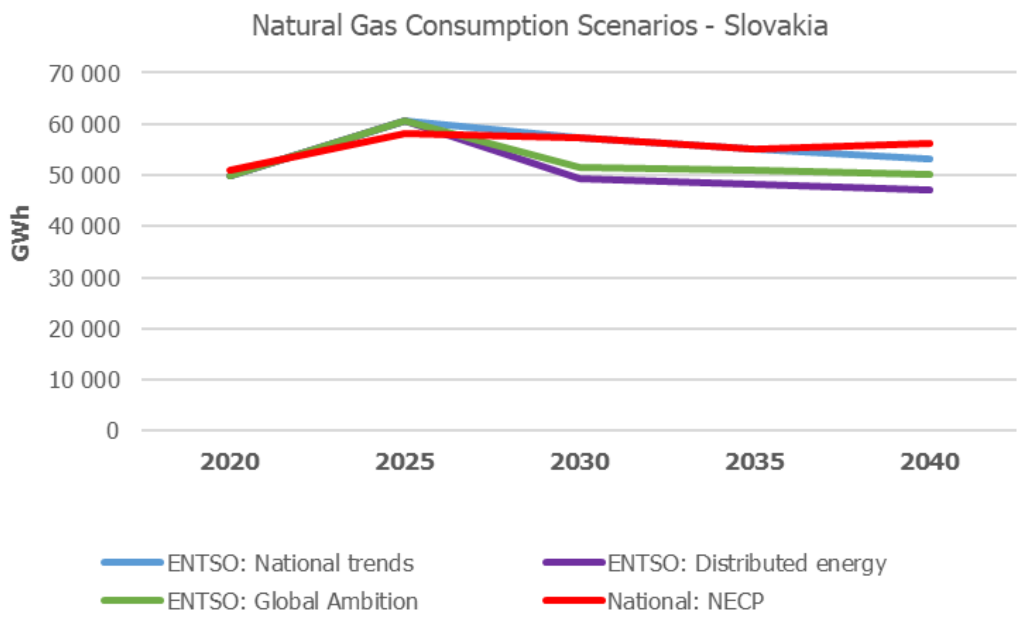


Figure 15. National natural gas consumption scenarios in Slovakia

As in other countries, peak demands and LDC shapes depend on the structure of natural gas use in the national gas system. In Slovakia, the transformation sector participates in total consumption with 15 percent during all planning periods while other consumption belongs to the final energy consumption sector. The manufacturing industry and transport sector participate in gross final energy consumption with 50 percent.

Slovakia belongs to a group of countries with colder climate conditions during wintertime and the peak HDD was noted on 23rd January 2006.

[4] https://ec.europa.eu/energy/sites/ener/files/sk_final_necp_main_en.pdf

Table 56. Annual and average daily natural gas use by sectors in Slovakia

Annual natural gas consumption, GWh	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	51.049,6	58.231,7	57.283,8	55.201,9	56.126,1
(1) Power generation	8.423,1	9.608,3	9.514,8	9.108,2	9.168,8
(2) Final energy consumption	42.626,5	48.623,5	47.769,0	46.093,7	46.957,3

Average daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	139,7	150,0	158,5	154,6	153,8
(1) Power generation	23,0	26,2	25,9	24,8	25,0
(2) Final energy consumption	116,8	123,8	130,9	129,8	128,7

Table 57. Peak daily natural gas use in Slovakia, average weather conditions

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	260,7	276,8	292,8	286,9	281,1
(1) Power generation	79,71	103,71	91,56	87,64	88,23
(2) Final energy consumption	185,3	196,5	207,6	205,9	204,2

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	1,9	1,8	1,8	1,9	1,8
(1) Power generation	3,5	4,0	3,5	3,5	3,5
(2) Final energy consumption	1,6	1,6	1,6	1,6	1,6

Table 58. Peak daily natural gas use in Slovakia, extremely cold circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	339,0	361,6	384,2	377,9	371,6
(1) Power generation	79,71	103,71	91,56	87,64	88,23
(2) Final energy consumption	266,7	282,7	298,8	296,3	293,9

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	2,4	2,4	2,4	2,4	2,4
(1) Power generation	3,5	4,0	3,5	3,5	3,5
(2) Final energy consumption	2,3	2,3	2,3	2,3	2,3

Table 59. Peak hourly natural gas consumption in Slovakia

Peak hourly use, 1000 m³/h	*2020*	*2025*	*2030*	*2035*	*2040*
Average winter conditions	1.251	1.328	1.405	1.377	1.349
Extremely cold day – peak	1.356	1.446	1.537	1.512	1.486
Extremely cold day – real peak hour	1.627	1.736	1.844	1.814	1.784

The ratio between peak load in extreme weather conditions and average daily consumption calculated from national estimate forecasts will increase in the future mostly due to changes in power sector operation.

2.5.12 Romania

Gross natural gas consumption scenarios in Romania show two trends: the first trend represents continuous and steady growth until 2035. The second trend is based on the natural gas decrease which will in 2040 amount to about 35 percent. The ENTSO 2020 National estimates scenario is overlaps with NECP scenarios and with recent estimates provided by Transgaz, the national TSO.

Table 60. Comparison of national natural gas consumption scenarios in Romania, GWh

GWh	2020	2025	2030	2035	2040
ENTSO 2020 - National trends	113.260	120.159	116.540	118.384	120.229
ENTSO 2020 - Distributed energy	113.260	120.159	91.941	86.502	81.064
ENTSO 2020 - Global ambition	113.260	120.159	98.946	95.005	91.064
National estimates 1 - NECP/TSO	119.818	115.021	116.786	120.132	121.227

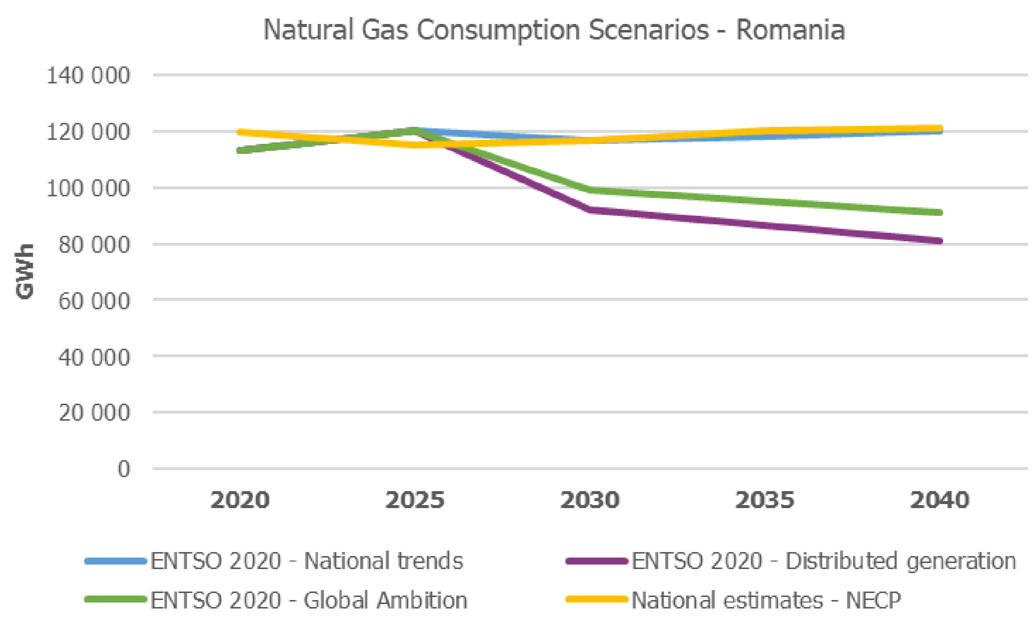


Figure 16. National natural gas consumption scenarios in Romania

Natural gas scenarios are characterized by a slight increase in natural gas consumption in transformation processes until 2040. But only part of it is used for electricity generation or for combined heat and electricity generation. A large share of natural gas use in transformation processes belongs to heat plants whose operation is affected by weather conditions. This type of transformation process in this study is considered as final consumption.

The manufacturing industry, non-energy consumption, distribution, and losses have a significant share in total final energy consumption which amounts to approximately 51 percent.

Romania belongs to a group of countries with less favorable climate conditions during wintertime. Average HDDs are 2207, the average HDD index on a typical winter day is 16,3, while the maximum HDD index amounts to 32,1 and is noted on 2nd February 2012.

Table 61. Annual and daily average natural gas use by sectors in Romania

Annual natural gas consumption, GWh	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	119.817,5	115.021,0	116.786,0	120.132,0	121.227,0
(1) Power generation	13.357,8	13.904,6	14.949,4	17.575,6	17.743,1
(2) Final energy consumption	106.459,7	101.116,4	101.836,6	102.556,4	103.483,9

Average daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	310,0	*304,7*	299,5	*303,7*	307,8
(1) Power generation	18,3	19,0	20,5	24,1	24,3
(2) Final energy consumption	291,7	285,3	279,0	281,3	283,5

Table 62. Peak daily natural gas use in Romania, average weather conditions

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	658,2	630,4	602,6	601,9	601,2
(1) Power generation	34,7	33,2	35,7	41,9	42,3
(2) Final energy consumption	627,0	602,2	577,4	573,9	570,3

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	2,1	2,1	2,0	2,0	1,9
(1) Power generation	1,9	1,7	1,7	1,7	1,7
(2) Final energy consumption	2,1	2,1	2,1	2,0	2,0

Table 63. Peak daily natural gas use in Romania, extremely cold circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	1009,1	970,3	931,5	928,7	926,0
(1) Power generation	34,7	33,2	35,7	41,9	42,3
(2) Final energy consumption	981,2	942,8	904,3	899,0	893,7

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	3,2	3,2	3,1	3,0	3,0
(1) Power generation	1,9	1,7	1,7	1,7	1,7
(2) Final energy consumption	3,4	3,3	3,2	3,2	3,1

Table 64. Peak hourly natural gas consumption in Romania

Peak hourly use, 1000 m^3/h	*2020*	*2025*	*2030*	*2035*	*2040*
Average winter conditions	1.239,88	1.218,90	1.197,93	1.214,61	1.231,29
Extremely cold day – peak	**2.632,97**	**2.521,62**	**2.410,28**	**2.407,49**	**2.404,69**
Extremely cold day – real peak hour	4.036,47	3.881,22	3.725,97	3.714,92	3.703,88

Metered peak load in 2018 is 2.652 thousand m^3/h and this year can be considered as an average year concerning daily heating degree days. The estimated peak in extremely cold weather circumstances resulted in a 64 percent demand increase due to a high share of consumers which are sensitive to weather circumstances.

The load duration curve for power generation, final and total consumption is presented in Annex 2 of this report.

2.5.13 Austria

Gross natural gas consumption scenarios in Austria show three trends developed by ENTSO which do not show significant differences in 2040. It is expected that consumption will decline after 2025 and will amount to between 12,8 and 15,7 TWh in 2040. The National Energy and Climate Plan does not publish Gross final energy supply by fuel or final energy consumption by fuels.

Table 65. Comparison of national natural gas consumption scenarios in Austria, GWh

GWh	2020	2025	2030	2035	2040
ENTSO 2020 - National trends	87.330	90.600	84.227	83.079	81.931
ENTSO 2020 - Distributed energy	87.330	90.600	83.252	78.674	74.096
ENTSO 2020 - Global ambition	87.330	90.600	74.935	71.418	67.901

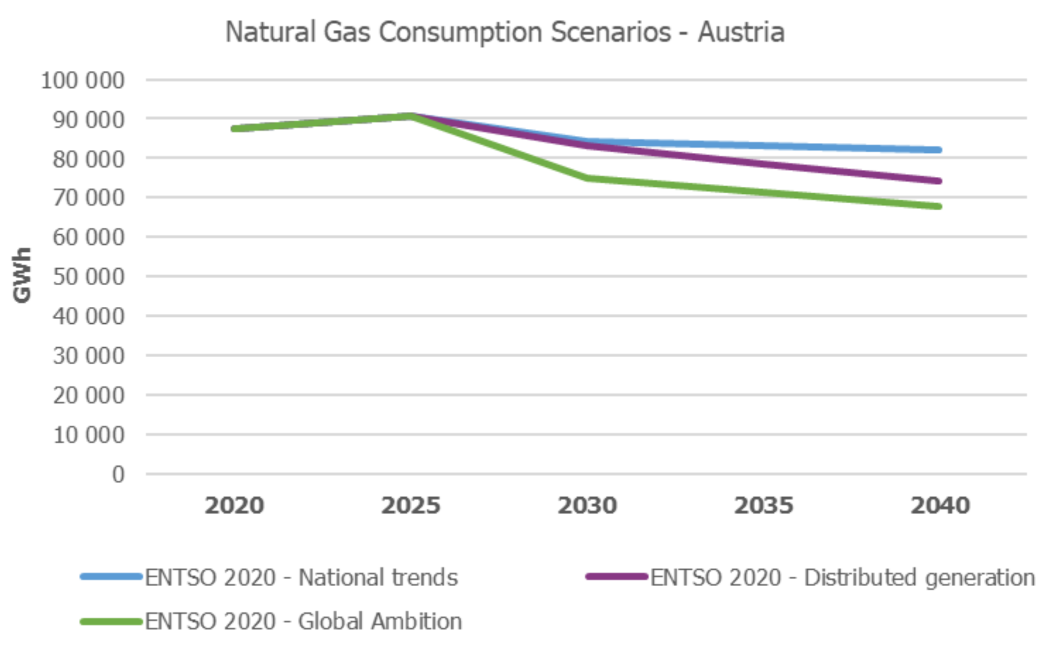


Figure 17. National natural gas consumption scenarios in Austria

Natural gas scenarios are characterized by a significant decrease in natural gas consumption in transformation processes until 2040 when it will be almost 1.8 times less than in 2020. It is expected that most of the consumption will be realized in CHP plants. Final energy consumption will slightly increase until 2040.

The manufacturing industry, non-energy consumption, distribution, and losses have a significant share in total final energy consumption which amounts to approximately 63 percent.

Austria belongs to a group of countries with less favorable climate conditions during wintertime. Average HDDs are 1952, the average HDD index on a typical winter day is 16,3, while the maximum HDD index amounts to 25,9 and is noted on 20th December 2009.

Table 66. Annual and average daily natural gas use by sectors in Austria

Annual natural gas consumption, GWh	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	87.329,9	90.599,5	84.227,4	83.079,4	81.931,3
(1) Power generation	26.199,7	30.119,0	14.965,0	15.340,8	15.716,7
(2) Final energy consumption	61.130,2	60.480,5	69.262,4	67.738,5	66.214,7

Average daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	183,82	192,63	202,12	195,34	202,12
(1) Power generation	16,38	14,01	11,64	9,75	7,86
(2) Final energy consumption	167,48	178,62	189,76	185,59	181,41

Table 67. Peak daily natural gas use in Austria, average winter conditions

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	282,1	*297,2*	312,2	*300,5*	288,7
(1) Power generation	38,36	37,07	35,49	29,73	23,96
(2) Final energy consumption	251,6	*268,3*	285,0	*278,8*	272,5

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	1,5	1,5	1,5	1,5	1,4
(1) Power generation	2,3	2,6	3,0	3,0	3,0
(2) Final energy consumption	1,5	1,5	1,5	1,5	1,5

Table 68. Peak daily natural gas use in Austria, extremely cold circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	373,8	*394,5*	415,3	*403,2*	391,0
(1) Power generation	38,36	37,07	35,49	29,73	23,96
(2) Final energy consumption	337,8	*367,1*	396,4	*387,6*	378,9

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	2,0	2,0	2,1	2,1	1,9
(1) Power generation	2,3	2,6	3,0	3,0	3,0
(2) Final energy consumption	2,0	2,1	2,1	2,1	2,1

Table 69. Peak hourly natural gas consumption in Austria

Peak hourly use, 1000 m^3/h					
Average winter conditions	1.347,76	1.414,58	1.512,44	1.454,40	1.396,42
Extremely cold day – peak	**1.495,10**	**1.578,17**	**1.661,24**	**1.612,62**	**1.564,00**
Extremely cold day – real peak hour	1.785,90	1.878,21	2.011,78	1.951,38	1.891,03

Metered peak load in 2018 is 1.495 thousand m^3/h and this year can be considered as an average year concerning daily heating degree days. Estimate of the peak in extremely cold weather circumstances resulted in a 13 percent demand increase due to a high share of consumers which are not sensitive to weather circumstances.

2.5.14 Slovenia

Natural gas scenario options in Slovenia are elaborated in the recently adopted Integrated National Energy and Climate Plan[5] which includes NECP final scenario and reference scenarios. The trends in consumption are shown in the figure below. Recent national scenarios are significantly less ambitious than ENTSO 2020 scenarios but they emphasize the importance of the use of natural gas in high-efficiency cogeneration heat and power plants.

Table 70. Comparison of national natural gas consumption scenarios in Slovenia, GWh

GWh	2020	2025	2030	2035	2040
ENTSO 2020 - National trends	9.709	14.500	14.308	14.411	14.514
ENTSO 2020 - Distributed energy	9.709	14.500	13.038	14.043	15.049
ENTSO 2020 - Global ambition	9.709	14.500	14.895	16.395	17.895
National estimates 1 - NECP final scenario	7.932	8.217	8.540	9.544	10.762
National estimates 2 - reference scenario	8.250	8.410	9.061	9.830	10.676

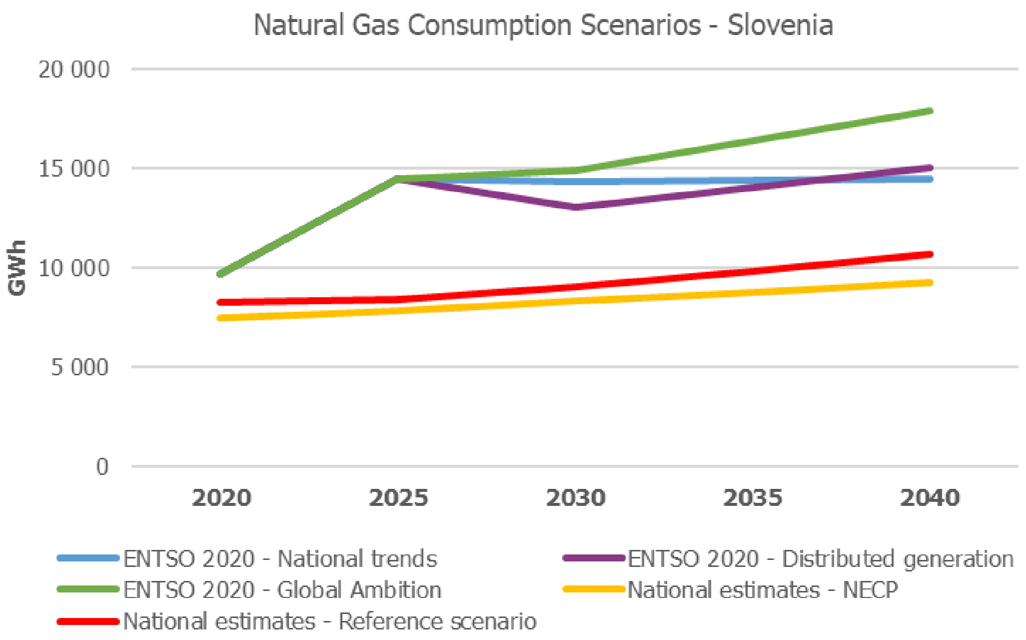


Figure 18. National natural gas consumption scenarios in Slovenia

Natural gas scenarios are characterized by a slight increase in natural gas consumption in transformation processes until 2040. The large share of natural gas use in transformation processes belongs to heat plants whose operation is affected by weather conditions. This type of transformation processes in this study is considered as final consumption.

The manufacturing industry, non-energy consumption, distribution, and losses have a significant share in total final energy consumption which amounts to approximately 85 percent and this makes Slovenia insensitive to weather conditions.

Slovenia belongs to a group of countries with less favorable climate conditions during wintertime. Average HDDs are 1900, the average HDD index on a typical winter day is 16,3, while the maximum HDD index amounts to 32,1 and is noted on 12th January 2012.

[5] https://ec.europa.eu/energy/sites/ener/files/documents/si_final_necp_main_en.pdf

Table 71. Annual and average daily natural gas use by sectors in Slovenia

Annual natural gas consumption, GWh	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	7.438,1	7.855,4	8.320,9	8.740,2	9.229,2
(1) Power generation	740,4	798,0	904,0	1.060,3	1.286,3
(2) Final energy consumption	6.697,8	7.057,3	7.416,9	7.679,9	7.942,9

Average daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	19,4	*20,5*	21,6	*22,5*	23,5
(1) Power generation	1,0	1,1	1,2	1,5	1,8
(2) Final energy consumption	18,4	19,3	20,3	21,0	21,8

Table 72. Peak daily natural gas use in Slovenia, average winter conditions

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	29,6	*31,5*	33,4	*35,3*	37,2
(1) Power generation	3,5	3,8	4,3	5,1	6,2
(2) Final energy consumption	26,4	*27,8*	29,2	*30,3*	31,3

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	1,5	1,5	1,5	1,6	1,6
(1) Power generation	3,5	3,5	3,5	3,5	3,5
(2) Final energy consumption	1,4	1,4	1,4	1,4	1,4

Table 73. Peak daily natural gas use in Slovenia, extremely cold circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	31,8	*34,3*	36,8	*38,7*	40,6
(1) Power generation	3,5	3,8	4,3	5,1	6,2
(2) Final energy consumption	29,9	*31,5*	33,2	*34,3*	35,5

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	1,6	1,7	1,7	1,7	1,7
(1) Power generation	3,5	3,5	3,5	3,5	3,5
(2) Final energy consumption	1,6	1,6	1,6	1,6	1,6

Table 74. Peak hourly natural gas consumption in Slovenia

Peak hourly use, 1000 m^3/h					
Average winter conditions	120,0	127,6	135,2	142,9	150,7
Extremely cold day – peak	129,0	139,0	149,0	156,9	164,8
Extremely cold day – real peak hour	171,5	184,9	198,2	208,7	219,1

The ratio between peak load in extreme weather conditions and average daily consumption calculated from national estimated forecasts will remain quite stable in the planned period. The ratio between the peak daily consumption in average weather (winter) circumstances and extremely cold weather circumstances is only 7 percent and results from the specific structure of consumption which is not sensitive to weather conditions.

2.5.15 Hungary

Gross natural gas consumption scenarios in Hungary exhibit three trends developed by ENTSO which do not show significant differences in 2040, in fact, they are equal. It is expected that consumption will decline after 2020 and will amount to approximately 68 TWh in 2040. The National Energy and Climate Plan does not publish gross final energy supply by fuel or final energy consumption by fuels.

Table 75. Comparison of national natural gas consumption scenarios in Hungary, GWh

GWh	2020	2025	2030	2035	2040
ENTSO 2020 - National trends	125.341	121.596	92.345	79.753	67.160
ENTSO 2020 - Distributed energy	125.341	121.596	74.831	70.197	65.564
ENTSO 2020 - Global ambition	125.341	121.596	75.071	71.613	68.154

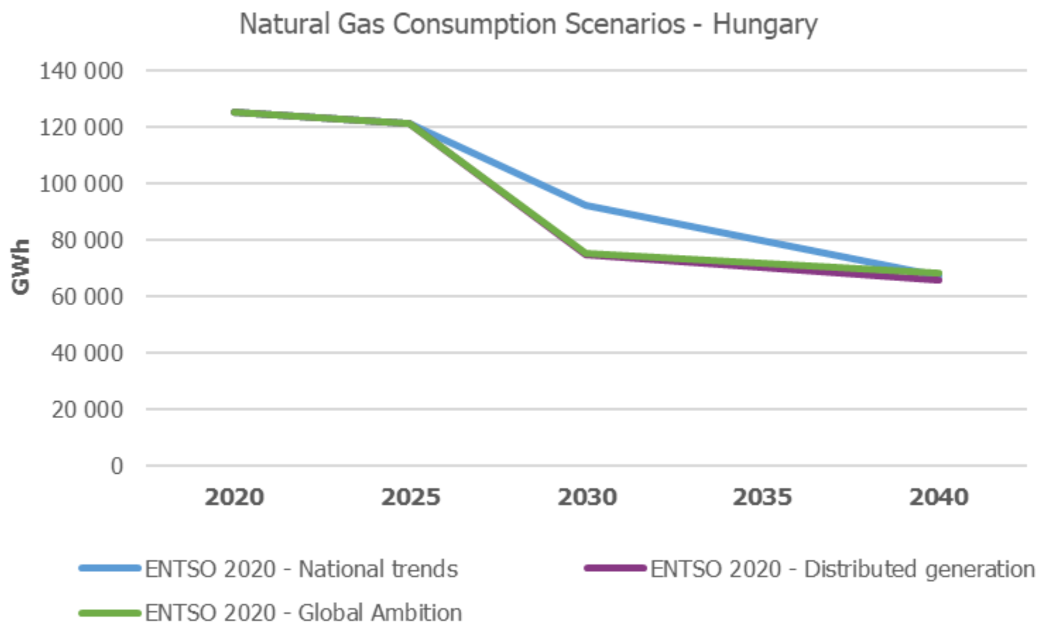


Figure 19. National natural gas consumption scenarios in Hungary

Natural gas scenarios are characterized by a significant decrease in natural gas consumption in transformation processes until 2040 when it will be nearly half the value in 2020. It is expected that most of the consumption will be realized in CHP plants. Final energy consumption will slightly increase until 2040.

The manufacturing industry, non-energy consumption, distribution, and losses have a significant share in total final energy consumption which amounts to approximately 44 percent.

Hungary belongs to a group of countries with less favorable climate conditions during wintertime. Average HDDs are 2207, the average HDD index on a typical winter day is 16,3, while the maximum HDD amounts to 32,1 and is noted on 2nd February 2017.

Table 76. Annual and average daily natural gas use by sectors in Hungary

Annual natural gas consumption, GWh	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	125.341,0	121.596,3	92.345,0	79.752,5	67.160,0
(1) Power generation	20.075,0	19.870,8	10.585,0	10.402,5	10.220,0
(2) Final energy consumption	105.266,0	101.725,5	81.760,0	69.350,0	56.940,0

Average daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	304,74	270,21	236,36	199,75	236,36
(1) Power generation	16,38	14,01	11,64	9,75	7,86
(2) Final energy consumption	288,40	256,20	224,00	190,00	156,00

Table 77. Peak daily natural gas use in Hungary, average winter conditions

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	461,5	*412,3*	363,0	*307,0*	251,0
(1) Power generation	38,36	37,07	35,49	29,73	23,96
(2) Final energy consumption	433,2	*384,9*	336,5	*285,4*	234,3

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	1,5	1,5	1,5	1,5	1,1
(1) Power generation	2,3	2,6	3,0	3,0	3,0
(2) Final energy consumption	1,5	1,5	1,5	1,5	1,5

Table 78. Peak daily natural gas use in Hungary, extremely cold circumstances

Peak daily consumption, GWh/day	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	617,7	*552,3*	486,8	*412,4*	337,9
(1) Power generation	38,36	37,07	35,49	29,73	23,96
(2) Final energy consumption	581,8	*524,8*	467,9	*396,9*	325,8

Table 79. Ratio between peak daily use in extremely cold circumstances and average consumption

Peak daily/average daily consumption	*2020*	*2025*	*2030*	*2035*	*2040*
Gross Energy Consumption	2,0	2,0	2,1	2,1	1,4
(1) Power generation	2,3	2,6	3,0	3,0	3,0
(2) Final energy consumption	2,0	2,0	2,1	2,1	2,1

Table 80. Peak hourly natural gas consumption in Hungary

Peak hourly use, 1000 m³/h					
Average winter conditions	1.128,31	1.188,60	1.248,90	1.201,91	1.154,92
Extremely cold day – peak	1.495,10	1.578,17	1.661,24	1.612,62	1.564,00
Extremely cold day – real peak hour	2.998,01	2.679,45	2.374,79	2.008,09	1.641,58

Peak load in 2020 is estimated at 2.998 thousand m^3/h and this year can be considered as an average year concerning daily heating degree days. Estimate of the peak in extremely cold weather circumstances resulted in a 13 percent demand increase due to a high share of consumers which are not sensitive to weather circumstances.

2.6 Conclusions, recommendations and follow up

The analysis of forecasts in **Albania** is grounded on the scenario developed in the framework of the previous EE-NGP study "*Optimization of the Regional Gas System to Reach Lowest Cost Maximum Diversification of Gas Supply for Target Year 2040*" as the ENTSO's estimate has not been developed yet. The results shown in this study are not entirely finalized due to the lack of appropriate data from the EMI working group. Scenarios that the EMI group prepares are currently in the development phase and analysis in this study is based on the first draft results for 2020, 2025, and 2030. Similar approaches and results are achieved in **Kosovo** and **Montenegro**.

Natural gas consumption forecasts in **Bosnia and Herzegovina** are based on a national Reference scenario which assumes an increase in final consumption but not consumption in the power sector. Peak load ratios in Bosnia and Herzegovina are the highest among partner countries and amount to 4,1 in the base year 2020 due to the dominant use of natural gas in final consumption, mostly for heating purposes. It decreases slightly to 3,6 until 2040 due to an increase in consumption in the manufacturing industry. This analysis is performed using good quality data provided by BH Gas. The calculated peak in extremely cold weather circumstances shows a demand of about 114.000 m^3/h. This can be considered as theoretical demand as BH-Gas reports that the current technical capacity is 80.000 m^3/h. The final peak load scenario which is used for technical optimization is based on Reference 2 scenario.

The new national scenario in **Croatia** which is adopted in NECP shows significant differences and reductions in consumption compared to assessments made in 2018 and the ENTSO 2020 national scenario. The reason for this change is the continuous adaptation of national policy to EU's targets and goals.

The analysis of scenarios in **Greece** shows a similarity between the national and ENTSO approach, particularly in the planning period 2030 - 2040. The biggest deviation appears in estimating peak loads where the ENTSO's estimates lower peaks than real, measured values.

Forecasting of consumption and loads in **Bulgaria** is based on expert assumptions for final energy consumption and EMI data for the power sector. It should be noted here that ENTSO's approach shows significant differences in modelling consumption categories compared to official statistics which should be used as the base for planning processes. For example, in 2018 official statistics shows consumption in the power sector of about 7.676 GWh, while ENTSO presents consumption for the same year in the amount of 17.251 GWh. A similar, but reverse situation is true for final consumption. Only about 25 percent of total natural gas use in Bulgaria is sensitive to weather circumstances. Extreme weather conditions do not have a large impact on total consumption and on peak demand.

Scenarios in **North Macedonia** are modelled based on data provided by GAMA, the national TSO. The national consumption scenario used for estimating peak loads in the frame of this activity significantly differs from ENTSO's scenario which shows almost 55 percent higher consumption, and consequently, the peak loads also differ significantly. Therefore, a new scenario has been developed for this study considering the gas consumption forecast from the new energy strategy.

Poland has the highest consumption and demand scenarios among the target countries. The extreme peak is estimated at around 5,065 mil. m^3/h in 2020, while ENTSO's estimates are 4,307 mil. m^3/h.

In **Romania**, estimated peak loads in extremely cold winter conditions range from 2.6 mil. m^3/h in 2020 to 2.4 mil. m^3/h in 2040. The Romanian natural gas system relies significantly on final energy consumption and as a result it is considered as very sensitive. It is estimated that in the cases of extreme temperature real hourly peak lows can be 50 percent higher than average daily peak hours. These estimates are similar to ENTSO's estimates - 2,791 mil. m^3/h.

Peak loads in **Austria, Slovenia** and **Hungary** present only rough estimates of possible situations and the deviation of consumption in extreme weather circumstances from normal winter conditions. In the cases of these three countries, ENTSO's scenario does not distinguish properly the power sector from the total transformation sector.

3 EVALUATION OF SUPPLY AND GAS SYSTEM DEVELOPMENT OPTIONS

The target region contains numerous potential gas infrastructure projects. Many of these projects are in the final phases (near commissioning), some are under construction and some are just being conceptualized.

One of the goals of this study is to identify all relevant gas infrastructure projects in EE-NGP countries. Relevant projects are considered to be those projects that are either part of the national network development plans or are part of the regional gas infrastructure development initiatives such as Projects of the Energy Community Interest (PECI), Projects of Mutual Interest (PMI) and Projects of Common interest (PCI). The result of this task is the EE-NGP publication "EE-NGP *Catalog of Potential Eastern European Natural Gas Investment Projects in Support of the Three Seas Initiative.*"

Each of the projects detailed in this catalog have been incorporated into the EE-NGP Max 2040 Natural Gas Transmission Network Planning Model and have been analyzed in terms of their technical characteristics, their contribution to diversification of energy supply and to the regional gas market development.

During this task the goal was to collect the technical and selected financial parameters for each of the identified projects. The following three types of projects were identified:

- Supply points such as new production facilities, LNG, and UGS facilities. The following information was collected:
    - For Underground Gas Storage projects (UGS): project name, country, UGS facility type, project promoter, maturity status, project phase, working gas volume (mcm), withdrawal capacity (mcm/d), injection capacity (mcm/d), investment costs, annual operating and maintenance costs.
    - For Liguified Natural Gas facilities (LNG): project name, country, project promoter, maturity status, project phase, reloading ability, yearly volume (bcm/y), project ship size (m^3 LNG), project storage capacity (m^3 LNG), investment costs, annual operating and maintenance costs.
    - For New production facilities: no new production facilities have been identified.
- Pipeline infrastructure for which we collected the following data: project name, country, project promotor, maturity status, commissioning year, investment costs, annual operating and maintenance costs, length, diameter, start point, endpoint, capacity at entry and exit points
- Compressor stations for which we collected the following data: project name, country, project promotor, maturity status, commissioning year, investment costs, annual operating and maintenance costs.

We relied on the following sources:

- Data provided within the Ten-Year Network Development Plans of EE-NGP members.
- Data provided within the PECI and PMI projects;

- Data provided by EE-NGP members. Following the collection of data from publicly available sources, NGP partners were asked to verify the data and make corrections or additions, as necessary.

Based on a preliminary analysis of the data, we collected a total of 47 projects[6]. The list of projects is below. .

3.1 Review of LNG projects

We identified three LNG projects that are planned to be constructed or updated:

1. Croatia, LNG Terminal Krk.
2. Greece, LNG Terminal Alexandroupolis.
3. Poland, upgrade of the LNG Terminal Świnoujście.

To have an accurate presentation of the facilities, it would be desirable to have the following additional information for LNG projects:

- Geo-coordinates of all facilities,
- Annual operating and maintenance costs for all terminals,
- Investment costs for LNG terminals in Alexandroupolis and Świnoujście.

Unfortunately, such data was not available to the authors. The reason is that EE-NGP group consists of TSO members that do have technical characteristics of the LNG terminals but not financial and operating. Financial and operating characteristics could only be provided by the LNG operators, who are not members of the EE NGP group.

3.2 Review of UGS projects

We identified ten underground gas storage facilities that are planned to be constructed:

1. Romania, Bilciuresti
2. Romania, Targu Mures, two phases
3. Romania, UGS SARMASEL
4. Romania, Ghercesti
5. Romania, Falticeni UGS
6. Bulgaria, UGS Chiren
7. Croatia, Grubisno Polje
8. Greece, South Kavala
9. Poland, UGS Damasławek
10. Slovakia, Underground Gas Storage Velke Kapusany.

The following additional information would improve the accuracy of the presented data:

- Geocoordinates of the facilities. This is particularly important as the existing data does not allow for precise positioning of the facilities on the existing networks (e.g., it appears that some facilities require additional investments in the pipeline infrastructure to be connected to the network).

[6] A project between two countries where each country builds its own part is considered a single project

- Investment costs (except for UGS Chiren and UGS Velke Kapusany) and annual operating and maintenance costs (except for UGS Velke Kapusany).

Unfortunately, such data was not available to the authors. The reason is that EE-NGP group consists of TSO members that do have technical characteristics of UGS but not financial and operating. Financial and operating characteristics could only be provided by the UGS operators, who are not members of the EE NGP group.

3.3 Review of compressor station projects

We identified the following investments in reconstruction or construction of new compressor station points:

1. Compressor station 1 in the Croatian gas transmission system (TYNDP code: TRA-F-334)
2. Compressor stations 2 and 3 in the Croatian gas transmission system (TYNDP code: TRA-N-1057)

3.4 Review of pipeline projects

We identified the following pipeline projects:

1. Northern Interconnection of BiH and Croatia (TYNDP codes - HR: TRA-N-66 and BH: TRA-N-224)
2. Western Interconnection of BiH and Croatia (TYNDP codes - HR: TRA-N-303 and BH: TRA -N-910)
3. Southern Interconnection of BiH and Croatia (TYNDP codes - HR: TRA-A-302 and BH: TRA-N-851)
4. Gas Interconnector Serbia (Inđija) - Republic of Srpska (Janja)
5. North Macedonia - Greece Interconnector (TYNDP codes - MK: TRA-A-980 and GR: TRA-A-967)
6. North Macedonia - Kosovo interconnector. There are two projects, stated below.
    a. TYNDP codes MK: TRA-N-966 from Skopje Sever to Blace.
    b. The second interconnection extends from Glumovo-Matka to Vorba.
7. Serbia - North Macedonia (PECI Gas_11)
8. North Macedonia - Albania that consists of two projects:
    a. From Bitola to Struge
    b. From Struge to Kjafasan
9. North Macedonia - Bulgaria
10. Romania - Serbia (TYNDP code RU: TRA-A-1268)
11. Balkan Gas Hub - Interconnection Bulgaria - Serbia (TYNDP code for RU: TRA-N-137
12. Interconnection Croatia-Serbia (Slobodnica-Sotin-Bačko Novo Selo) (TYNDP code for HR: TRA-A-70)
13. Albania - Kosovo* Gas Pipeline (ALKOGAP)
14. Ionian Adriatic Pipeline (Fier, AL - Split, HR)
15. Interconnection Croatia-Slovenia (Umag-Koper) (TYNDP code: TRA-N-336)

16. Krk LNG terminal with connecting and evacuation pipelines towards Hungary and beyond (TYND code: TRA-F-90, TRA-N-75, TRA-N-1058)
17. Interconnection Slovenia-Croatia (Gas pipeline Lučko-Zabok-Rogatec) (TYNDP code: TRA-A-86)
18. Poland - Ukraine interconnection (TYNDP code: TRA-A-561, TRA-A-621)
19. Poland - Slovakia interconnection (TYNDP code: TRA-F-190, TRA-F-275)
20. Poland - Lithuania interconnection (TYNDP code: TRA-F-212)
21. Poland - Denmark interconnection (TYNDP code: TRA-A-271)
22. Poland - Czech Republic interconnection (TYNDP code: TRA-A-273)
23. Greece - Bulgaria interconnection (TYNDP code: TRA-F-378)
24. Slovak - Hungarian capacity increase (TYNDP code: TRA-N-524)
25. Romania - Hungary reverse flow (TYNDP code: TRA-F-286)
26. Interconnection Italy - Slovenia - Hungary (TYNDP code: TRA-N-108, TRA-N-325)
27. Interconnection Hungary - Austria (TYNDP code: TRA-N-423)
28. Interconnection Austria - Slovenia (TYNDP code: TRA-N-389, TRA-A-21)
29. Eastring (TYNDP code: TRA-A-628, TRA-A-654, TRA-A-655, TRA-A-656)
30. Romania - Ukraine interconnection (TYNDP code: TRA-F-378)
31. Black Sea gas pipeline (TYNDP code: TRA-A-362)
32. BRUA Phase II (TYNDP code: TRA-N-959)

4 UPDATE OF THE SIMONE REGIONAL GAS TRANSMISSION SYSTEM MODEL

The main tool used by the EE-NGP for technical hydraulic optimization is the Max 2040 Regional Natural Gas Transmission Network Planning Model which utilizes the SIMONE gas network simulation planning software. Going into this study, the 8 original EE-NGP members had already submitted their natural gas transport networks which were incorporated into the EE-NGP model.

The scope of this study increased significantly and in order to be able to perform the optimization of technical development options, new countries needed to be added. Those countries include new EE-NGP members (Greece, Poland, Romania and Slovakia) and Austria, Hungary and Slovenia.

Due to the unavailability of detailed national models from the non-EE-NGP members, those networks had to be simplified, but had to retain their physical properties for a precise optimization. Since some of the EE-NGP members are cut off from the rest of the group, their networks were modelled in the same manner as for non-EE-NGP members. This is due to the consistency between countries, since implementing a complicated model amidst simplified models would result in balancing issues, gaps and other unaccountable problems.

The networks were modelled by implementing all available data including TSO information, ENTSO-G information and Transparency Platform, maps, etc. Furthermore, existing parts of the model were used and spliced to preserve lengths and to produce the most accurate result. Due to the unavailability of mapped consumption data, consumption was condensed into three points: distribution, industry and power generation (with exports for border members). Likewise, supply points were simplified into one point for: domestic production and UGS (with imports for border members). The simplification of the supply/demand points does not heavily affect the goal of the study which is the optimization of the infrastructure for maximizing North-South/South-North throughput as well as maximizing security of supply and supply source diversification.

Eight countries were members during the first phase of the Partnership. Detailed national networks were modelled and obtained through coordination with respective TSOs. Three members – Greece, Romania and Poland joined during and after the first phase. Simplified, but detailed networks from Greece and Romania were incorporated into the regional model. Networks from Austria, Slovenia, Hungary, Slovakia and Poland were also added, but in a more simplified manner to aid in necessary study calculations.

Prior to to this study the model contained 7,271 nodes (out of which 33 were supply nodes), and 3,318 elements (out of which 1,880 were pipes). The updated model now contains 8,513 nodes (out of which 148 are supply nodes) and 4,435 elements (out of which 2,384 are pipes).

The elements in the image below shown in pink are the added elements to the network used in the previous study.

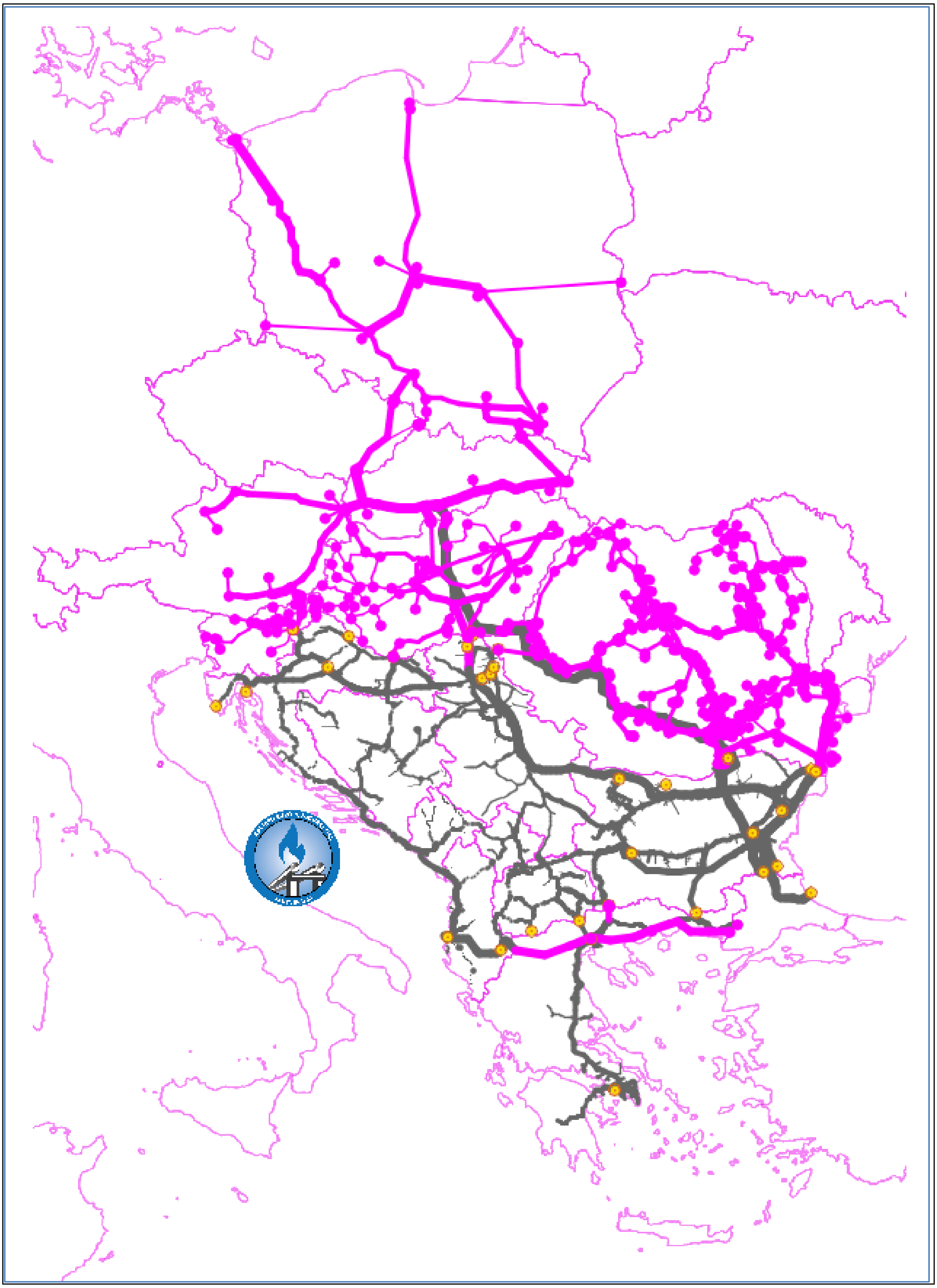


Figure 20. The updated EE-NGP Max 2040 Regional Natural Gas Transmission Planning Model. The elements in pink have been added for this study.

5 OPTIMISATION OF TECHNICAL DEVELOPMENT OPTIONS

This chapter provides the results of the technical optimization of the proposed gas infrastructure development options in the area observed. Considering the existing gas infrastructure, and the proposed new gas infrastructure projects, SIMONE software is used to analyze the possibility of the regional gas infrastructure to transport required gas quantities and to identify possible technical shortcomings that limit free gas flows between the four seas.

The observed region contains numerous potential gas infrastructure projects. Many of these projects are in the final phases of implementation or near commissioning, some are under construction and some are just being conceptualized. The proposed new gas infrastructure projects are identified and listed in chapter 3 of this report and presented in more detail in the *Catalog of Potential Eastern European Natural Gas Investment Projects in Support of the Three Seas Initiative*. The projects identified in the Catalog are incorporated in the EE-NGP Max 2040 Regional Natural Gas Transmission Planning Model used for the hydraulic simulation and optimization of the technical development.

Based upon the detailed analysis of the demand forecasts presented in chapter 12, the following demand data were selected to be used for further analysis:

Table 81. Total peak natural gas demand by countries

Country	Unit	2020	2025	2030	2035	2040
Albania	[Nm3/h]	0	79 100	141 540	230 854	335 557
Austria*	[Nm3/h]	2 275 156	2 244 732	2 447 430	2 314 327	2 181 225
Bosnia and Herzegovina	[Nm3/h]	79 750	155 886	196 593	281 863	328 992
Bulgaria	[Nm3/h]	669 910	686 661	759 346	815 027	870 708
Croatia	[Nm3/h]	824 001	839 759	686 307	657 495	628 683
Czech Republic*	[Nm3/h]	2 967 290	3 231 571	2 441 589	2 911 014	3 380 440
Greece	[Nm3/h]	1 231 105	1 466 711	1 536 682	1 361 595	1 314 574
Hungary*	[Nm3/h]	3 427 181	3 299 649	2 207 944	1 902 301	1 596 658
Kosovo	[Nm3/h]	0	3 341	26 722	61 562	119 357
Montenegro	[Nm3/h]	0	1 944	38 350	66 032	88 558
North Macedonia	[Nm3/h]	75 280	153 413	189 734	228 503	237 173
Poland	[Nm3/h]	4 307 009	4 562 287	4 834 327	5 579 097	6 323 867
Romania	[Nm3/h]	2 624 611	2 704 332	2 659 657	2 725 360	2 791 063
Serbia	[Nm3/h]	662 237	784 961	925 818	926 131	926 444
Slovakia	[Nm3/h]	1 191 338	1 477 323	1 363 236	1 343 313	1 323 390
Slovenia*	[Nm3/h]	223 910	299 939	305 296	305 551	305 807
Total	**[Nm3/h]**	**20 558 776**	**21 991 608**	**20 760 570**	**21 710 024**	**22 752 494**

** - not members of the EE-NGP*

The demand data presented above are the result of the gas demand forecasting made within this study or the result of the ENTSO-G National Trends scenario and are agreed with the EE-NGP partner countries' representatives. ENTSO-G and ENTSO-E cooperated among them on the demand scenarios development since there are strong synergies and co-dependency between gas and electricity infrastructures. The National Trends scenario is the central policy scenario, which is designed to reflect the most recent EU member state National Energy and Climate Plans (NECP). Also, this scenario is developed with more in-depth analysis as compared to the other scenarios.

Gas supply data used for the gas system optimization in the EE-NGP Max 2040 Regional Natural Gas Transmission Planning Model are based on the current technical capacities of the main gas supply routes for the observed region, considering the planned increase in capacities, both of existing and planned gas infrastructure. This includes all gas supply pipelines, LNG terminals, domestic production, and underground gas storage facilities, which are a very important part of the gas infrastructure enabling the security of gas supply during the peak demand.

Gas supply quantities from the existing and the planned LNG terminals and underground gas storage facilities are based on the available data from transparency platforms, project promotors, etc. The planned new LNG terminals and UGS's, or the projects that bring capacity expansion for the existing ones are also listed in the Catalog.

The data for the domestic gas production forecast by countries are based on the publicly available data, inputs from the EE-NGP partners, and ENTSO-G domestic gas production forecast under the National Trends scenario. Domestic gas production in the region is expected to decrease. However, in the period up to 2030, it is expected to increase on the back of new planned Romanian production from the Black Sea, which is expected to contribute gas supply to the regional gas system by 2025.

The North-South Gas Corridor in this context refers to gas infrastructure connections between the Baltic Sea and Poland and countries with coastlines on the Adriatic, Aegean, and Black Seas, notably Croatia, Greece, and Romania. To be more specific, it assumes connecting Poland's LNG terminal at Świnoujście with Croatia's LNG terminal, Romanian new gas production in the Black Sea, the LNG terminals in Greece, and the Southern Gas Corridor.

Historical development of the gas pipeline infrastructure in the EU lead to a lack of North-South connections. Today, new gas supply routes, the Southern Gas Corridor and the TurkStream pipeline, as well as new LNG supplies, provide the ability to ensure a radical diversification of European gas supply.

5.1 Pipelines

The Southern Gas Corridor includes the Trans Anatolian Gas Pipeline (TANAP) and the Trans Adriatic Pipeline (TAP), which brings Caspian gas from the Shah Deniz gas field to Greece, Albania, and further on to Italy.

Figure 21. Map of TANAP

Figure 22. Map of TAP

When at the border of Europe, that gas needs connecting infrastructure to penetrate the existing gas network. The most important planned infrastructure in this case, are the Ionian Adriatic Pipeline (IAP), Greece-Bulgaria Interconnection, and to a lesser extent Greece-North Macedonia Interconnection.

The Ionian Adriatic Pipeline is an important regional project intended to connect the existing gas transmission system in Croatia with the Trans Adriatic Pipeline, and will establish a new supply route for Caspian gas to head north to markets in Central Europe. It is also a precondition for the gasification of Albania and Montenegro, which could also be supplied by gas from Croatia's LNG terminal, if necessary.

Figure 23. Map of IAP

The Greece-Bulgaria Interconnection and Greece-North Macedonia Interconnection enables gas flows from TAP to the north via Bulgaria towards Romania and Serbia, or via North Macedonia to Kosovo (and perhaps Serbia, if the North Macedonia-Serbia Interconnection in place).

Figure 24. Map of Greece-Bulgaria Interconnection

Furthermore, the Bulgaria-Serbia Interconnection, which is planned to be commissioned in 2023, as well as the increased capacity of the existing interconnection Bulgaria-Romania enables higher gas flows from the TurkStream, TANAP/TAP, or LNG terminals in Greece towards Serbia and Romania and further to Europe.

Figure 25. Map of Bulgaria-Serbia Interconnection

The next main gas supply pipeline to the region is the TurkStream pipeline, which connects the large gas reserves in Russia to the Turkish gas transmission network. With a technical capacity of 31.5 bcm (15.75 bcm to Europe, 15.75 bcm to Turkey), it is the largest pipeline project in the region. This pipeline brings diversification in terms of supply routes, but it does not provide diversification of gas sources to the region since it brings Russian gas. This pipeline was commissioned in 2019 and has replaced gas supply via Ukraine since January 1st, 2020 (at least for this part of the region).

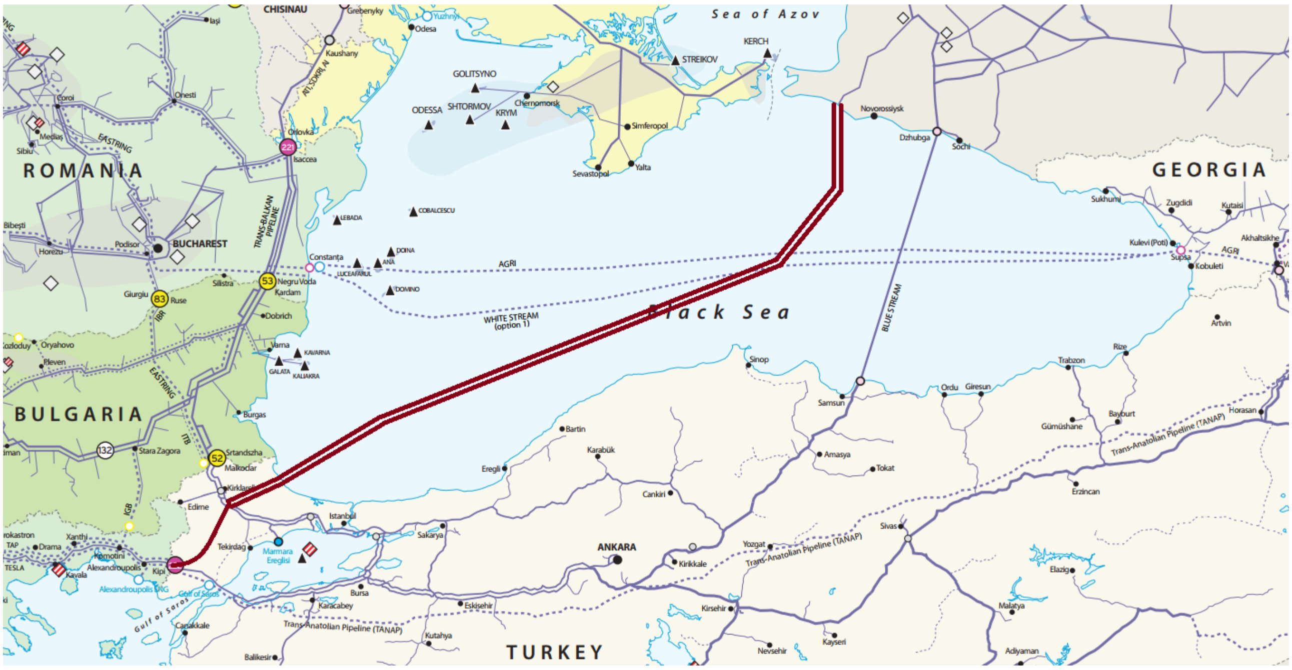


Figure 26. Map of the TurkStream pipeline

When in Europe the gas is transiting through Bulgaria, Serbia, Hungary to Austria through the so-called SouthStream Lite route, since the route is very similar to the route of the scrapped SouthStream project. The part of the pipeline which traverses Bulgaria is named "Balkan Stream", while the part in Serbia is named "Interconnector Bulgarian border-Hungary border". The pipeline originates from the Turkish-Bulgarian border and it is de facto an extension of the TurkStream.

Figure 27. Map of the BalkanStream pipeline

The next big project envisaged is the 1,208 km long bi-directional Eastring pipeline, connecting Turkey and Slovakia, via Bulgaria, Romania, and Hungary. The initial capacity should provide 20 bcm in 2025, and up to 40 bcm with additional compressor stations in the second phase from 2030. There are two offtake points planned in Bulgaria, each one with a capacity of 3.3 bcm per year. This pipeline provides an opportunity for diversification of transmission routes as well as supply sources since it will bring gas from new sources from the Caspian/eastern Mediterranean/Black Sea/Middle East region. At the same time, it will provide Southeast Europe with gas from European gas hubs.

Figure 28. Map of the Eastring pipeline

5.2 LNG Supplies

One of the cornerstones of increasing security of supply and supply source diversification are liquid natural gas (LNG) regasification terminals. These terminals enable the import of natural gas via shipping from any natural gas exporting country which has liquefication capabilities and access to the sea. This enables a large variety of partners increasing source diversification and minimizing the impact pipeline disruptions might have on the system.

In the observed region, there are currently three operating LNG terminals. In the north, on the Baltic Sea, located in the Polish city of Świnoujście is the Polskie LNG terminal. Its annual regasification capacity is 5 bcm. In 2020, the total amount of LNG gas supplied by the terminal amounted to 3.6 bcm. The terminal's regasification capacity is planned to be expanded to 7.5 bcm/y (additional 2.5 bcm/y).

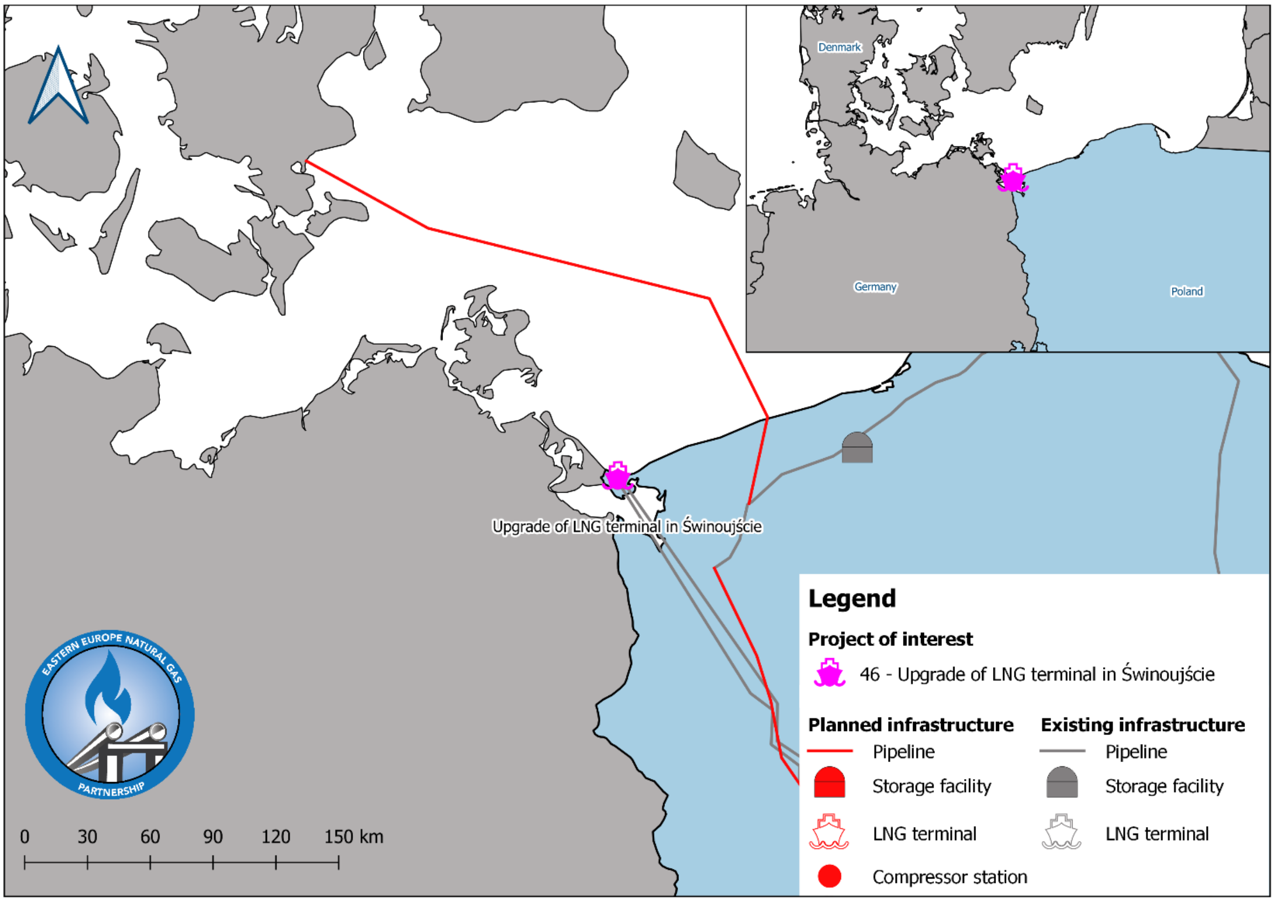


Figure 29. LNG Terminal in Świnoujście

The second LNG terminal is located on Krk Island, off the coast of Croatia in the Adriatic Sea. It began operating in January of 2021. Its annual regasification capacity is 2.6 bcm/y. The regasification capacity increase is planned by 2025. An additional 4.4 bcm is planned to be expanded, reaching a total regasification capacity of 7 bcm/y.

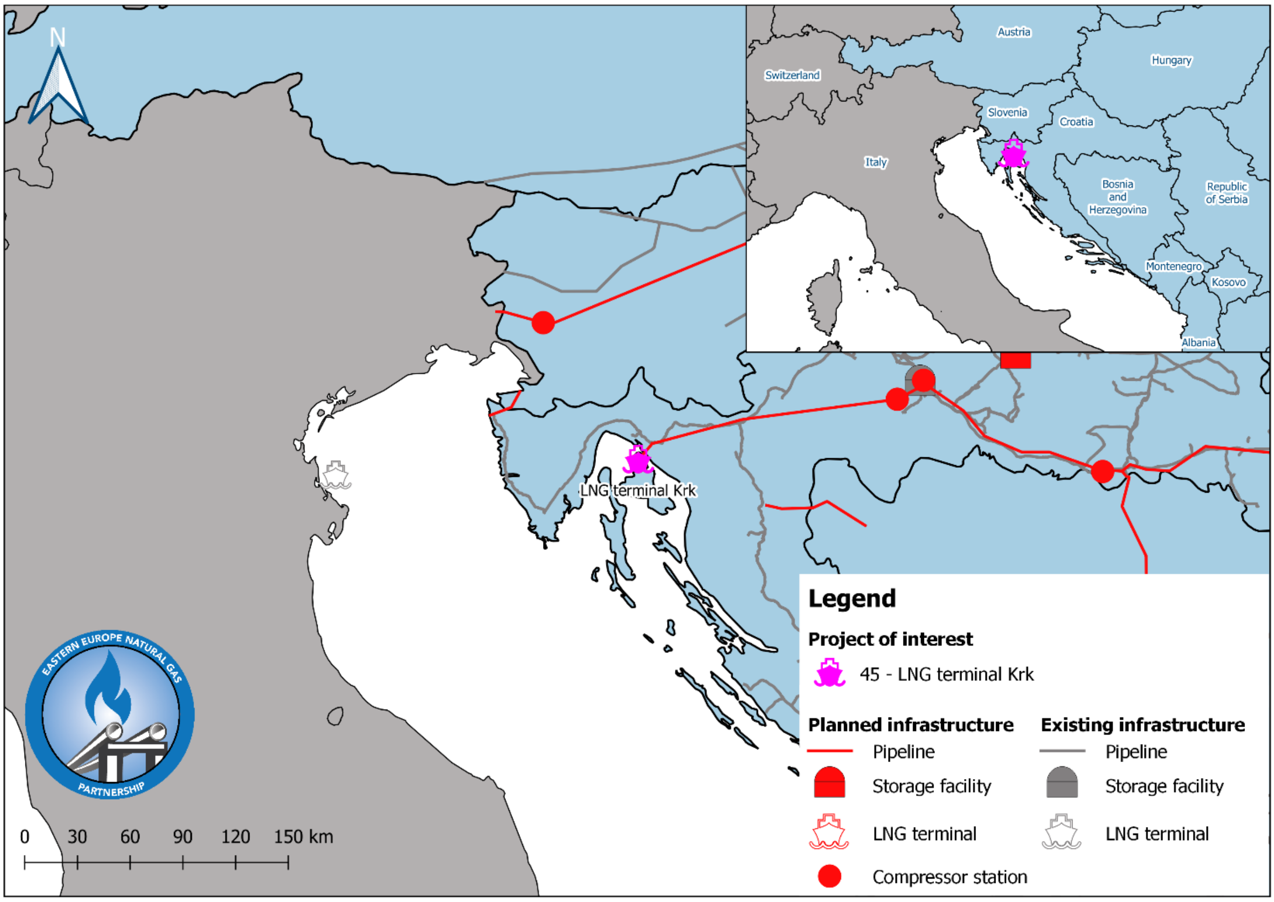


Figure 30. LNG Terminal on Krk Island

The third active LNG terminal in the observed region is located in Greece, near the city of Athens on an island called Revythoussa. Its regasification capacity is 7 bcm annually. In 2020, the terminal regasified a total of 3 bcm.

Figure 31. Revythoussa LNG Terminal

Two more LNG terminals are planned. One near the city of Gdansk in Poland – FSRU Polish Baltic Sea Coast and one near the city of Alexandroupolis in Greece.

The FSRU Polish Baltic Sea Coast is planned to have a regasification capacity of 4.5 bcm/y and is expected to commence operation in 2025.

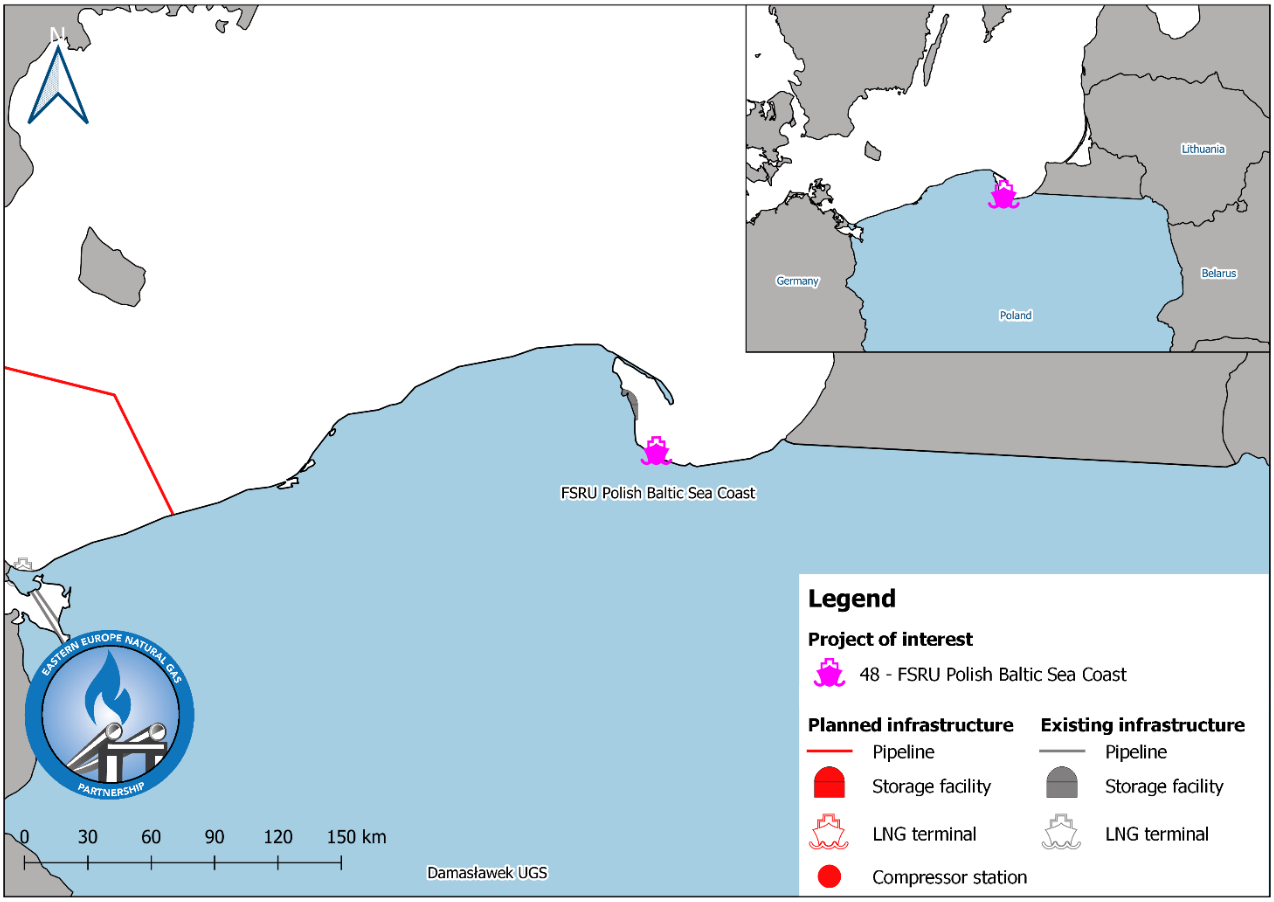


Figure 32. FSRU Polish Baltic Sea Coast

LNG Terminal Alexandroupolis is planned to have a capacity of 8.3 bcm/y. The planned construction year was 2022, but has been delayed.

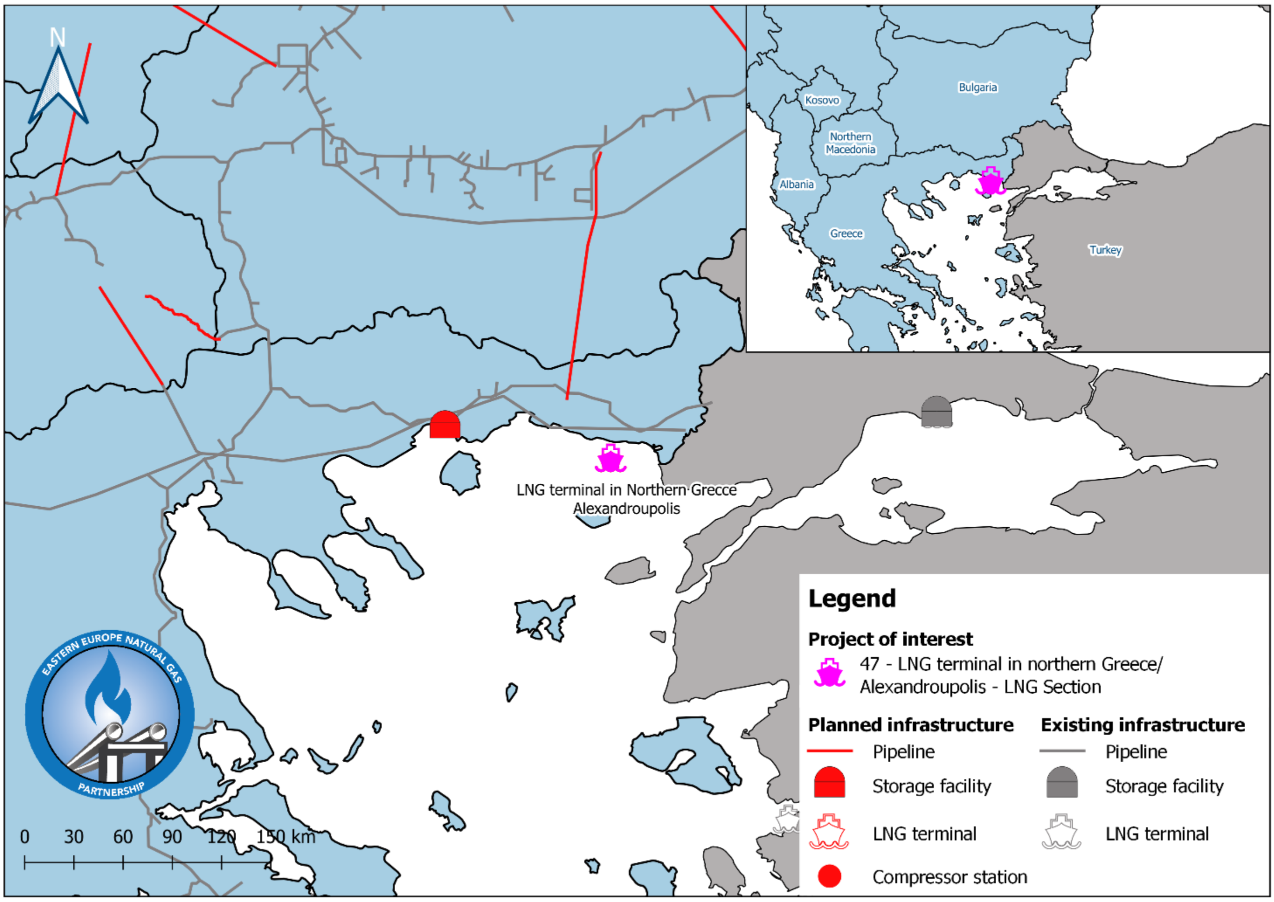


Figure 33. LNG Terminal Alexandroupolis

Considering the total existing and planned regasification capacities in the observed region and the total forecasted demand, we can calculate that LNG supplies could cover about 19% of the region's demand in 2020, and could cover up to 43% of the forecasted gas demand up to 2040. If we consider EE-NGP member countries only, up to 65% of the forecasted demand could be covered by LNG supplies.

5.3 UGS facilities

One of the most important balancing elements during peak demand are underground gas storages (UGS). They enable the user country to physically balance their natural gas network without external intervention. Depending on their size, they also enable continued supply during import pipeline disruption. UGS are the key element of security of supply and network robustness. In the observed network, there are currently 20 underground gas storage facilities.

There are currently 5 individually operated UGS complexes in Austria, totaling 9.55 bcm capacity and 105.9 mcm/d withdrawal capacity:

1. UGS Haidach (astora) - 1.13 bcm capacity, 10.5 mcm/d withdrawal capacity
2. UGS Haidach (GSA) - 2.12 bcm capacity, 20.9 mcm/d withdrawal capacity
3. VGS OMV Gas Storage Pool - 2.53 bcm capacity, 30.4 mcm/d withdrawal capacity
4. RAG Storage Pool - 2 bcm capacity, 22.3 mcm/d withdrawal capacity
5. UGS 7 Fields (Uniper Energy Storage) - 1.75 bcm capacity, 21.9 mcm/d withdrawal capacity.

Figure 34. Locations of UGS in Austria

There is currently only one operating UGS in Bulgaria – UGS Chiren, with 627 mcm capacity and 0.36 mcm/d withdrawal capacity.

The planned expansion of UGS Chiren was due in 2025, but is delayed. The planned expansion capacity would expand Chiren by 1 bcm capacity and 9 mcm/d withdrawal capacity, up to a total capacity of 1.6 bcm and 9.3 mcm/d withdrawal capacity.

Figure 35. Location of UGS Chiren in Bulgaria

In Croatia, there is currently only one operating UGS – UGS Okoli, with 521 mcm capacity and 0.56 mcm/d withdrawal capacity. Planned UGS infrastructure includes the UGS Grubišno Polje, with a capacity of 60 mcm and a withdrawal capacity of 2 mcm/d planned in 2025.

Figure 36. Location of UGS Okoli in Croatia

There are two operating UGS in Hungary, totaling 6.96 bcm capacity and 8.39 mcm/d withdrawal capacity:

1. UGS Szöreg-1 - 2.01 bcm capacity, 2.64 mcm/d withdrawal capacity,
2. VGS MFGT - 4.95 bcm capacity, 5.75 mcm/d withdrawal capacity.

Figure 37. Location of UGS in Hungary

Poland has three operating UGS, totaling 3.58 bcm capacity and 5.96 mcm/d withdrawal capacity:

1. UGS Wierzchowice - 1.47 bcm capacity, 1.58 mcm/d withdrawal capacity,
2. VGS GIM Kawerna - 0.92 bcm capacity, 3.07 mcm/d withdrawal capacity,
3. VGS GIM Sanok - 1.19 bcm capacity, 1.3 mcm/d withdrawal capacity.

The new planned facility is the UGS Damasławek, with 800 mcm capacity and 9 mcm/d withdrawal capacity planned for 2026.

Figure 38. Location of UGS in Poland

Romania has six operating UGS, totaling 3.3 bcm capacity and 3.43 mcm/d withdrawal capacity:

1. UGS Bălăceanca - 54.5 mcm capacity, 0.13 mcm/d withdrawal capacity,
2. UGS Bilciuresti - 1.42 bmc capacity, 1.52 mcm/d withdrawal capacity,
3. UGS Ghercesti - 160 mcm capacity, 0.21 mcm/d withdrawal capacity,
4. UGS Sărmășel - 952 mcm capacity, 0.79 mcm/d withdrawal capacity,
5. UGS Urziceni - 395 mcm capacity, 0.49 mcm/d withdrawal capacity,
6. UGS Târgu Mureş - 1.05 bcm capacity, 0.28 mcm/d withdrawal capacity.

Planned expansions include the UGS Bilciuresti withdrawal capacity increase from 1.52 to 5 mcm/d in 2025; UGS Ghercesti capacity increase from 160 mcm to 610 mcm and withdrawal capacity increase from 0.21 mcm/d to 3.2 mcm/d in 2026; UGS Sărmășel capacity increase from 952 mcm to 1.6 bcm and withdrawal capacity increase from 0.79 mcm/d to 3.8 mcm/d in 2024; and UGS Târgu Mureş withdrawal capacity increase from 0.28 to 2.3 mcm/d in 2024 and to 4.3 later on (but has been delayed).

Furthermore, the implementation of UGS Falticeni, with a capacity of 200 mcm and 2 mcm/d withdrawal capacity is envisioned in 2029.

Figure 39. Location of UGS in Romania

There are two operating UGS in Slovakia, totaling 4.25 bcm capacity and 4.92 mcm/d withdrawal capacity:

1. UGS Láb - 3.56 bcm capacity, 4.19 mcm/d withdrawal capacity,
2. UGS Lab IV - Pozagas - 695 mcm capacity, 0.73 mcm/d withdrawal capacity.

The new planned UGS facility is located near the IP Vel'ke Kapušany. It is a 340 mcm capacity UGS with 4 mcm/d withdrawal capacity in 2023.

Figure 40. Location of UGS in Slovakia

Serbia has one operating UGS - UGS Banatski Dvor, with 5 mcm/d withdrawal capacity. The planned expansion is to increase the daily withdrawal capacity to 10 mcm by 2025.

Figure 41. Location of UGS Banatski Dvor

The only other expansion planned in the region is the South Kavala UGS in Greece, with a capacity of 720 mcm and 8 mcm/d withdrawal capacity. The construction was set for 2023 but is delayed.

Figure 42. Location of South Kavala UGS in Greece

The total existing storage capacities are 29.3 bcm, with planned expansion to 33.5 bcm by 2030. These quantities are sufficient to cover about 43% of the forecasted demand. If we consider EE-NGP member countries only, the total existing storage capacities are 12.8 bcm, with planned expansion to near 17 bcm by 2030, wich covers up to 32% of the forecasted gas demand.

5.4 Domestic gas production

Domestic energy supply is the cornerstone of energy security and sovereignty. Expansion of domestic production should be the strategy of every country where possible.

The planned expansion in the region regarding new gas fields is in the Black Sea, supplying Romania with domestic gas.

Figure 43. Location of Black Sea gas fields off the coast of Romania

The gas is to be supplied to the region and connected to the Romanian gas network via a newly planned gas pipeline (TYNDP: TRA-A-362), in 2022. The gas fields in Romania are planned to supply the region with 7.3 bcm in 2025, reducing to 6.3 bcm in 2030, falling to 4.9 bcm in 2035 and to 3.9 bcm in 2040. These quantities provide a strong contribution to the region both in terms of security of supply, as well as the diversification of gas supply.

5.5 Concluding remarks

Overall gas demand in the region is forecast to increase by 2.4% by 2040 and peak demand is forecasted to increase by 8.2% compared to 2020. Gas demand for power generation is forecast to increase by 31% by 2040 and peak gas demand for power generation by 74%. Gas demand for all other purposes is forecast to decrease by 5% and peak demand to decrease by 5.5% by 2040.

Historical development of the gas pipeline infrastructure in the EU was east-west oriented, which lead to a lack of North-South connections. New gas supply routes to the SEE region, Southern Gas Corridor, and the TurkStream pipeline, as well as new LNG supplies, provide the ability to ensure a radical diversification of European gas supply.

With the planned expansion in regasification capacities, LNG supplies could cover up to 43% of the forecasted gas demand up to 2040. If only EE-NGP member countries are considered, up to 65% of the forecasted demand could be covered by LNG supplies.

The current capacity of the Southern Gas Corridor can provide approximately 20% of the demand, or about 30% if only EE-NGP member countries are considered. With the possible capacity increase, it could cover up to 60% of the EE-NGP member countries' forecasted demand in 2040. However, not all capacities are marked for this region.

To be able to utilize all the supply diversification potential, a planned new gas infrastructure needs to be in place.

The North-South Gas Corridor should enable gas flows between the Baltic, Adriatic, Aegean, and Black Seas. At its northern end, Poland, the Czech Republic, Slovakia, and Hungary can all secure access to alternative supplies by pipelines connecting them to countries farther west. However, interconnections among some of these countries are what needs to be developed.

LNG terminal in Świnoujście is currently able to handle 5 bcm/y of gas imports, with planned expansion to handle a further 2.5 bcm/y, and the additional planned LNG facility to handle 4.5 bcm/y. Considering the total LNG supplies and domestic production of up to 4 bcm/y, up to 70% of Poland's demand in 2040 could be supplied from these sources.

In terms of the North-South gas corridor, according to the available data, Poland cannot send gas to the south, although the "STORK" interconnection with the Czech Republic exists. Therefore, one of the infrastructure projects that should be implemented to enable the North-South gas throughput is the Poland-Czech Republic Interconnection (STORK 2) which is the first missing link that should fill the gap in the existing gas infrastructure on the North-South Corridor. However, considering the information provided by Gaz System, the Polish gas TSO, that the Poland-Czech Republic Interconnection is suspended and should be excluded from the analysis, the conclusion that arises is that the North-South gas corridor has failed at its first bottleneck. The same information was provided for the Poland-Ukraine Interconnection, while the Poland-Slovakia Interconnection is still in the game, presenting the only pipeline that should connect Poland with other countries on the North-South Corridor route.

Considering the planned technical capacity of the Poland-Slovakia interconnection, as well as the ratio of Poland's forecasted gas demand and LNG supply capacities, we could say that this interconnection does not provide diversification in terms of gas supply to the region, but it provides diversification of gas routes enabling gas flows from north to south (Poland to Slovakia), and from south to north, providing access to possibly even Caspian gas from the planned Eastring pipeline to Poland.

Most of the infrastructure further south to Croatia's LNG facility is in place. Interconnection Slovakia-Hungary is in place and Hungary's gas transmission system is connected to all its neighbors, except Slovenia. Interconnection Hungary-Croatia constitutes the southern backbone of a North-South interconnection system. In the Croatia to Hungary gas flow mode, this interconnection plays an important role for gas delivery from Croatia's LNG terminal towards the north. An important gas infrastructure here, providing gas flow to the north is the Croatian compressor station, commissioned at the end of 2019. Interconnections Hungary-Romania and Hungary-Serbia are also in place.

The Krk LNG terminal was commissioned on January 1st, 2021. The initial capacity is 2.6 bcm/y, with plans to provide up to 7 bcm/y in the second phase sometime by 2030. The planned Zlobin-Bosiljevo-Sisak-Kozarac-Slobodnica pipeline is an integral part of the overall Croatian LNG project and an integral part of the North-South Gas Corridor, as an extension of the Hungary-Croatia Interconnection. It is also being designed to connect with the Ionian Adriatic Pipeline.

In the south, the development of new pipelines to connect with offtake points along the Southern Gas Corridor, and with LNG facilities in the Aegean Sea, should be prioritized to enable gas connections throughout the Balkans. Since most of the interconnection pipeline projects planned are in the final development phase or already under construction, what should be "pushed" are the bigger pipelines that enable higher gas flows towards the north. One of these projects is the Ionian Adriatic Pipeline that connects TAP in Albania with the Croatian gas transmission system, and the other one is the Eastring pipeline, which connects Turkey and Slovakia, via Bulgaria, Romania, and Hungary, bringing Caspian gas to the north but also provide gas from European gas hubs to SEE.

Domestic production and the planned expansion in the storage capacities are crucial to provide security of supply during the peak demand. Romania's plan to develop offshore gas resources will strongly contribute to the region both in terms of security of supply and the diversification of gas supply.

6 REFERENCES

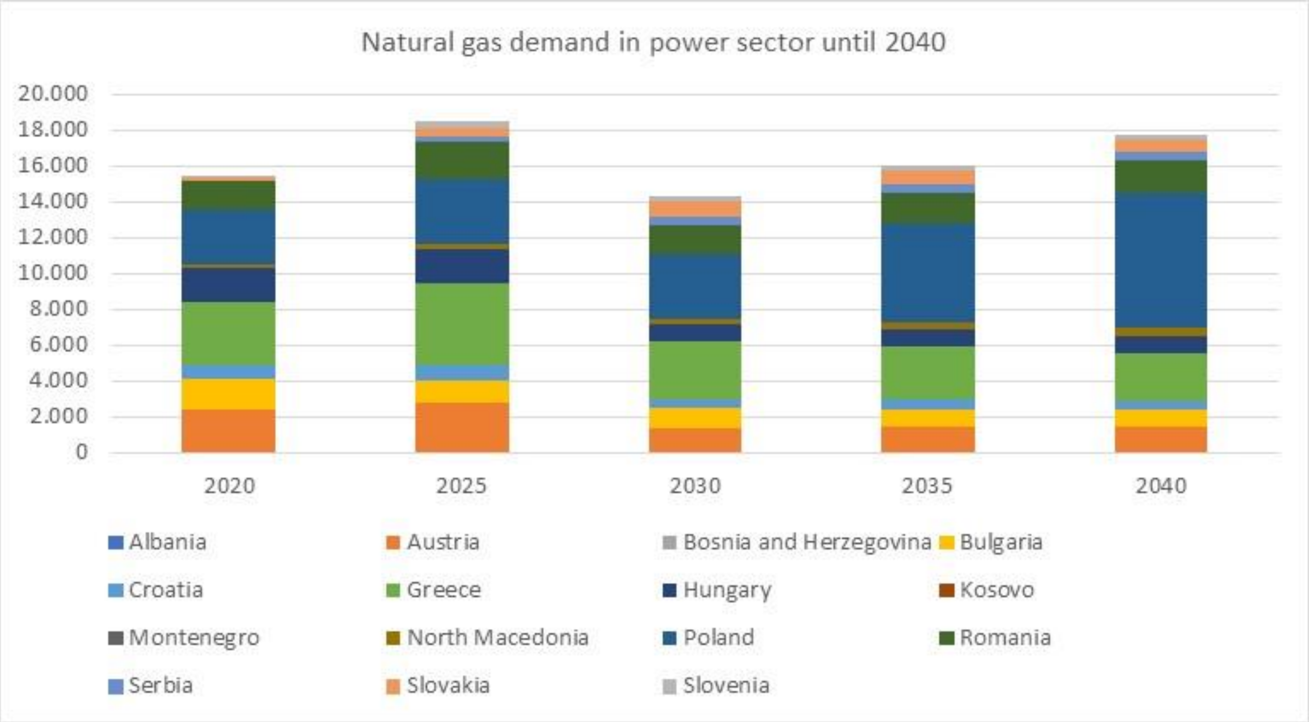
1. Integrated National Energy and Climate Plan 2021-2030; Federal Ministry for Sustainability and Tourism, Republic of Austria, Vienna, 18 December 2019 *https://ec.europa.eu/energy/sites/ener/files/documents/at_final_necp_main_en.pdf*
2. Integrated National Energy and Climate Plan of the Republic of Slovenia, Government of the Republic of Slovenia, 27 February 2020 https://ec.europa.eu/energy/sites/ener/files/documents/si_final_necp_main_en.pdf
3. National Energy and Climate Plan, Ministry of Innovation and Technology, Hungary, February 2020, https://ec.europa.eu/energy/sites/ener/files/documents/hu_final_necp_main_en.pdf
4. European Commission, Eurostat, National Energy Balances and Monthly Energy Statistics Database, https://ec.europa.eu/eurostat/data/database
5. EUROSTAT: Monthly and annual energy statistics database
6. European Commission: Macroeconomy forecasts, Summer edition 2020
7. ENTSO-G Ten-Year Network Development Plan (TYNDP), Edition 2018 and 2020
8. Study on Regulation (EU) 994/2010 on measures to safeguard security of gas supply in the Energy Community, September 2013
9. International Energy Agency (IEA) - World energy balances, Editions 2015 - 2018
10. Eurostat energy balance sheets, Editions 2010 - 2020
11. ACER - Report on unit investment cost indicators and corresponding reference values for gas infrastructure
12. Western Balkans Investment Framework Infrastructure Projects Facility, Technical Assistance 4 (IPF TA 4), Gas Development Master Plan - Priority Project Portfolio Identification in Montenegro - Market Review and Gas Demand and Supply Assessment, 2015
13. Western Balkans Investment Framework Infrastructure Project Facility, Technical Assistance 4 (IPF 4) - Gas Master Plan for Albania & Project Identification Plan - Gas Infrastructure Master Plan, November 2016
14. European Commission, Projects of common interest (PCI) - Interactive map
15. Gas Infrastructure Europe (GIE) - System development map, Editions 2016/2017, 2017/2018 and 2019/2020
16. Gas Infrastructure Europe (GIE) - LNG map 2019
17. Gas Infrastructure Europe (GIE) - Storage map 2018
18. World Development Indicators (WDI), World Bank
19. IAP Feasibility - Final report, Economic Consulting Associates, February 2018

7 ANNEXES

7.1 ENTSO 2020 - National trends scenario

7.1.1 Natural gas demand forecasts for power generation

GWh	2020	2025	2030	2035	2040	2040/2020
Albania	-	-	-	-	-	-
Austria	2.449	2.815	1.399	1.434	1.469	0,60
Bosnia and Herzegovina	0	0	0	0	0	0
Bulgaria	1.656	1.252	1.092	1.015	938	0,57
Croatia	782	796	512	517	523	0,67
Greece	3.546	4.617	3.207	2.933	2.660	0,75
Hungary	1.876	1.857	989	972	955	0,51
Kosovo	-	-	-	-	-	-
Montenegro	-	-	-	-	-	-
North Macedonia	156	269	239	353	467	3,00
Poland	3.099	3.697	3.650	5.576	7.503	2,42
Romania	1.588	2.093	1.637	1.713	1.789	1,13
Serbia	59	249	443	454	465	7,89
Slovakia	138	527	887	779	672	4,86
Slovenia	7	345	307	317	326	47,82
Total	**15.354**	**18.517**	**14.361**	**16.064**	**17.767**	**1,16**



7.1.2 Natural gas demand forecasts for final consumption

GWh	2020	2025	2030	2035	2040	2040/2020
Albania	-	-	-	-	-	-
Austria	2.449	2.815	1.399	1.434	1.469	0,60
Bosnia and Herzegovina	0	0	0	0	0	0
Bulgaria	1.656	1.252	1.092	1.015	938	0,57
Croatia	782	796	512	517	523	0,67
Greece	3.546	4.617	3.207	2.933	2.660	0,75
Hungary	1.876	1.857	989	972	955	0,51
Kosovo	-	-	-	-	-	-
Montenegro	-	-	-	-	-	-
North Macedonia	156	269	239	353	467	3,00
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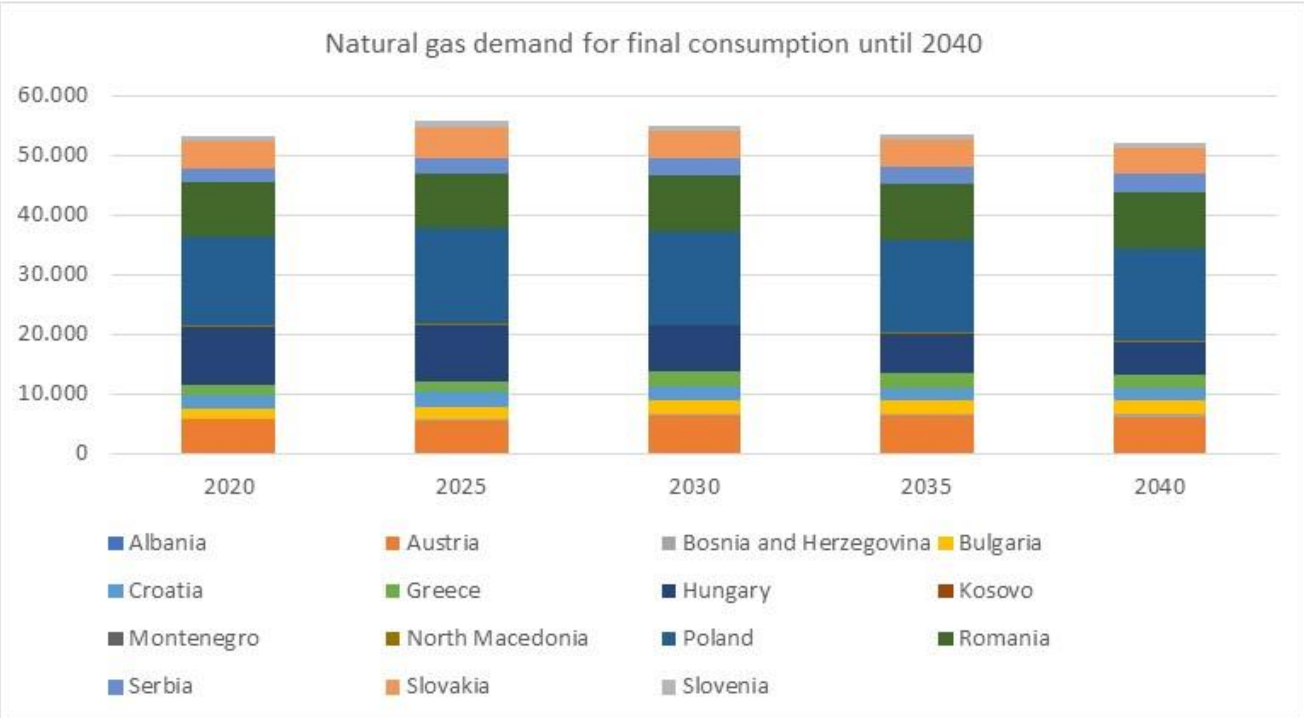
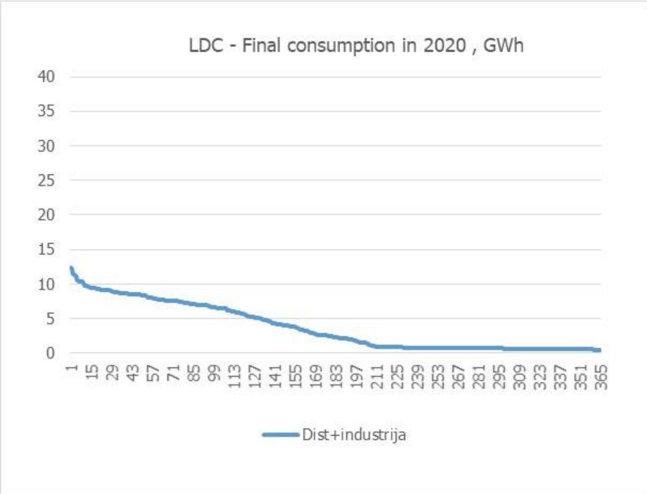
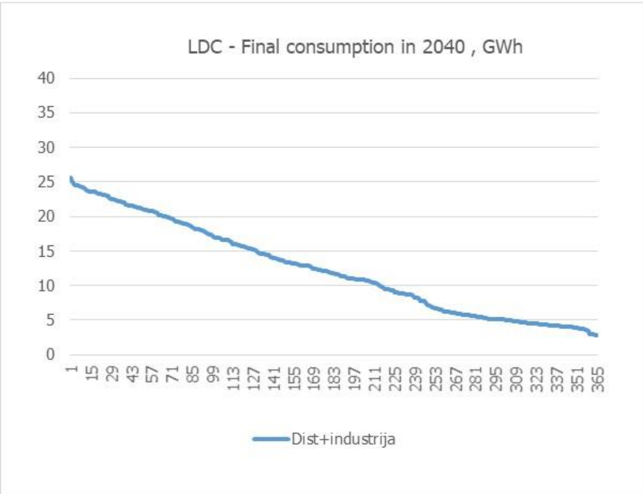


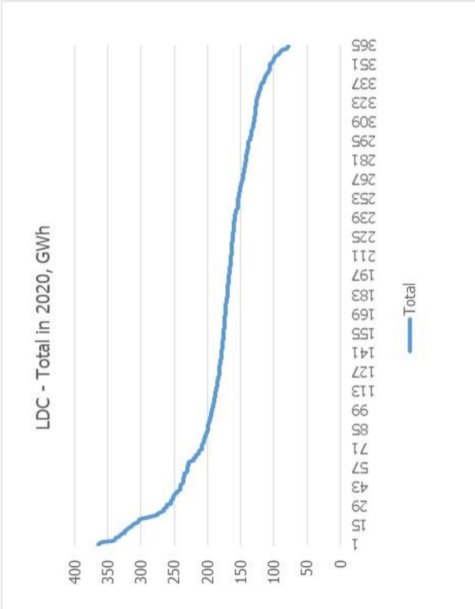
7.2 Load duration curves

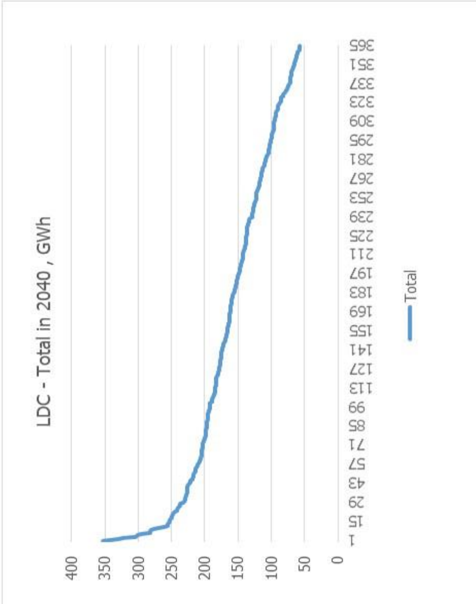
7.2.1 Bosnia and Herzegovina

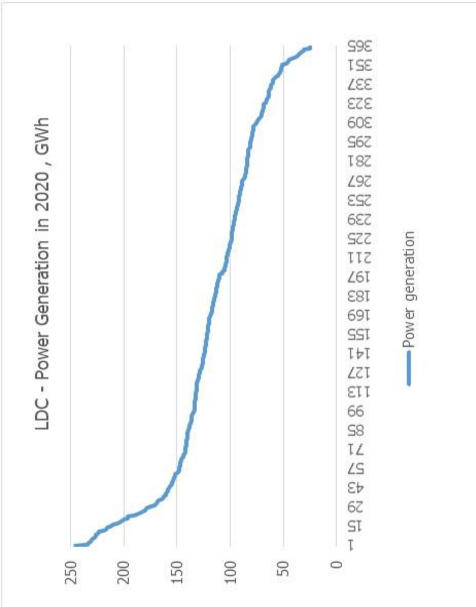


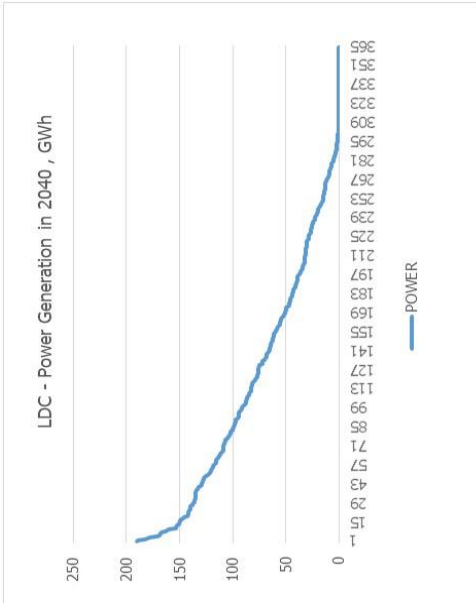


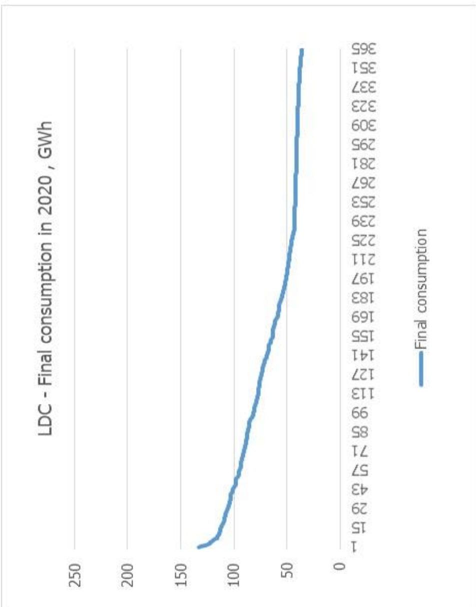
7.2.2 Greece

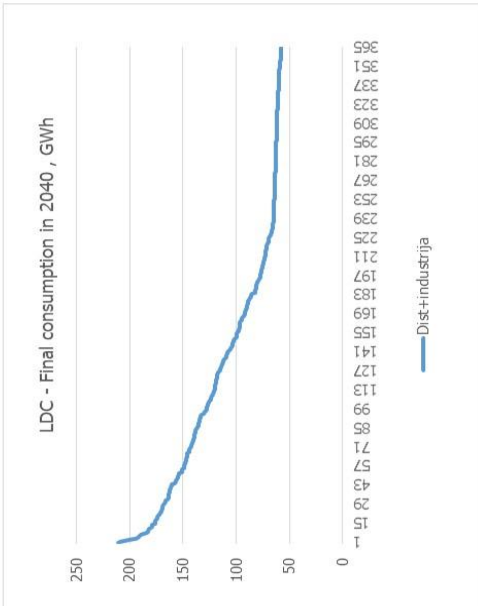

LDC - Total in 2020, GWh
Total


LDC - Total in 2040 , GWh
Total


LDC - Power Generation in 2020 , GWh
Power generation


LDC - Power Generation in 2040 , GWh
POWER


LDC - Final consumption in 2020 , GWh
Final consumption


LDC - Final consumption in 2040 , GWh
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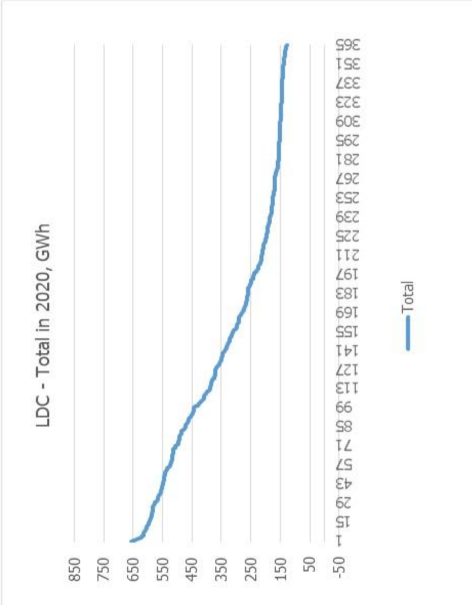
7.2.3 Romania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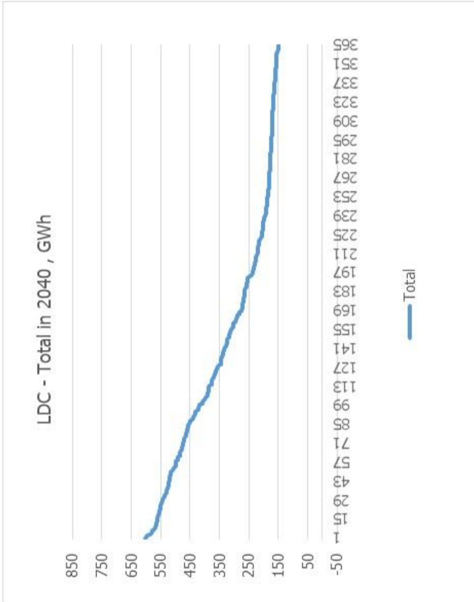
Total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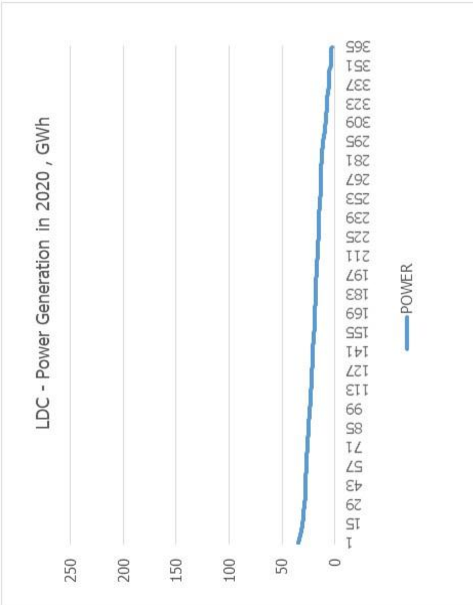
Total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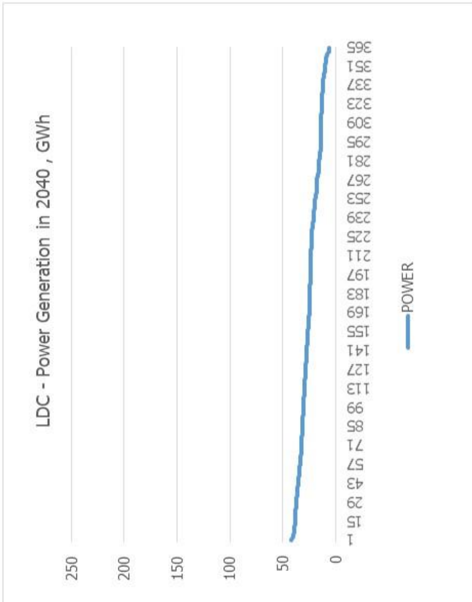
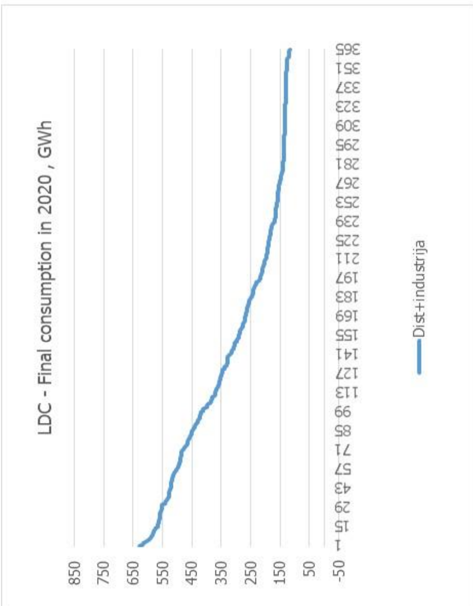
POWER


LDC - Power Generation in 2040 , GWh
POWER


LDC - Final consumption in 2020 , GWh
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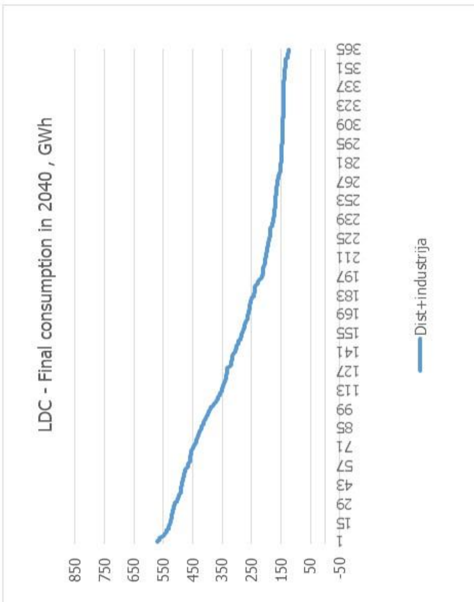
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