REPUBLIC OF SERBIA

SECURITY OF SUPPLY STATEMENT

Year 2019

TABLE OF CONTENTS

ABBREVIATIONS

AERS	-	Energy Agency of the Republic of Serbia
APKM	-	Autonomous Province of Kosovo and Metohija
ECS	-	Excavator Conveyor Stacker System
CESEC	-	Central and South Eastern Europe Connectivity
CHP	-	combined heat and power plant
EMS JSC	-	Joint Stock Company "Електромрежа Србије" Belgrade
DSO	-	distribution system operator
ELV	-	emission limit values
EnC	-	Energy Community
EU	-	European Union
GMRS	-	main gas pressure regulating and metering station
HPP	-	hydro power plant
IEI	-	energy intensity index
JSC		joint stock company
MB	-	mine basin
MG	-	main gas pipeline
NERP	-	National Emission Reduction Plan
OHL	-	overhead line
OPGW	-	Optical Power Ground Wire
OTS	-	transport system operator
PCI	-	European Commission Projects of Common Interest
PE	-	public enterprise
PECI	-	Projects of Energy Community Interest
PMI	-	Projects of Mutual Interest
PPS	-	handover station
PS	-	petrol stations
PSP	-	pumped storage plant
PSHPP	-	pumped storage hydro power plant
RMC	-	remote, monitoring and control system
RS	-	Republic of Serbia
SBRA	-	Serbian Business Registers Agency
SCADA	-	Supervisory Control and Data Acquisition
SEEPEX	-	South-eastern European Power Exchange

SFO	-	natural gas storage facility operator
SS	-	switching station
TPP	-	thermal power plant
TPPNT	-	Thermal Power Plant Nikola Tesla
TS	-	transformer station
TSO	-	transmission system operator
UGSF	-	underground gas storage facility
WB6	-	Western Balkan Six
WBIF	-	Western Balkan Investment Framework project list

1. INTRODUCTION

1.1. Legislative and Regulatory Framework of the Energy Sector

The basic legal and strategic documents which regulate the operation of the energy sector and define and implement the energy policy:

- Energy Law,
- Energy Sector Development Strategy of the Republic of Serbia,
- Program of the Energy Development Strategy of the Republic of Serbia, and
- Energy Balance of the Republic of Serbia.

These documents define the general objectives in terms of security of supply of market with energy and energy sources, and certain guidelines and frameworks for the adoption of other acts that further and closer define this issue.

Energy Law, adopted in December 2014 (Official Gazette of the RS, no. 145/2014, 95/18) [1], among others, regulates:

- energy policy objectives and manner of its implementation,
- conditions for reliable, secure and high quality supply of energy and energy sources for a secure customer supply,
- energy and energy sources customer protection, conditions and manner of performing energy activities,
- conditions for the construction of new energy facilities,
- status and scope of the Energy Agency of the Republic of Serbia,
- use of renewable energy sources,
- organization and functioning of the electricity, natural gas, petroleum and petroleum products markets,
- the rights and obligations of participants in the market,
- establishment of ownership on the network operator systems,
- field of heat energy as the energy industry, and its production, distribution and supply, etc.

Energy policy of the Republic of Serbia shall be diluted and implement using Energy Sector Development Strategy of the Republic of Serbia (hereinafter referred to as Stategy), Program of the Energy Development Strategy of the Republic of Serbia (hereinafter referred to as Program) and Energy Balance of the Republic of Serbia (hereinafter referred to as Energy Balance).

The Strategy is a document that outlines the energy policy and planning of energy sector development. Strategy is adopted by the National Assembly of the Republic of Serbia at the proposal of the Government of the Republic of Serbia (hereinafter referred to as Goverment) for a period of at least 15 years. The Ministry in charge of energy prepare a report every year for the Government on the realization of the Strategy.

Program defines the conditions, manner, dynamics and measures for the implementation of the Strategy. The program is adopted by the Government, for a period of up to six years on the proposal of the Ministry in charge of energy. The Ministry in charge of energy monitors the achievement of the Program and, if necessary, propose its adjustment to the actual needs at least every other year. The Government submits to the National Assembly an annual report on the

Strategy and Program implementation, which comprises: the results accomplished against the objectives set by the Strategy, or the Programme for the year in which the annual report on the Strategy and Program is being submitted; estimated effects of the achieved results and their impact on the Program in the upcoming year; a proposal of measures for a more efficient Strategy and Program implementation; estimated needs for adjusting the Program and possible Strategy adjustment to the actual needs. Government in accordance with the Strategy and Program brings national action plans that more closely define development objectives and measures for their implementation.

Energy Sector Development Strategy of the Republic of Serbia for the period 2015-2025 with projection up to 2030 was adopted in 2015 (Official Gazette of the RS, no. 101/2015) [2], and the passing of Program of the Energy Development Strategy of the Republic of Serbia until 2025 with Projections to 2030 for the period 2017 to 2023 was adopted in 2017 (Official Gazette of the RS, no. 104/2017) [3].

Energy Balance determines the annual need for energy and energy sources (expressed on a monthly basis), which is necessary to provide for the reliable, safe and quality supply of customers. It also emphasizes the rationality of energy consumption and energy optimization of resources and the required amount of energy, and energy sources, defines the required level and structure of energy stocks and spare capacity. Required contents of the Energy Balance are: balances of electricity, coal, oil, oil products and biofuels, natural gas, thermal energy and renewable energy. Government brings the Energy Balance on proposal of the Ministry in charge of energy, by the end of December of the current year for the following year. The Ministry in charge of energy monitors the implementation of the Energy balance, analyze its performance in the previous year and, if necessary, propose to the Government measures to ensure its implementation.

Ministry in charge of energy monitors the implementation of the National Action Plan For Renewable Energy and every two years submit a report about that to the Government.

1.2. Institutional Framework Governing the Energy Sector

The institutional framework for the energy sector is determined by the Constitution, the Energy Law [1] and Law on Ministries [4].

In the energy sector of the Republic of Serbia, the jurisdiction primarily have:

- The Government of the Republic of Serbia,
- Ministry in charge of energy and
- Energy Agency of the Republic of Serbia.

The Government of the Republic of Serbia prescribes conditions for delivery and supply of electricity, oil and natural gas, as well as measures to be taken in the event of an endangered security of energy and energy sources supply due to disturbances in the power system or the energy market. The Government adopts the Preventive Action and Contingency plan, in order to ensure safety of natural gas supply. Preventive Action plan contains a risk assessment in terms of achieving security of supply, as well as measures to mitigate the identified risks related to the required transportation capacity in order to meet the total demand for natural gas and to secure the supply of certain groups of final customers of natural gas. The Contingency plan determines measures, energy service companies which will be responsible for ensuring the security of the transmission system and the security of supply of certain groups of end customers, the quantity and capacity of natural gas in case of general shortage of natural gas. In case of compromised security of customer supply or energy system, due to insufficient offer in the energy market or the occurrence of other extraordinary circumstances, the Government provides measures and limits the supply of electricity or natural gas. The Government can also provide special conditions for the import or export of certain types of energy, method and conditions for determination and price control, obligation to supply only certain customers or special conditions for energy activities with minimal disruption of the energy market in the region. If the safety of the supply is endangered because of the lack of oil offer in the energy and energy source market or because of the occurrence of other extraordinary circumstances, the Government can approve amendment of the limits of certain characteristics of petroleum products quality that can be put on the market of the Republic of Serbia for a period not exceeding six months.

Ministry in charge of energy performs state administrations related to: energy, energy policy and planning of energy development in the field of electricity, natural gas, oil and oil derivatives, the energy balance of the Republic of Serbia, the oil and gas industry, strategy and policy of energy security, development of annual and medium-term programs of energy security and providing material and other conditions for the implementation of these programs, mandatory and other reserves of energy sources, safe pipe transport of gaseous and liquid hydrocarbons, manufacturing, distribution and supply of thermal energy, rational use of energy and energy efficiency, renewable energy, environmental protection and climate change in the field of energy, coordinating activities in connection with investments in the energy sector, as well as other duties specified by law.

Energy Agency of the Republic of Serbia (AERS) was established in June 2005, on the basis of the Energy Law 84/04. Position, operating mode and activities of AERS are regulated by the Energy Law (Official Gazette of the RS, no. 145/2014) [1]. AERS is the only regulatory body for energy sector and was established in order to promote and direct the development of the electricity and natural gas market on the principles of non-discrimination and effective competition, through the creation of a stable regulatory framework, as well as to perform other tasks established by the mentioned law. AERS is an independent legal entity and independent from the executive authorities in performing their duties, as well as from other state agencies and organizations, legal entities and individuals engaged in the energy industry. Members of the Council are elected by the National Assembly, thus acquiring independence in decision-making from its purview.

The Energy Law [1] regulates the tasks performed by AERS. In performing these tasks AERS take measures that, among other things, contribute to achieving the following objectives: ensuring secure supply of energy through efficient operation and sustainable development of the energy system, in accordance with the energy policy of the Republic of Serbia, including environmental protection and the development of renewable energy sources; the development of the electricity market in the Republic of Serbia and its integration into the regional and pan-European electricity market. Also, AERS gives approval to market and technical rules, system development plans, brings the methodology for determining the price for access to the transmission or distribution of electricity, rates of access to transport, distribution and storage of natural gas, prices for guaranteed electricity supply and prices for natural gas public supply, and the cost of access to the system of oil transport pipelines and systems for the transportation of oil derivatives.

Local self-government units also have a specific role in the implementation of energy policy, which is defined through the institutional framework of the Republic of Serbia. Article 361 of the Energy Law [1] defines that local self-government units on their territory may establish an energy entity for performing the activity of thermal energy production, distribution and supply to customers, where the act on association shall determine the conditions and manner of performing each of these activities. It implies that founding act must be in accordance with the Energy Law and other acts from the institutional framework of the Republic of Serbia for energy sector.

1.3. Working Group on Security of Supply

Since 2005, the competent Ministry in charge of energy sector introduced the practice of forming Working Group to review and monitor the situation regarding security of energy and fuels supply in the Republic of Serbia. The main task of the Working Group is monitoring the situation regarding reliable and optimal supply of energy market. The working group is formed by a decision issued by the Minister in charge of energy. Meetings are held on a monthly basis during the hole year and more often, if it is necessary, depending on the situation.

Task of the Working Group is consideration and monitoring security of energy and energy sources supply, proposing appropriate measures, preparing the basis for a report on the security of electricity and natural gas supply and proposing measures in case the compromised security of customer supply or energy system operation, due to insufficient offer on the energy market or the occurrence of other extraordinary circumstances.

Working Group members are representatives of Ministry in charge of energy, "JP Elektroprivreda Srbije Beograd" (PE EPS), "Operator distributivnog sistema EPS Distribucija d.o.o. Beograd" (EPS Distribucija), "Elektromreža Srbije a.d. Beograd" (EMS JSC), "JP Srbijagas Novi Sad" (PE Srbijagas), "Naftna industrija Srbije a.d. Novi Sad" (NIS JSC), Serbian Association of heating plants, Provincial Secretariat for Energy and Mineral Resources, Energy Administration of the Belgrade city, AERS and "JKP Beogradske elektrane Beograd".

Energy entities deliver Reports on activities for the Working Group meetings which contain information on the operation of the energy sector, their operating status and readiness, actual and potential problems, as well as projections for the next period (30 days).

1.4. Other Important Acts for the Functioning of the Energy Sector

1.4.1. Ordinance on Terms of Energy Supply

Ordinance on Conditions for Delivery and Supply of Electricity (Official Gazette of the RS, no. 63/2013, 91/18) [5] shall regulate more specific terms of energy supply, as well as the measures taken in case the security of energy supply has been jeopardized due to the functional disruption of the energy system or the disruption in the energy market in the Republic of Serbia, namely:

- Terms and procedure of granting approval for connection to the electric energy transmission or distribution systems,
- Measures to be undertaken in case of short-term disruptions caused by breakdowns and other unforeseen circumstances whereby safety of the energy system operation is jeopardized, as well as due to unforeseen and necessary works on maintenance of electric power facilities and required works on the expansion of the electric power system, and also other terms and measures for the purpose of supplying customers with electric energy,
- Measures to be undertaken in the case of a general electric power shortage, terms and conditions for undertaking measures and the schedule of restricting energy supply, as well as measures of energy saving and rational consumption in case of a general energy shortage,
- Terms and conditions of electricity supply suspension, as well as the rights and obligations of system operators, suppliers, or the public supplier and final customers,
- Terms and conditions for rational use of energy and energy saving,
- Method of calculation of unauthorized take-off of energy,
- Terms and conditions for the supply of electricity to customers,

- Terms and manner of fulfilling responsibilities of the supplier and public supplier.

1.4.2. Ordinance on Terms of Natural Gas Supply

Ordinance on Terms of Natural Gas Delivery and Supply (Official Gazette of the RS, no. 47/06, 3/10 and 48/10) [6] presents detailed terms of delivery and supply of natural gas, as well as measures to be taken in case of failing safety of natural gas delivery and supply to end-users due to disruptions in transmission or distribution system operation, or disturbances in the natural gas market in the Republic of Serbia, as follows:

- Conditions and procedure of granting approval for connection to the transmission or distribution system of natural gas,
- Measures to be taken in the event of short-term disruptions caused by failures and other unforeseen circumstances which threaten the safety of transportation, and natural gas distribution system, as well as the necessary maintenance of energy facilities and required works on the upgrade of the system, as well as other conditions and measures for supplying customers with natural gas;
- Measures to be taken in case of general shortage of natural gas, due to the circumstances referred to in Article 164 of the Energy Law [1],
- Conditions and methods of the suspension of natural gas supplies,
- Conditions and rational use of energy and saving natural gas,
- Terms and methods of measures and schedule constraints of natural gas supply, as well as measures for saving and rational use in case of general shortage of natural gas,
- Conditions of supplying privileged end-users' facilities to whom cannot be suspended supply due to outstanding liabilities for delivered natural gas or in other cases,
- Method of regulating relations between the supplier and the end-user to whom cannot be suspended natural gas supply,
- Method of measuring natural gas quantities,
- Calculating method for unauthorized natural gas take over,
- End-users public information.

According to the provisions of this by-law regulation, in the case of short-term disruption of natural gas supplies, caused by breakdowns in its facilities, equipment, pipelines and installations for the transport and distribution of natural gas, and other unforeseen circumstances which threaten the safety of transportation and distribution system, due to unforeseen reparation, reconstruction and maintenance of transportation and distribution systems as well as required system expansion works, the transmission or distribution system is required to measure the degree of a disruption, and take the necessary actions to bring the system in a safe and uninterrupted operation as well to determine the terms of use the remaining capacity of production, transportation or distribution systems and develop the plan for limiting the delivery of natural gas.

The plan for limiting the delivery of natural gas comprises of the following measures: replacement of natural gas with other energy sources, limit supplies of natural gas and the suspension of natural gas supplies.

This Regulation set forth the restrictive measures to be taken in case of general shortage of natural gas, conditions and terms of suspension of natural gas supplies, conditions and rational use of energy and saving natural gas, as well as objects of end-users to whom cannot be suspended natural gas supply and methodology for regulation of the relation between the supplier and the end-user to whom cannot be suspended natural gas supplies.

The transmission and distribution system operators and public suppliers are obliged in case of general shortage immediately inform the ministry about the occurrence of general shortage. The Ministry, on the basis of this notice as soon as possible submits a proposal to the Government for a decision on the implementation of measures under Article 164 of the Energy Law [1].

1.4.3. Regulations of Commodity Reserves

In the part of security of supply, the area of oil is regulated by the Law on commodity reserves which regulates the conditions for the formation, financing, deployment, use and restoration of the obligatory reserves of oil and petroleum products, provision and maintenance of space for storage, as well as the operation and management of the compulsory reserves and storage facilities on the territory of the Republic of Serbia.

2. STRUCTURE OF ENERGY SECTOR

The energy system of the Republic of Serbia is consisted of oil, natural draft, coal, power engineering sector, the sector of thermal energy and renewable energy sources. This chapter provides a brief overview of the basic data relating to the mentioned energy sectors, while a detailed description will be given in the context of specific chapters.

2.1. Crude Oil Sector

Exploitation of domestic crude oil reserves is performed within the limits of NIS JSC (in 2018 it amounted 0.877 million tonnes, which is 25% of total needs). The NIS JSC is the only company in Republic of Serbia engaged in crude oil and natural gas exploration and production. Since 25th January, 2009 the majority stock holder (owner) in NIS JSC is the Russian company Gazprom Neft.

Production of petroleum products is carried out within Pančevo Oil Refinery which is a part of NIS JSC (in 2018 domestic production of petroleum products amounted 3.885 million tonnes, which is 90.6% of total needs for petroleum products).

By the new Energy Law [1] some of the existing energy activities, for which a license has been provided in this area, have gained new meanings. Thus, the activity of producing oil products includes not only the processes of obtaining oil products by crude oil refining, degasolination or separating light liquid hydrocarbons, but also all the technological processes that give standardized products of the prescribed quality.

In Republic of Serbia, the production of oil products, more precisely liquefied petroleum gases, is performed, except in the refinery in Pančevo, at the NIS JSC plant for stabilization, i.e preparation of natural gas for transportation in Elemir (propane, as well as gas condensate). Also in plants in Odzaci by Standard gas (propane and butane as well as pentane-hexane fraction, or solvent), where imported gas condensate i.e wide fraction of light hydrocarbons is used as the raw material for production; and in the "Hipol a.d. Odžaci" (Hipol JSC), where the propane receives as a by-product in the process of purification of petrochemical propylene to propylene polymeric purity. At the same location, but in other plants, the Energreen MTV is also produces the same products. The production of propane-butane mixture and autogas, based on the mixing of components, is carried out by Petrol LPG in Smederevo and VML at the plant in Jakovo.

The only service provider - operator is "JP Transnafta Pančevo" (PE Transnafta), which is founded on October 1, 2005 until when the service was carried out within NIS JSC company. The business activities of transportation of crude oil through crude oil pipelines and petroleum products through product pipelines are the regulated busiess activity of general interest and is carried out by PE Transnafta by regulated prices.

The activity of trade of crude oil and petroleum products including biofuels and compressed natural gas and storage is operated by a large number of economic entities. There are 22 licenses being issued for crude oil and petroleum products storage, also 51 for crude oil and petroleum products wholesale and 463 for crude oil and petroleum products retail trade. The import of crude oil is liberal and the prices are commercial. The retail trade of petroleum products on the territory of the Republic of Serbia is performed through the developed and outspread trade network of 1,481 retail facilities.

In Republic of Serbia, the supply of transport vehicles with compressed natural gas, as a fuel, is done at 20 stations.

In addition to the traditional trade in motor and other fuels at the stations for the supply of transport vehicles, the new Energy Law provides a license for fuel trade out of the fuel station. In this way, the supply of sports airplanes by jet fuel and direct supply of end users with energy and heating products, such as fuel oils, biofuels, propane, propane-butane mixture and other, are regulated. For this activity, for now, the license have five energy entities.

Total consumption of petroleum products as final energy-generating product amounted 3.411 Mtoe, out of which 0.609 Mtoe was spent for non-energy purposes and 2.802 Mtoe was spent for energy purposes whereby mostly in traffic sector 80%, then in industry and construction 11.05%, in agriculture was spent 4.76%, and in households about 1.69%, while the rest of consumers participate with 2.41%.

Directive 2009/28/EC, which refers to the share of renewable energy in the transport sector, in order to reduce the greenhouse gas emissions, has not been implemented in this area at domestic legislation yet. During 2018 some work was done on drafting by laws of the Energy Law, which regulates this area. The adoption of these acts is planned for 2019. By the National Renewable Energy Action plan is assumed obligation to reach 10% of the share of renewable energy sources in transport sector by 2020, but the share of biofuels in the oil products in 2018 was still negligible. So far, the license for production of biofuels and bioliquids has been given to a single entity, whereas for the mixing biofuels with petroleum fuels the license have two energy entities.

2.2. Natural Gas Sector

Natural gas sector comprises of:

- Exploration of indigenous natural gas reserves within NIS JSC (production in 2018 was 449.6 million Sm^3)[1],
- Natural gas import (one direction from Russia via Ukraine and Hungary, total amount of 2,153.38 million Sm^3 in 2018),
- Storage of natural gas and storage management (Underground storage Banatski Dvor - UGS Banatski Dvor, capacity of 450 million m^3 of natural gas),
- Natural gas supply,
- Natural gas transmission and transmission management (Transportgas Srbija d.o.o. Novi Sad and "Yugorosgaz-Transport d.o.o. Niš"),
- Natural gas distribution and distribution management is performed by 33 licensed distribution system operators. License for natural gas distribution is possessed for one additional company, but it haven’t not performed this activity.

In 2018, natural gas consumption in Republic of Serbia had the following structure:

- Transformation input 35.80%;
- Consumption in the energy sector 7.50%;
- Transmission and distribution losses 1.39%;
- Non-energy consumption 7.50%;
- Final energy consumption 47.81%.

In process of natural gas transformation in other forms of energy, highest share had district heating plants – 56.98%, followed by autoproducers with 15.90%, refineries with 14.82% and CHP with 12.30%.

[1] Sm^3 is standard cubic meter of natural gas at a temperature of 15˚C, 1013.25 mbar pressure and lower calorific value of H_d=33338 kJ/m3.

The highest share within final energy consumption for energy purposes had the industry (57.20%) followed by commercial and public sectors with 19.87%, households with 19.38%. while the agriculture and the traffic sectors had a share of 1.87% and 1.68%, respectively.

2.3. Coal Sector

The largest part of the energy reserves fossil fuels of the Republic of Serbia (about 99%) are various types of coal, whose exploitation takes place within of:

- Mining of PE Resavica (in 2018 it produced 0.433 million tonnes of coal),
- Underwater exploitation in Kovin (in 2018 it produced 0.238 million tonnes)
- Surface coal mining in two major mines in Kolubara (in 2018 domestic production was 28.374 million tonnes) and Kostolac (in 2018 production was 8.604 million tonnes of coal), which are located within PE EPS.

Of the total domestic production of coal, 98% comes from surface exploitation, and the rest of the underground and underwater exploitation. Domestic production mainly produces low-quality lignite, so the need for higher quality types of coal covered from imports and and coal-fired plants at Vreoci. That is the reason why the domestic production satisfies 97% of the total demand for coal and the rest is imported.

Import includes import of coal shortage types of coal and coke for the needs of metallurgical complex and high-calorie coal for the industry, and the brown coal for different consumers. Total domestic coal production in 2018 amounted to 37.649 million tonnes, or 6.608 Mtoe, while the total amount of coal available for consumption is about 7.533 Mtoe. Of this amount for the transformation process has been spent up to 7.148 Mtoe (95%), of which 6.272 Mtoe (87.7%) in thermal power plants, and the remaining of 12.3% in industrial power plants, heating plants, blast furnaces and coal processing.

Within the processing of coal in Vreoci, which is part of PE EPS, in 2018 was produced 392,064 tonnes of dry lignite.

Final consumption of coal in 2018 amounted 0.561 Mtoe of which in non energy purposes 0.005 Mtoe, and in energy purposes 0.558 Mtoe. In the structure of final consumption for energy purposes, the participation of industry is 49%, 43% of households and other sectors with 8%.

2.4. Energy Sector

Capacities for the production of electricity in the Republic of Serbia, for the most part are owned by PE EPS (95%), and their structure that is net production capacities, in 2018 is [26]:

- Thermal Power Plants (TPP), net output capacity of these plants is 4,079 MW
- Combined Heat and Power Plants (CHP), with net output capacity 336 MW
- Hydro Power Plants (HPP) with net output capacity 3,045.08 MW (including small hydro power plants)
- Wind Power Plants, with net output capacity 264.28 MW
- Solar Power plants, with net output capacity 10.708 MW
- Biogas Power plants, with net output capacity 15.909 MW
- Industrial power plants, with net output capacity 28.426 MW
- Gas plants, with net output capacity 3.41 MW.

Total electricity production in 2018 was 37,426 GWh (3.218 Mtoe). The largest part of production was realized in thermal power plants (67%) and hydro power plants (30%).

Combined heat, wind power plants and industrial power plants in total electricity production together accounted for about 3%. Import of electricity was 6,400 GWh (0.55 Mtoe), export 6,283 GWh (0.54 Mtoe), so that net gross import amounted to 116.5 GWh (0.01 Mtoe) [16], [26].

Power consumption of the energy sector in the same year amounted to 13% of the total generated electricity (gross production). Losses in the transmission and distribution system amounted to 11.91% of the total electricity production (gross production) [16], [26].

Final electricity demand was 28,111 GWh (2.417 Mtoe). Electricity as final energy is consumed mostly in households (49%), then in industrial plants along with the construction sector (30%), and transport, agriculture and other consumers (21%) [16], [26].

In 2018, there were 66 licenced electricity suppliers for open market supply (only 18 were active). PE EPS remained dominant with 96.4 share of total energy sold in the open market and 98.3% of final consumption.

2.5. Thermal Energy Sector

Capacities for the production of thermal energy in the Republic of Serbia are installed in:

- Power Plants within the district heating system
- Thermal Power Plants (TPP)
- Combined Heat and Power Plants (CHP)
- Industrial Power Plants
- The individual boiler rooms that are not covered by energy balance.

Centralized heat supply exists in 57 towns in Serbia, with the total installed thermal capacity of boilers 6.548 GW.

Industrial power plant are used to produce thermal energy for needs of different industrial process. Except for manufacturing processes, thermal energy produced in these power plants is also used for heating of working space. In particular industrial enterprises are power plants that provide combined heat and power generation (it is estimated that in 2018 11,062 TJ of heat and 543.052 GWh of electricity was produced) [16], [26].

Production of thermal energy takes place in thermal power plants and combined heat and power plants. These are the following objects in the composition of PE EPS:

- TPP Nikola Tesla A (unit A1 and A2) for district heating of Obrenovac (steam coal units)
- TPP Kostolac A for district heating of Požarevac and Kostolac (steam units for coal)
- TPP Kolubara A for district heating of Lazarevac
- CHP Novi Sad, Zrenjanin and Sremska Mitrovica for district heating and process steam (steam units for the gas and liquid fuel, new boiler in TPP Sremska Mitrovica on biomass).

Natural gas, coal, oil products and biomass are used for the production of heat in district heating plants. In 2018, in the thermal power plants was spent 536.915 million m^3 of natural gas, 181,489 tonnes of coal, 67,651 tonnes of petroleum products and 8,055 tonnes of biomass [16], [26].

The thermal energy production in 2018 amounted about 36,177 TJ or 0.864 Mtoe. The largest part of the production was achieved in industrial power plants (31%) and thermal power plants (59%) [16], [26].

Distribution losses were 3,104 TJ, or 0.074 Mtoe and consumption of the energy sector was 2,156 TJ or 0.051 Mtoe. Final energy consumption in 2018 amounted to 30,917 TJ or 0.738 Mtoe. When it comes to this amount, in industrial power plants was spent (29%) and in household (55%). Other consumers accounted for 16% of final energy [16], [26].

2.6. Renewable Energy Sector

Renewable energy sector includes:

- The production of geothermal energy,
- Use of hydropower potential, solar and wind energy,
- The production of solid, liquid and gaseous biomass,
- Import and export of biomass,
- The production of electrical and thermal energy from plants using renewable energy sources.

Electricity production from large and small watercourses was included in the balance of the total electricity production in the Republic of Serbia and was 11,392 GWh or 0.980 Mtoe. This means that in 2018 the hydropower plants produced 30% of the total gross electricity generation [16], [26].

Geothermal energy production is followed by the Statistical Office of the Republic of Serbia within their statistical surveys and in 2018 this production was 0.0052 Mtoe which is less than 1% of the total domestic production of primary energy. This data did not cover use of geothermal energy through the use of heat pumps [16], [26].

Production and consumption of solid biomass, includes, not only the production and consumption of firewood, but also the production of pellets and briquettes, for energy purposes (heating). Biomass production in 2018 in the Republic of Serbia was 1.121 Mtoe, of which the largest part of 0.864 Mtoe was consumed in households [16], [26].

2.7. Energy Resources

Energy resources and potentials of the Republic of Serbia consists of fossil, conventional (coal, oil and natural gas) and unconventional fuels (oil shale), as well as renewable energy sources.

Good quality energy reserves, such as oil and gas are symbolic and make less than 1% of geological reserves, while the remaining 99% of energy reserves are various types of coal, with the largest share of lignite from over 95% of the balance reserves. Considering the total geological reserves, among the most abundant coal reserves, the presence of still unexploited oil shale, at around 9% of the total geological reserves, is observed.

Coal reserves should, according to the projections of the consumption, meet consumption requirement until the end of this century.

Oil shale reserves are significant, but the conditions for their exploitation and technology for their use has yet to be defined, given that this is an unconventional fuel.

The volume of oil and natural gas reserves will last until 2030, and further exploitation, will depend on the translation of the off-balance reserves into balance reserves, as well as on the discovery of new deposits. Thus, the geological reserves of primary energy sources still represent a significant basis.

For the renewable energy sector, with the exception of large hydro power plants, it can be said that it is in the early stage of development. Estimated total technically available potential of renewable energy sources in Serbia is 5.65 Mtoe per year. From this potential 1.054 tonnes of oil equivalent of biomass and 909 thousand tonnes of oil equivalent of hydropower is already used.

Primary production includes exploitation, or use of domestic resources of coal, crude oil, natural gas and renewable energy sources (hydro potential, geothermal energy, and biomass). In Republic of Serbia 10.110 Mtoe of primary energy was produced in 2018. This production has satisfied more than 60% of the total demand for primary energy. The structure of domestic production of primary energy is as follows: coal production amounts to 6.608 Mtoe of the total domestic production of primary energy, while the remaining part is the production of crude oil and natural gas, hydropower and wind and solar energy, the production of firewood and geothermal energy.

Total primary energy consumption in 2018 was 14.875 Mtoe. Net import dependence of Republic of Serbia in 2018 was 37.2%. During 2018, mostly imported energy sources were: crude oil and petroleum products 54.29%, natural gas 26.8%, coal 10.97%, 7.74% electricity and etc.

Primary energy was used for:

- Transformation in the thermal power plants, hydro power plants, combined heat and power plants, heating plants, industrial power plants, oil refineries, coal processing, blast furnace;
- The consumption of the energy sector;
- Losses in transmission and distribution of energy and energy sources;
- Direct consumption by end users.

In the consumption structure for the transformation processes, dominates the consumption of coal 54.2%, then 35.4% of crude oil and petroleum products and natural gas 6.3%. Total consumption of final energy includes energy consumed in transformation processes as well as part of the total available primary energy which is not included in the processes of transformation and are directly consumed by end users.

Total final energy consumption in Serbia in 2018 was 9.407 Mtoe of which 0.761 Mtoe was consumed for non-energy purposes, while the consumption of final energy for energy purposes was 8.657 Mtoe.

By consumption sectors, final energy was most consumed in the household sector 33.68%, followed by industry 26.93%, then traffic 24.8%, while other sectors accounted for 14.6%.

On the other hand, in the final energy consumption, energy products consumption is dominated by oil with 30.77% and electricity with 27.85%, followed by natural gas with 12.86%, coal with 6.45%, thermal energy with 8.53%, while renewable energy (firewood) participate with 12.02%.

3. ELECTRICITY

Energy Law [1] in electricity defines the energy activities related to: electricity generation, combined generation of electricity and thermal energy, electricity transmission and electricity transmission system management, electricity distribution and electricity distribution system management, power distribution and management of the closed distribution system, electricity supply, wholesale electricity supply and organised electricity market operation. An energy-related activity can be performed by a public enterprise, business entity or other legal entity or entrepreneur having a license for performing the energy-related activity.

Energy activities of public interest, are carried out in accordance with this Law wich regulates the status of public companies (Official Gazette of the RS, no. 15/2016). In the area of electricity those are: electricity transmission and transmission system management, electricity distribution and distribution system management. The other listed energy activities are performed in accordance with market principles.

To perform these energy-related activities, all domestic and foreign entities must obtain a permit, ie license issued by the AERS. The license is an administrative act on fulfilment of conditions stipulated by the Energy Law [1] and the Rulebook on Licence for Performance of Energy Activities and Certification (Official Gazette of the RS, no. 87/15 and 44/18 [7]).

License is issued for each energy activity separately. It is issued for ten years, and for the production of electricity, the combined production of electricity and thermal energy and thermal energy production for 30 years.

In the energy sector of Republic of Serbia, following energy entities have a part:

- EMS JSC which in 2016 changed the legal form from a public company to a joint stock company, performs the activities of transmission and electricity transmission system management
- PE EPS performing the following activities: electricity generation, electricity supply and wholesale electricity supply. PE EPS is the founder of the subsidiary EPS Distribucija consisting of previous companies "Elektrovojvodina", "Elektrodistribucija Beograd", "Elektrosrbija", "Jugoistok" and "Centar", for the performance of the activity of electricity distribution and distribution system management and subsidiary "EPS Trgovanje d.o.o. Ljubljana" by PE EPS set up for electricity trading.
- "SEEPEX a.d. Beograd" (SEEPEX), licensed market operator on organized market/power exchange.
- Other electricity producers
- Other electricity suppliers.

3.1. Electricity Market

By adopting the Energy Law at the end of 2014 [1], the field of energy in domestic legislation is harmonized with the provisions of the Third energy legislative package of the European Union, continued the process of introducing competition in the electricity sector in Serbia, in order to increase the efficiency of the sector through the effects of market mechanisms in the production and supply of electricity, while retaining the economic regulation of the activity of transmission and distribution of electricity as natural monopolies.

According to the Energy Law [1], from January 1, 2015 households and customers who have the status of a small customers are entitled to guaranteed supply, at prices regulated by AERS. In accordance with that, the following applies:

- end customer is a legal or natural person or entrepreneur purchasing electricity or natural gas for its own needs;
- small electricity customers are end customers (legal persons and entrepreneurs) with fewer than 50 employees and a total annual revenue of up to 10 million € in dinar counter value, whose all facilities are connected to the electricity distribution system with the voltage level lower than 1 kV, and whose electricity consumption in the previous year was not higher than 30,000 kWh;
- guaranteed supply is a public service ensuring the right of households and small customers to the supply of electricity having prescribed characteristics in the territory of the Republic of Serbia, at reasonable, clearly comparable, transparent and non-discriminatory prices;

Households and small customers can remain under guaranteed supply and supplied in accordance with existing contracts, but they have the right and the possibility to contract supply with any licensed electricity supplier in the free market.

If a household or small customer chooses a supplier in the free market and then for any reason remains without the selected supplier, it can always return to regulated, guaranteed supply. Other customers must have a supply contract on market terms. Only one agreement on full supply may be concluded for one point of takeover and for the same period of supply. For one point of takeover, for each accounting period during the period of supply, several agreements on supply with predefined amounts of electricity may be concluded. Upon the conclusion of the agreement the final customer shall, prior to the commencement of supply, conclude: an agreement regulating balance responsibility for its points of takeover, and an agreement on access to the system with the operator of the system to which its facility is connected.

An end customer of electricity that is not entitled to guaranteed supply, who does not have a valid supply contract (Article 192 of the Energy Law [1]), has the right to last resort supply for a period of 60 consecutive days, in which he must find a new supplier (otherwise the system operator shall suspend electricity supply to that customer). On the basis of the conducted public tender procedure, the Government shall designate the supplier to perform last resort supply. The price at which the guaranteed supplier shall carry out last resort supply may not be lower than the average price of electricity in the organised market for the previous year (Article 193 of the Energy Law [1]).

According to the Energy Law [1], the electricity market in Republic of Serbia includes:

- bilateral electricity market;
- balancing electricity market and
- organized electricity market.

3.1.1. Participants in the Electricity Market

Energy Law stipulates that players in the electricity market may be: an electricity producer, a supplier, a public supplier, the final customer, the electricity transmission system operator, the electricity distribution system operator, the electricity closed distribution system operator and the market operator. The organised electricity market participants may also be other legal persons, in accordance with the rules on the organised market operation. Electricity market players are obligated to submit all necessary data to the transmission, i.e. distribution system operator pursuant to Electricity Transmission Grid Code ("Official Gazette of RS", no. 114/2017) [8], Electricity Distribution Grid Code (Official Gazette of the RS, no. 71/17 [9] and Official Gazette of the RS, no. 14/19 [10]) and Electricity Market Code [11].

The number of currently active licences for energy operations in electricity sector is presened in the following table.

Table 1: Active licences in electricity sector in year 2018 [12]

Activity	Active licenses
Electricity production	23
Combined power and heat production	7
Electricity transmission and transmission system operation	1
Elecricity distribution and distribution system operation	1
Electricity supply	66
Wholesale electricity supply	48
Ogranised electricity market operation	1

On the territory of the Republic of Serbia, EMS JSC is selected for performing of energy operations in the field of transmission of electricity and EPS Distribucija in field of distribution of electricity, as noted in the introduction to this chapter.

Energy Law 2014 [1] prescribes new obligations that those energy entities must fulfill in the process of obtaining a license, which relate to the provisions regarding the separation and certification of the electricity transmission system operator, as well as the provisions related to the separation of operators distribution system of electricity and provisions related to the compliance program and the person who monitors its implementation. By the decision of the Council of AERS, on 8 December 2017, EMS JSC is licensed for energy transmission and transmission system operation.

3.1.2. Bilateral Electricity Market

A bilateral electricity market is the market on which electricity is directly purchased and sold among the market participants on the basis of agreements on electricity supply (the Energy Law [1]).

The agreement on electricity supply particularly defines the amount of electricity, the price and the period of supply.

The amount of electricity may be:

- determined in advance for each accounting period during the period of supply,
- determined on the basis of the recorded electricity consumption at the point of takeover during the supply period, and
- determined on the basis of the recorded electricity production at the point of takeover during the supply period.

On the wholesale bilateral market the participants trade in electricity at open prices, whereas on the retail bilateral market supply is organized at open market prices and regulated prices, considering that since 2015 all customers, except for households and small customers, have been obliged to purchase electricity in the open market.

The activities of the suppliers and wholesale suppliers in the open market were mostly concerned with the field of cross-border exchange, mostly for transit through Serbia which is dominant due to the central geographic position of the power system of Serbia in the region with eight borders, as well as for the purpose of export and import for final customers.

Table 2 and Table 3 present the relevant indicators of the electricity market in Serbia during the period 2013-2018.

Table 2: Electricity market concentration level in Serbia (2013-2015)[2] [12]

Supplier's activity	2013			2014			2015			
	Electricity quantity [GWh]	Share of three suppliers with the greatest trading scale [%]	Market concentration level	Electricity quantity [GWh]	Share of three suppliers with the greatest trading scale [%]	Market concentration level	Electricity quantity [GWh]	Share of three suppliers with the greatest trading scale [%]	Herfindahl-Hirschman Index - HHI	Market concentration level
Trade with PE EPS										
Sales to EPS	4	100	High	2,047	51	Moderately high	659	72	2,160	High
Purchase from EPS	3,297	54	Moderately high	980	39	Low	1,535	53	1,535	Moderately high
Trade between suppliers										
Sales	1,143	63	High	948	40	Low	1,349	42	852	Low
Purchase	1,298	54	Moderately high	941	26	Low	1,345	36	620	Low
Electricity import and export										
Import	486	46	Moderately high	2,925	43	Low	2,926	49	893	Low
Export	3,672	52	Moderately high	1,255	29	Low	2,306	60	536	Low
Transit										
Transit	8,328	57		12,774	41		14,092	48	815	Low

[2] Herfindahl-Hirschman index (HHI) is defined as the sum of squares of share of a single company in the market. The lower the value, the more developed is market competition. In order to rank market concentration, following boundaries are used: HHI < 1000 – not concentarted, 1001 < HHI < 2000 – moderately concentrated, HHI >2001 – highly concentrated market.

Table 3: Electricity market concentration level in Serbia (2016-2018)[3] [12], [13]

Supplier's activity	2016					2017				
	Electricity quantity [GWh]	Share of three suppliers with the greatest trading scale		Herfindahl-Hirschman Index - HHI	Market concentration level	Electricity quantity [GWh]	Share of three suppliers with the greatest trading scale		Herfindahl-Hirschman Index - HHI	Market concentration level
		[%]	[GWh]				[%]	[GWh]		
Trade on organized electricity market										
Sales	533	80	425,752	3,389	High	848	62	527	1,812	Moderately high
Purchase	533	72	423,169	1,985	Moderately high	848	59	496	1,446	Moderately high
Trade between suppliers on bilateral electricity market										
Sales	5,279	57	2,836	1,883	Moderately high	4,033	36	1,454	732	Low
Purchase	5,279	35	1,481	702	Low	4,033	50	2,018	1,148	Moderately high
Electricity sales to final costumers on open market										
Sales	11,603	98.6	11,424	9,130	High	12,637	97	12,303	8,892	High

Supplier's activity	2018				
	Electricity quantity [GWh]	Share of three suppliers with the greatest trading scale		Herfindahl-Hirschman Index - HHI	Market concentration level
		[%]	[GWh]		
Trade on organized electricity market					
Sales	2,318	64	1,473	1,760	Moderate
Purchase	2,318	41	954	985	Low
Trade between suppliers on bilateral electricity market					
Sales	3,951	33	1,296	659	Low
Purchase	3,951	35	1,372	688	Low
Electricity sales to final costumers on open market					
Sales	13,370	98	13,192	9,273	High

[3] Herfindahl-Hirschman index (HHI) is defined as the sum of squares of share of a single company in the market. The lower the value, the more developed is market competition. In order to rank market concentration, following boundaries are used: HHI < 1000 – not concentarted, 1001 < HHI < 2000 – moderately concentrated, HHI >2001 – highly concentrated market.

In 2018, out of 60 active suppliers, there were 5 of them among the three dominant ones in each activity. Sales on the organized market is moderately concentrated and purchase low concentrated. Trade on the bilateral market is at the level of trade from 2017 with the tendency of reducing market concentration. Unlike 2017, when the high concentration of the bilateral market in the domain of purchase, in 2018 this concentration is low for both directions of trade. The concentration of the retail market is very high, even there is a slight increase in concentration compared to 2017, which is a consequence of the dominant position of PE EPS on the retail market.

Table 13 on the page 15 presents the electricity consumption in Serbia (without APKM) during the period 2013-2018. There was a 1.15% increase in the electricity consumption in 2018 in comparison with 2017.

The total number of metering points for customer delivery in Serbia, without APKM (withut metering points of facilities within Železnice Srbije– 41 in total), was 3,651,169 in the end of 2018. Compared to 2017, the number was increased by 0.3% (3,639,637) [12].

In 2018, only households and small customers (besides having to meet the conditions related to annual income and number of employees, they are restricted to 30,000 kWh consumption in the previous year and all their facilities must be connected to the grid voltage lower than 1 kV) purchased in the organized market. Enforced legal restriction had a dominant impact on the reduction of supply in the regulated market from 15,600 GWh in 2017 to 14,852 GWh in 2018, which is a 4.8% decline. At the end of 2018, electricity at regulated prices was delivered at about 3 million metering points to final customers [12].

The valid regulated price of electricity for the guaranteed supply of end customers was approved on October 1, 2017. The average price increase for all customers with a right at a regulated price is 2%.

Since 2015, all final customers have been able to purchase electricity in the open market where 13,370 GWh was delivered in 2018, which amounted to 47.1% of the total consumption of final customers. The customers in the open market, which included a small number of households, had their electricity delivered to over 110,000 metering points (it amounts to 130,000 along with public lighting). Out of 66 companies licenced for electricity supply in 2018, there were 18 of them active in the open retail market. The dominant supplier in the free market was still PE EPS with a 96.4% share in the total electricity quantites sold to final costumers in the open market and 98.3% share in the final consumption [12].

3.1.3. Balancing Electricity Market

Balancing electricity market was established on January 1, 2013 and functions pursuant to Energy Law [1], Electricity Market Code [11] and Electricity Transmission Grid Code [8]. The legal form for establishing and functioning of balancing electricity market is defined by Energy Law [1], and transmission system operator is responsible for system balancing, according to the Law, which includes the following:

- providing the balancing services in accordance with transparent, non-discriminatory and market principles which will provide adequate incentives for system users to keep balance between their delivery and takeover of electricity;
- determination of the price of electricity for the needs of system balancing, pursuant to Electricity Market Code;
- regular publication of data relating to activated balance energy and settlement price.

On the balancing electricity market, the transmission system operator purchases and sells balancing energy for the purpose of balancing between production, consumption and electricity exchange in real time and ensuring the necessary level of frequency restoration reserve and replacement reserve. Pursuant to Energy Law [1], the transmission system operator, with the prior approval of AERS, shall adopt the Rules of Operation of the electricity market. The rules on the electricity market operation shall regulate in more detail: balance responsibility of market participants, balancing electricity market, calculation of balance group deviations, calculation of financial offsets between balance responsible parties, the payment security instrument and criteria for determining the amount and the period for which it is required, calculation of electricity needed for balancing and ensuring safe system operation, the method for providing system services and other matters necessary for the electricity market functioning.

During 2018, further improvement of the electricity market in the Republic of Serbia was continued, through the introduction of the new information system for market management (Market Management System).

In 2018, 63 electricity market participants had a contract on balance responsibility with EMS JSC, which is, as the transmission system operator, responsible for system balancing and providing system services within its control area. Since the beginning of the balancing market operation, EMS JSC publishes hourly values of activated balancing energy and the settlement price.

In 2018, in line with Contract on Providing Ancillary Services and Contract on Participation in Balancing Mechanism signed with PE EPS, EMS JSC activated the balancing entities of frequency restoration and reserve replacement within its control area for the purpose of keeping balance between the total electricity production, consumption and nominated exchange blocks and calculate the deviations of the balance groups on the basis of which a financial settlement between the EMS JSC and the balance-of-responsibility parties at the monthly level. Also, during 2018 EMS JSC performed so called cross-border balancing for the purpose of keeping balance within its own control area. This was done by activating balancing energy pursuant to contracts on cross-border exchange of balancing energy for replacement reserve with neighbouring transmission system operators, and the engagement consisted of the activation of slow cross-border reserve (emergency electrical energy) and the activation of balancing reserve within accounting period (in accordance with Contract on Sales and Purchase of Balancing Energy for Replacement Reserve for Ensuring Safe System Operation, signed with the transmission system operator of Montenegro (CGES) and NOSBIH (B&H TSO)).

In 2018, the total engaged balancing energy was 832 GWh, for which the total weighted settlement price amounted to 47.83 €/MWh, or, bearing in mind the direction of activated balancing entities [17]:

- In cases where the total balance energy in the calculation interval was greater than zero: 61.06 €/MWh,
- In cases where the total balance energy in the calculation interval was less than zero: 25.04 €/MWh.

The transmission system operator is also responsible for providing necessary system services in order to meet the needs of transmission system customers. In order to provide necessary resources, i.e. power capacities and energy for the needs of frequency containment, frequency restoration and replacement reserve, voltage regulation, as well as system restoration after blackout. The contracted reserve of active power for the needs of frequency containment process amounted to 37 MW in 2018. Also in 2018, the contracted active power range for the needs of frequency restoration was 160 MW, while the contracted positive and negative replacement reserve were 300 MW and 150 MW, respectively.

In accordinance with ENTSO-E requests, 37 MW frequency containment reserve were contracted. During the year, after each failure of the aggregate exceeding 1,000 MW in interconnection, total response of frequency containment proceess in Serbia was tested and satisfactory results were obtained.

Required reserve of active power in frequency restoration within the EMS JSC control area is 160 MW, while on the other hand the total available frequency restoration reserve in the EMS JSC control area is 986 MW (out of which 826 MW in hydro power plants and 160 MW in thermal power plants), so it can be concluded that EMS JSC should not have problems in securing frequency restoration reserve in the coming period. However, even though the quality of frequency restoration process has had a slight upward trend for a while, it should be mentioned that it is still not on a satisfactory level. After December 2017, there was a sharp deterioration in quality of operation of frequency restoration process due to unauthorized takeover of electricity in part of control area of Serbia in Autonomous Province of Kosovo and Metohia.

In 2018, the number of hours of satisfactory operation of frequency restoration was between 0% (the value in February) and 54% (the value in April). The average hourly regulation error was between -367.5 MW and -34.4 MW, while the average hourly regulation error without UMNIK was between 1.6 MW and 87.1 MW. The standard deviation of regulation error was between 0 MW and 221.5 MW.

EMS JSC is taking mesures in order to additionally improve the quality of operation of frequency restoration. In this respect, EMS JSC, together with the transmission system operators of Macedonia (MEPSO) and Montenegro (CGES) with whom it forms a control block within a synchronised area Continental Europe, during 2018 continued redefining the operating mode of frequency restoration in the way which would enable the exchange of frequency restoration energy in real time, in accordance with European grid codes.

During 2018 PE EPS satisfactorily fulfilled contractual obligations related to securing reserve replacement, while EMS JSC covered his needs for the procurement of reserve from abroad mainly by exchange of cross-border regulating energy for replacement reserve from CGEC (transmission system operator of Montenegro) and NOS BiH (transmission system operator of Bosnia and Herzegovina). In relation to emergency situation energy, cross-border tertiary regulating energy can be activated much faster (in 15 minutes), the procedure is simple, and the price of energy is usually lower. In 2018, EMS JSC procured the total of 3,546 MWh and delivered 2,997 MWh of cross-border regulating energy. Also, during the 2018 EMS JSC procured the total of 900 MWh and delivered 700 MWh of emergency energy.

During 2018, EMS JSC actively participated in the establishment of a single European balancing market through membership of working groups and project teams within the ENTSO-E. EMS JSC is also an active participant in two European projects:

- IGCC project - the future European platform for netting of unwanted deviations - Imbalance Netting - EMS JSC is a non-operational member with membership in the IGCC steering committee.
- MARI project - the future European platform for the market of fast tertiary regulation (mFRR) - EMS JSC has the status of an observer and actively participates in the modeling and implementation of the future EU platform.

3.1.4. Organized Electricity Market

Pursuant to Energy Law [1], organised electricity market is an institutionally regulated relationship between supply and demand of the electricity market participants with predefined standardised products and physical delivery, on a time-scale of one day in advance and within a day. The activity of organised electricity market management shall be performed by the market operator founded by the transmission system operator, in the manner prescribed by an act of the Government.

The market operator shall be responsible for establishment of the organised electricity market, administering of the organised electricity market, efficient and functional connection of the electricity market in the Republic of Serbia with neighbouring electricity markets, in cooperation with the transmission system operator in the Republic of Serbia, as well as transmission system operators and market operators of neighbouring countries, in accordance with internationally defined principles and undertaken obligations.

EMS JSC, as an energy entity that was licensed to perform energy activities in the organization of the electricity market, founded on July 14, 2015 SEEPEX - power exchange, formed on the basis of partnership with EPEX SPOT. At the beginning, SEEPEX [13] decided to manage an organized market with standardized products on a day-ahead market.

The benefits that SEEPEX has generated in the development of the electricity market in Serbia and the region is reflected through:

- getting a new product,
- harmonization of the trade process and clearing in the organized market in accordance with the best European practice,
- transparent pricing mechanism,
- getting and publishing the reference price,
- financial security of transactions concluded on the organized market through a centralized clearing and financial settlement process and
- promotion of competition.

The power exchange[4] started operating in February 2016. On the stock exchange, 18 participants were registered in 2018, which is 2 more than in 2017. All registered participants were actively involved in the trade, which is for 3 participants more than in the previous year. Currently SEEPEX has two standardized products ― Single Contract Orders and Block Orders. Offers for individual hours contain up to 256 price/quantity combinations for each hour of the next day. Prices must be between 0.0 €/MWh and 3,000 €/MWh. A volume (whether positive, negative or nil) must be entered in the price range. Block Orders were successfully introduced on March 22, 2017 which enabled the participants to enter orders for one or more delivery periods with a minimum one-hour delivery for the same day of delivery. Block orders are used to link several hours on an all-or-none basis, which means that either the bid is matched on all hours or it is entirely rejected. Pre-defined Block Orders exist but participants are not restricted in the determination of the Block Orders of their choice.

The total amount of electricity that was traded on SEEPEX in 2018 was 2,318 GWh. Part of that energy was delivered for final consumption, since one of the participants on the trade since July 1, 2018, until the end of year, was a transmission system operator. The transmission system

[4] SEEPEX activities can be followed on the website www.seepex-spot.com.

operator purchased part of the electricity to compensate losses, and in certain hours sold the surplus electricity purchased through its auction platform for the compensation of losses. The highest monthly trading volume of 259,995 MWh was realized in December, and highest daily trading volume of 12,367 MWh on November 25, 2018. The lowest monthly trading volume was in February and accounted for 95,978 MWh. The highest hourly rate reached on November 22, at 6 p.m. and amounted to 126,8 €/MWh. The average annual price was 50.1 €/MWh.

3.2. Production, Transmission and Distribution Capacities

3.2.1. Production Capacities

3.2.1.1. Conventional Energy Sources

The total net installed capacity of the power plants in Republic of Serbia in 2018 amounts to 7,783 MW: in lignite-fired thermal power plants 4,079 MW, in hydro power plants 2,948 MW, in natural gas-fired or heat oil-fired thermal power plants 336 MW and in small hydro power plants 97.076 MW (Table 4). The lignite used in thermal power plants is produced in open pits which belong to PE EPS.

In addition to the production capacities of Republic of Serbia, the renewable sources includes power plants, CHP and gas plants with a total net production capacity of 322.73 MW.

Table 4: Net production capacities from 2013 to 2018 [26]

Technology	Net production capacity [MW]					
	2013	**2014**	**2015**	**2016**	**2017**	**2018**
Thermal power plants (coal)	3,827	3,846	3,971	4,032	4,054	4,079
Combined heat and power plants (gas, fuel oil)	277.0	249.0	249.0	336.0	336.0	336
Hydro power plants	2,918	2,929	3,010.59	3,016.08	3,029.13	3,045.08
Small power plants	34.25	44.92	46.09	52.28	57.03	97.076
Other sources (renewable sources)	8.88	13.86	14.69	37.56	39.84	290.90
Wind power plants	0.5	0.5	0.5	17	17	264.28
Solar power plants	3.48	8.46	9.29	10.22	10.5	10.708
Biogass power plants	4.9	4.9	4.9	10.34	12.34	15.909
CHP	9.6	11.9	11.9	20.80	20.50	28.426
Gas plants						3.410
Total	**7,041**	**7,050**	**7,257**	**7,442**	**7,479**	**7,783**

The share of the capacities within thermal power plants (TPP) and combined heat and power plants (CHP) amounts to 57%, while the hydro power plants (HPP) cover 39%. There is also one pumped-storage hydro power plant among HPPs of PE EPS with 2x307 MW capacity which is very important for system operation, apart from covering an important energy share, and about 4% of the installed capacity are other power plants.

In addition to PE EPS, which is the largest and dominant electricity producer, the license for the production of electricity has 22 more energy entities and for combined production of electricity and heat has another 7 energy entities (including PE EPS). Of all of them, the highest are NIS JSC with 11.94 MW installed in 9 facilities, Vetropark Kula with 9.9 MW, power plant in Novi Sad with combined production of 9.98 MW, Elicio company with wind farm Alibunar with 42 MW and Malibunar with 8.320 MW, "ENERGOBALKAN d.o.o." with the wind farm "La Piccolina" with 6.6 MW, "Electrawinds K-Wind d.o.o. Beograd-Novi Beograd" with wind farm Kovačuca with 104.5 MW and "Vetroelektrane Balkana d.o.o, Beograd (Stari grad) " with wind farm Čibuk 1 with 158.46 MW.

The construction of new production units is needed in order to replace the existing ones, which, due to outdated technology cannot meet the requirements of environmental protection, as well as to cover the possible increase in electricity consumption.

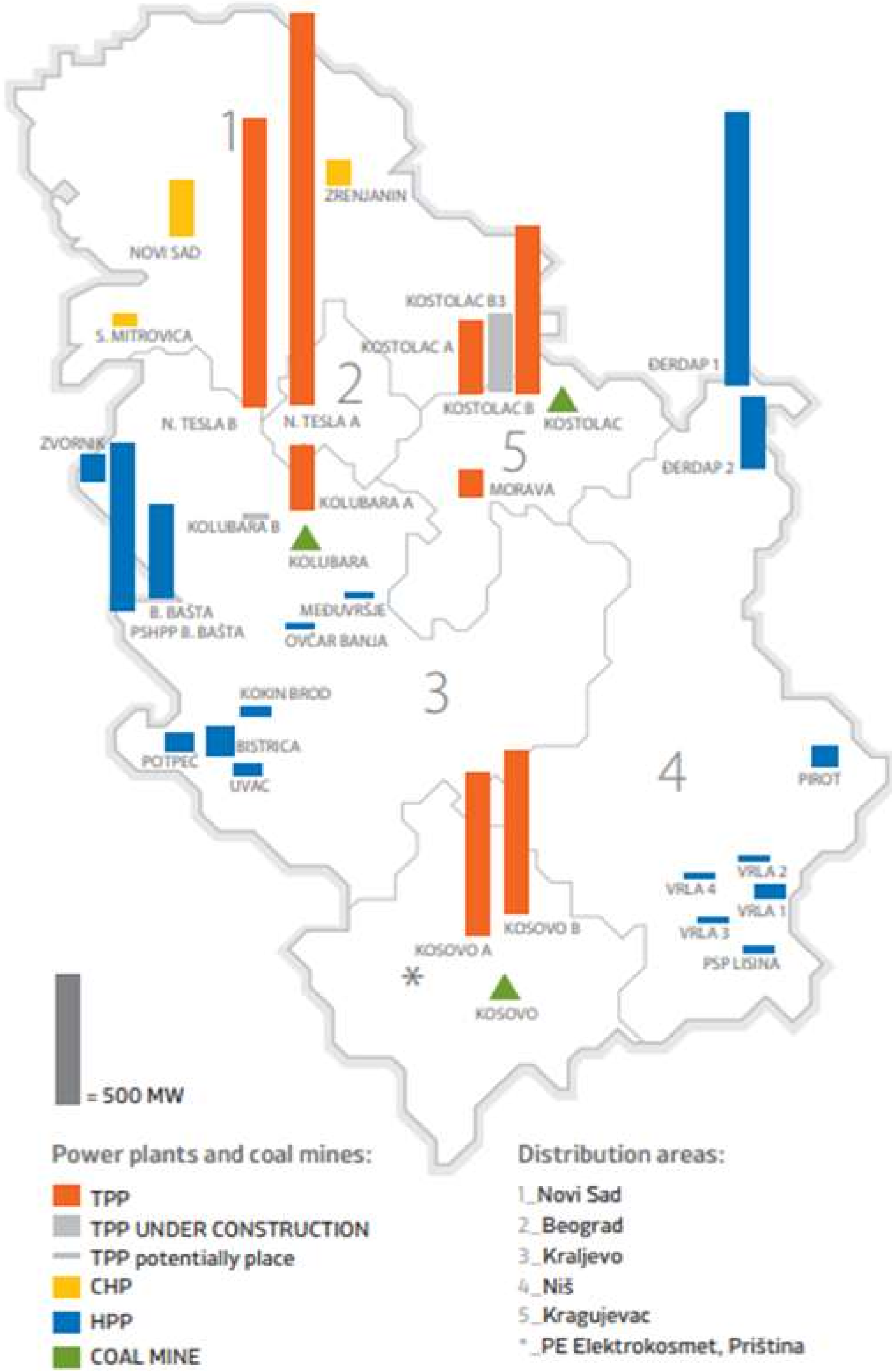


Figure 1: Production capacities PE EPS[5]

[5] As of June 1999, EPS does not operate its facilities on the territory of Autonomous Province of Kosovo and Metohija.

3.2.1.2. Renewable Energy Sources

Pursuant to the Article 20 of the Energy Community Treaty (Official Gazette of the RS, no. 62/06) the Republic of Serbia accepted the commitment to apply European Directives in the field of renewable energy sources - Directive 2001/77/EC for the promotion of electricity from renewable energy sources and the Directive 2003/30/EC for the promotion of biofuels or other fuels produced from renewable energy sources for transport. Since 2009 mentioned Directives were gradually replaced and in January 2012 they were repealed by a new Directive 2009/28/EC of the European Parliament and Council, dated April 23, 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

In accordance with the Directive 2009/28/EC [14] and the Decision of the Council of Ministers of the European Community dtd. October 18, 2012 (D/2012/04/MC-EnC) a very ambitious binding target was set for the Republic of Serbia, amounting to 27% renewable energy sources in final gross energy consumption in 2020 and 10% of the energy share of produced from renewable energy sources in transport in 2020. At the same time, it was defined that the National Action Plan for renewable energy sources of the Republic of Serbia should be prepared, in compliance with the adopted template for the preparation of this document (Decision 2009/548/EC).

The Republic of Serbia in 2013 has adopted the National Renewable Energy Action Plan [15] as a framework for the promotion of energy produced from renewable sources and has set mandatory national targets for the share of energy from renewable energy sources which defined the way of achieving binding national target.

Pursuant to the abovementioned and in order to increase the use of renewable sources, Republic of Serbia joined the countries that subsidize the production of electricity from renewable sources and introduced the most widespread model - stimulated fixed redemption price (the "feed-in" tariffs) with the guaranteed electricity takeover of 12 years.

The following indicators can be seen from the report on the collected and disbursed funds for incentives for privileged electricity producers for 2017. and 2018, published by PE EPS, a branch of EPS Supply. The total electricity generated in the incentive system for 2017. is 426,305,002.17 kWh, and for 2018. it is 628,164,607.31 kWh (an increase of 47.35%).

PE EPS, a branch of EPS Supply, as a guaranteed supplier, has a legal obligation to purchase the electricity produced from privileged and temporarily privileged producers. On that basis, in a separate account, funds from an incentive fee, which is invoiced to all final customers of electricity in accordance with Article 79 of the Energy Law (Official Gazette 145/14, 95/18-second Law) are collected, whose purpose is payment of electricity taken from the privileged and temporarily privileged producers. The amount of incentive fee has not changed since January 2015 and amounts to 0.093 RSD / kWh.

Incentive measures can be used by energy entities that have acquired the status of a privileged producer within the meaning of the Energy Law [1]. The privileged producer is entitled to incentive measures by concluding a contract on purchase of electricity with a guaranteed supplier.

The Government, at the proposal of the Ministry in charge of energy, adopts regulations that detail the conditions and procedure of acquisition, duration and termination of the status of privileged producer of electricity from renewable energy sources, the maximum capacity of all power plants using wind and solar energy that will get status of privileged producer, content and other elements of the contract on purchase of electricity. In accordance with the Energy Law [1] Ministry in charge of energy monitors the implementation of the National Renewable Action Plan and submits the annual report to the Government (hereinafter: the Report). Also, in accordance with Article 15 of the Decision of the Ministerial Council of the Energy Community (D/2012/04/MC-EnC) signatories to the Treaty establishing the EnC submit report to the EnC Secretariat on progress in the promotion and use of energy from renewable sources every two years. The first report was made in 2014 (Official Gazette of the RS, no. 8/15) and contains data for year 2012 and 2013, while the Report of the progress on implementation of the national action plan for renewable energy sources was adopted in December 2016.

The quantities of electricity taken over from renewable sources from 2013 to 2018 are shown in Table 5.

Table 5: Electricity production from renewable sources from 2013 to 2018 [16], [26]

Renewable energy sources	Electricity [GWh]					
	2013	2014	2015	2016	2017	2018
Hydro power plants	10,853	11,617	10,783	11,520	9,752	11,393
Solar power plants	1.50	6	11.45	12.43	13.14	13.04
Wind power plants	0.55	0.37	0.42	25.91	48.45	150.42
Biogass power plants	18.70	20.65	23	34	71.6	84.9
Total	**10,873.75**	**11,644.03**	**10,817.87**	**11,592.34**	**9,885.19**	**11,641.52**

3.2.2. Transmission Capacities

Transmission system of Republic of Serbia includes 220 and 400 kV network and one part of 110 kV network in accordance with the Energy Law [1].

Transmission lines 400 kV connect the largest and most important centres of production and consumption in Serbia. Mainly over this voltage level, whole power system of Serbia is interconnected with power systems of the neighbouring countries, allowing international trade of electricity. Transmission system makes Serbia part of a Pan-European system for the transmission of electricity. Over interconnection lines Republic of Serbia is directly connected with eight countries and provides the transmission of electricity from north to south, from east to west and from the northeast to the southwest of Europe [17].

Transmission system of EMS JSC is connected with the neighbouring power systems via twenty-seven 400, 220 and 110 kV interconnection lines, while 22 of them are active. In addition to transmission lines and power plants transmission system includes other supporting systems (telecommunication system, remote control system, power consumption, etc.). All of this makes transmission system one of the most complex infrastructure systems.

The electricity transmission system of the Republic of Serbia which EMS JSC is responsible for, is shown in Table 6 and Table 7.

When it comes to the capacity of the facilities which are owned by EMS JSC in 2018, only a small change in capacity occurred due to the replacement of three 110/35 kV transformers of 20 MVA with new transformers with the same characteristics but higher power (31.5 MVA) - two in TS Kruševac 1 during the reconstruction of this TS and one in the TS Požega. In 2018, there were no other changes in capacity in EMS JSC facilities, and three new switching stations for wind power plants were put into operation, SS 400 kV Čibuk 1, SS 220 kV Kovačica and SS 110 kV Alibunar.

During 2018, there was an increase in the transmission line capacity of EMS JSC in amounted to 118.9 km (21.63 km 400 kV, 3.09 km 220 kV and 94.18 km 110 kV) due to the following investments: introduction of OHL 453 SS Drmno - TS Pančevo 2 in SS Čibuk, introduction of OHL 254 TS Pančevo 2 - TS Zrenjanin 2 in SS Kovačica, introduction of OHL 151/2 TS Pančevo 2 - TS Alibunar in SS Alibunar, introduction of OHL 151/3 TS Alibunar - TS Vršac 1 in SS Košava, introduction of OHL 104B node Beograd 9 - TS Stara Pazova in TS Krnješevci and introduction of OHL 1127 TS Kraljevo 1 - TS Kraljevo 2 in TS Kraljevo 6. Also during 2018, the following 110 kV transmission lines were take over from the Serbian Railways Infrastructure: OHL 166/2 TS Sr. Mitrovica 1 - TS Sr. Mitrovica 2, OHL 166/3 TS Sr. Mitrovica 2 - node Martinci, OHL 166/4 node Martinci - EVP Martinci, OHL 170/1 TS Sr. Mitrovica 2 - EVP Martinci, OHL 170/2 TS Sr. Mitrovica 1 - TS Sr. Mitrovica 2 and OHL 1118 TS Prijepolje - EVP Brodarevo. Also, some of the changes in the table are related to the overview of the transmission lines are due to the fact that during the transfer of data to the new technical base of, certain defects that were figured in the previous technical base were noticed.

In line with the Energy Law [1], the handover of overhead lines and cables 110 kV between EMS JSC and PE EPS which started in 2013 is fully completed in 2018 [18].

Table 6: EMS JSC facilities [17]

Facilities owned by EMS JSC		2013	2014	2015	2016	2017	2018
400/x kV	Number of facilities	16	17	18	18	18	19
	Number of transformers	23	24	29	29	29	29
220/x kV	Number of facilities	14	14	14	14	14	15
	Number of transformers	31	31	30	30	30	30
110/x kV	Number of facilities	6	6	6	6	6	7
	Number of transformers	13	13	14	14	14	14
Total	**Number of facilities**	**36**	**37**	**38**	**38**	**38**	**41**
	Number of transformers	**67**	**68**	**73**	**73**	**73**	**73**

Table 7: EMS JSC transmission lines [17]

Power lines owned by EMS JSC		2013	2014	2015	2016	2017	2018
400 kV	Number of OHL	32	33	34	34	36	37
	Length of OHL (km)	1,613.72	1,613.72	1,630.04	1,629.4	1,766.1	1,787.7
220 kV	Number of OHL	48	48	46	46	46	47
	Length of OHL (km)	1,884.47	1,884.47	1,845.51	1,844.59	1,844.59	1,847.68
110 kV	Number of OHL	332	341	353	359	358	367
	Length of OHL (km)	5,578.68	5,641.47	5,785.78	5,821.29	5,805.23	5,899.41
110 kV	Number of cable каблова	-	-	-	-	9	9
	Length of cable (km)	-	-	-	-	36.58	36.58
< 110 kV*	Number of OHL	15	12	12	11	10	10
	Length of OHL (km)	245.50	235.03	231.85	220.62	220.63	220.63
Total	**Number of lines**	**427**	**434**	**445**	**450**	**459**	**470**
	Length of lines (km)	**9,322.37**	**9,374.69**	**9,493.18**	**9,515.90**	**9,673.09**	**9,791.99**

*110 kV OHL works on the 35 kV voltage.

3.2.3. Distribution Capacities

Distribution system of Republic of Serbia includes 35 kV, 20 kV and 0.4 kV network and transformer stations 110/X kV, in accordance with the Energy Law [1].

Within the EPS Distribucija there are 39,160 transformer stations with a total installed capacity of 32,615 MVA (Table 8) and 165,102 km of power lines of all voltage levels (Table 9).

The process of handover of substations between EMS JSC and PE EPS in accordance with the Energy Law [1], which started in 2013 is fully completed in 2018 [18].

Table 8: EPS Distribucija facilities [18]

Facilities owned by EPS Distribucija		2013	2014	2015	2016	2017	2018
110/X kV	Number of facilities	177	186	183	187	188	189
	Installed capacity [MVA]	9,476	10,388	10,326	10,623	10,540	10,595
35/10 kV	Number of facilities	589	589	583	581	562	583
	Installed capacity [MVA]	6,313	6,313	6,439	6,446	6,317	6,397
20/0,4 kV	Number of facilities	8,044	8,126	11,141	8,344	8,492	11,688
	Installed capacity [MVA]	3,052	3,087	5,174	3,188	3,247	5,510
10/0.4 kV	Number of facilities	25,542	27,535	26,372	25,765	25,916	26,700
	Installed capacity [MVA]	9,435	11,209	9,913	9,770	9,749	10,113
Total	**Number of facilities**	**34,352**	**36,436**	**38,279**	**34,877**	**35,158**	**39,160**
	Installed capacity [MVA]	**28,276**	**30,997**	**31,852**	**30,027**	**29,853**	**32,615**

Table 9: EPS Distribucija power lines [18]

Power lines owned by EPS Distribucija (km)	2013	2014	2015	2016	2017	2018
110 kV	183	151	33.66	33.66	7.86	
35 kV	6,844	6,830	6,823	6,791	6,582	6,613
20 kV	9,053	9,251	9,388	9,587	9,960	11,679
10 kV	30,530	32,349	32,701	32,929	33,153	33,637
0,4 kV	105,401	109,928	110,919	111,540	112,230	113,173
Total	**152,011**	**158,509**	**159,865**	**160,881**	**161,933**	**165,102**

3.3. Scope and Quality of the Production, Transmission and Distribution Systems Maintenance

3.3.1. Production Maintenance

The program for maintenance of electricity and heat production in 2018. included the following activities: (planned-preventive and corrective, ie intervention maintenance), overhaul (standard, extended and capital) and investment maintenance (modernization of equipment, increase efficiency, prolonging the life of plant exploitation, increasing installed capacity, environmental programs and other).

The goals of routine maintenance in 2018 were: determining and monitoring the state of the plant through regular preventive examinations and various methods of diagnostics, implementation of minor preventive work on plants, analysis of observed disorders and taking necessary corrective measures at a convenient time and in cases of sudden failure of the plant, organization of quickly failures repair and returning the plant to the working state.

Maintenance of TPP and CHP

When it comes to thermal power plants and combined thermal - heat power plants, even in previous report it was noted that during the year 2017 there was not a mid-volume overhaul, nor capital overhauls. Only standard overhauls on 17 blocks are done (from the total of 22, under the management of PE EPS). The typical duration of the standard overhaul is 3 - 6 weeks (per block), and during it the repair and recovery of the mutilated circuits were performed, as well as replacement of parts that are assumed to be unable to withstand, without failure, until the next overhaul.

During 2018, there was a increase in the number of outages of coal-fired thermoblocks. The summary of the data is given in the following table.

Table 10: The number of outages of coal-fired thermoblocks in PE EPS for 2017. и 2018.

Year	Boiler pipe system	Turbine facillity	Tehnological and electrical protection	Power facillity	Other	∑ without suppresion	Cold reserve suppression
2017	48	12	37	4	35	136	18
2018	78	29	22	2	48	179	22

The table shows the exacerbation of results in most categories. The total increase in the number of outages, excluding the cold reserve suppression, increased by 43, respectively 31.62%. Positive is certainly the reduction in the number of outages due to technological and electrical protections. The worst situation is reflected in the failure of the boiler pipe system and turbine facility as the vital elements of thermal power plants. This is a direct consequence of two reasons: losing dynamics in the overhaul during the recent years and increasing problem of variations in the quality of coal (as well as its shortages) delivered to power plants of the TENT branch (which occurred on a daily basis). Of particular concern is the large exacerbation of parameters when it comes to TPP Kostolac B. When analyzing the first three categories in the previous table, the number of outages in mentioned TPP increased from 15 to 33. It is also evident that the number of outages due to the boiler pipe system is significantly increasing when it comes to TENT B (by 60%). This is of particular concern as it is about individually our largest capacities for generating electricity. When it comes to TENT power plants, an effect of pushing blocks into the cold reserve is present (mainly due to lack of coal) and this parameter is also increasing. These data are taken from the official annual reports on the implementation of the program of maintenance of PE EPS power plants for 2017 and 2018. In the phase of preparation of substrates, certain data for individual categories for 2018 have been slightly adjusted by PE EPS, which does not affect the above conclusions.

The following overhauls are planned for PE EPS thermal units in 2018:

- Standard overhauls of up to 30 days on the following units: TENT A2, A3, B1, B2, TPP Kolubara A3, TPP Morava, TPP Kostolac A2 and B1.
- Extended overhauls of 30 to 60 days on aggregates: TENT A1, A5, A6, TPP Kostolac A1 and B2.
- Capital overhauls on TENT A4 units (more information on this project of power lift can be found in the section 3.10), TPP Kolubara A5 and CHP Novi Sad A2.

The repair works were carried out in approximately planned duration and volume on the following blocks of thermal power plants: TENT A3, B1 and B2, TPP Kolubara A3 and A5, TPP Morava, TPP Kostolac A1, A2, B1 and B2.

On other thermoelectric units, there was a change in the planned term of performing overhaul works, as well as in the volume of necessary works and the time required to perform them. The terms of the repairs have been harmonized with the consumption of electricity, overhauls of mining facilities and the realization of public procurement of goods and works. Maintenance in railway transport TENT was harmonized with the overhaul of the mines and reduced to the maintenance of parts of the track, overhaul of wagons and locomotives, recording of geometric characteristics of the track, installation of slip detectors on 324 circuits and other standard activities. PE EPS believes that the level and quality of the works performed are sufficient for reliable operation of thermal power plants in the winter.

According to The Strategy [2] and Program [3] by the end of 2023, it is planned to withdraw thermo-blocks from the plant: TPP Kolubara A1, A2, A3 and A5 (block A4 is out of operation since 2009), TPP Morava. TPP Kostolac A1 and A2 (meanwhile, a different decision was made for Kostolac A1 and A2 in PE EPS,). The total power of the mentioned capacities at the border of the transmission system is 605 MW. Based on the achievement of the electric power portfolio of PE EPS for 2016, the mentioned capacities produced a total of 3,042.2 GWh, and in 2017 they produced 3,234 GWh. More than 3 TWh these blocks have also achieved in the previous year, 2018. Therefore, taking average value in these three years, we can consider that due to the withdrawal of these blocks, the annual production of electricity after 2023 will be lower by 3.1 TWh. It should be said that the remodeling program for 2017 did not include blocks A1 and A2 in the TPP Kolubara A and that they are not scheduled to be reconnected to the network. However, looking at the previous year's performance, it can be seen that despite years of withdrawal announcements, the A1 and A2 units at TPP Kolubara A are still online and producing electricity in a in the mode of significantly less efficiency than other TPPs. Based on the technical documentation and decisions that are made, the units at the location of TPP Kostolac A continue to operate after 2023, that is, they will be revitalized for the next 100,000 hours (15 years).

Hydro sector

PE EPS has 49 classical hydro-generators, two pumping plants, two reversible hydro-generators and one household aggregate (the third aggregate in HPP Međuvršje). All these aggregates were organized in a total of 16 hydropower plants and one pumping accumulation plant through branches of HPP Đerdap and HPP Drina Limska. It should be emphasized that in the previous year, the two most important were the start of two revitalizations, completed one and completed four major overhauls:

- Unit A2 at HPP Đerdap 1. The revitalization of this unit started on September 3, 2018. year and the plan for completion is 13.5 months. This is the fifth unit to be revitalized and after its completion, unit A3 remains to be revitalized.
- Aregat A3 in HPP Zvornik. The revitalization of this unit started on January 11, 2018 and the plan for completion of works is January 10, 2019. years.
- Aggregate A2 in the HPP Zvornik. The revitalization of this unit started on December 27, 2016, and the plan for the completion of the works was on January 6, 2018. The official end of revitalization was 10.01.2018. year when trial work was completed. The power of the aggregate is now 31.4 MW, so increase is 7.4 MW in regard to the maximum power before revitalization.

Major overhauls were made at the units of HPP Bajina Bašta A1 (47 days), HPP Potpeć A2 (53 days), HPP Đerdap 2 A7 (114 days), HPP Đerdap 2 A8 (101 days).

Regarding other hydroelectric units, controls were mainly carried out and standard overhauls were carried out in several cases. The pump-aggregate line number 1 in PSP Lisina was damaged (electric motor M1). Rehabilitation is not complete. It should be noted that the revitalized A6 unit at HPP Đerdap 1 was out of operation for more than 22 days due to unplanned deadlock during 2018. Failures were removed and the unit is in operation.

Other activities:

- Preparation on construction site for the project "Construction of flue gas desulphurization plants TEHT, A3 and A6" (financed by the Government of Japan) has also been intensified. Deadline for finishing of the work is September 2021.
- Preparation of investment and technical documentation is in progress for the completion of the ash and slag landfill at the TENT A site - cassettes 4 and 5, because by the end of 2020, the projected capacities on cassettes 1 to 3 will be filled. This project is closely related to the ash and slag congestion project for the TENT A site.
- The construction of a hazardous and non-hazardous waste disposal site at TENT A has been completed and the construction of the same storage facility at TENT B has begun.
- Feasibility Study and Conceptual Design for Revitalization of Units A1 and A2 in TENT A have been adopted by the Expert Council of PE EPS, and in the meantime teams have been formed to prepare the implementation of this project.
- In 2018, the construction of a warehouse for the temporary storage of hazardous waste at the TENT A site are continued and completed.
- As regards to overhaul within the coal production, processing and transportation units, over the course of 2018, it is planned to start and complete overhaul of a total of 18 coal systems, 9 coal production systems and 3 coal processing lines. All planned overhauls were completed during 2017, except in the case of ECS discovery systems for coal where the overhaul was not performed on 3 coal systems (out of 18 planned).

3.3.2. Transmission System Maintenance

Energy Law [1] stipulates the obligation of the system operator to ensure safe and reliable transmission of electrical energy, which therefore implies adequate maintenance.

During 2018. the focus of works on power lines was on regular maintenance, inspections, and overhauls. The 99.3% of the planned disconnections were made to 110 kV, 100% to 220 kV and 93.1% to 400 kV voltage level (about 99% of planned by number). On all transmission lines 400 kV, 220 kV and 110 kV, which were excluded in 2018, works on maintenance of the corresponding fields were made.

It should be emphasized that in 2018 all planned overhauls and transmission line checks were carried out, except OHL 1140/2, problematic part of the route along the mainland safety zone with AP KiM, due to the inability to obtain approval for the execution of works, as well as OHL 425, OHL 449A, OHL 449B, OHL 101A/3, OHL 101A/4, OHL 101B/4, OHL 102A/1, OHL 102B/1, OHL 1144A, OHL 1144B, OHL1187A, OHL 1187B и OHL 154/2, due to the inability to obtain energy consent.

In 2018, a total of 8,722 km of transmission lines of all voltage levels were repaired. 89.32% of the total length of all transmission lines (without the Obilic sector), by voltage levels: 91.53% 110 kV transmission lines, 97.56% 220 kV transmission lines and 72.88% 400 kV transmission lines. In addition to the works on the installation of certain transmission lines in switching substation and substations, one investment is also worth of mentioning: the installation of OPGW ropes on the feeder OHL 198 between substations Kragujevac 2 - Kragujevac 3.

During 2018, works of replacement the damaged OPGW rope were carried out to on some EMS JSC transmission lines:

- OHL 110 kV no. 148/2 between substations Bor 2 - Zaječar 2, repair of damage to OPGW rope in pillar range no. 37 – 38.
- OHL 110 kV no. 133/1 between substations Srbobran - Bačka Topola 2, repair of damage to OPGW rope in pillar range substations Srbobran no. 1.
- OHL 110 kV no. 129AB/2 between substations Beograd 3 - Beograd 20, repair of damage to OPGW rope in pillar range substations Beograd 3 no. 9.

Operational competence of transformers and high-voltage equipment was at a high level during 2018. Quality preventive and corrective maintenance of high voltage equipment, regular inspections, checks and overhauls, and reconstruction of fields in transformer stations contributed to good competence of transformer stations.

In 2018, all overhaul of 220/X kV and 110/X kV transformers which are planned were done and for the transformers 400/X kV were completed 98.6% (no overhaul of the T-2 in substation Obrenovac was done since it was not possible to overhaul the related transformer fields).

In addition to the planned work, there were significant engagements to correct and intervene in the appered deficiencies.

Major works on high-voltage equipment and substations during 2018 are the following:

- Continuation of the reconstruction of the substation 220/110/35 kV Srbobran, the 110 kV switching substation and its own consumption have been reconstructed.
- On the substation 220/110/35 kV Smederevo 3 in 2018 reconstruction of 110 kV switching substation was completed and reconstruction of 10 kV switching substation for own consumption was started.
- On the substation 220/110/35 kV Kruševac 1, in 2018, the planned replacement of two transformers T-3 and T-4, 110/35 kV with a power of 20 MVA was done with new transformers of the same characteristics, only with a higher power of 31.5 MVA. Reconstruction of its own consumption, oil sewage system was performed and reconstruction of the 35 kV switching substation was started. Disassembled transformers in substation Kruševac 1 are conserved and stored as a reserve in the same substation.
- The planned replacement of transformer T-2 110/35 kV was carried out in the substation 220/110/35 kV Požega. A power transformer 20 MVA was dismantled and a 31.5 MVA power transformer installed. Due to changes in the value of short-circuit currents, switchgear equipment in the transformer and connection field 35 kV were replaced. The dismantled transformer 20 MVA from Požega TS was conserved and stored as a reserve in the same substation.
- At substation 400/220/110 kV Niš 2, planned replacement of worn out disconnectors 400 kV has been started.
- Adaptation of own consumption of switching substation 110 kV Đerdap 2 is completed.
- Planned replacement of the high voltage equipment was done in the fields of feeder: 297/2 and 291 in the Požega substation, feeder 142/3 in the Zrenjanin 2 substation and T2

110 kV in the Pančevo 2 substation and construction of the 110 kV field in the Beograd 17 substation.

3.3.3. Distribution System Maintenance

The revitalization of TS 110/X kV is being carried out phase-by-stage, starting in 2015. In the first phase, eight TSs for revitalization were selected: Petrovac 1, Šabac 1, Aleksinac, Gornji Milanovac, Lešnica, Niš 1, Zrenjanin 1 and Beograd 2. For the first five TSs funds were provided from the World Bank through loans. During 2017 and 2018, procurement and receipt of materials and equipment for these five TSs were carried out. In mid-2019, construction work on the 110/X kV Gornji Milanovac substation was started and the works will be completed by the end of the same year. The remaining four substations are in the process of obtaining the necessary permits for construction work (TS Šabac 1 is in the process of obtaining a building permit, TS Petrovac 1 has obtained location conditions, TS Aleksinac and TS Lešnica are in the phase of obtaining a certificate for usage permit). According to the plan, the completion of the reconstruction of these 4 TSs is planned for 2020. For the remaining three TSs, preliminary projects were made.

The second phase started the contracting of investment-techniques documentation that includes the collection of building works permits. In the second phase, the following TS 110/X kV are planned: Beograd 10, Požarevac 1, Kuršumlija, Raška and Bor 1 (TS Kuršumlija obtained a building permit, TS Beograd 10 received location conditions, TS Požarevac 1 ia in the process of obtaining location conditions, TS Raška is in the process of drafting a usage permit).

The third phase involves the reconstruction of eight more TS 110/X kV, four of them are over jurisdiction of EMS JSC, and four were owned by PE EPS. During 2018, project technical documentation was prepared.

The most significant new elements of the distribution system put into operation in 2018 are two new transformer stations of primary voltage 110 kV, 110/10 kV Kraljevo 6 - Ribnica with power 31.5 MVA and 110/35/10 kV Kopaonik with 63 MVA, and a new 110 kV transmission line in the 110/35 kV Raška substation. In this way, the installed capacity at the 110 kV voltage level in 2018 was increased by a total of 94.5 MVA. At the medium voltage level, with the construction of 239 new transformer stations, the installed capacity of this category of facilities was increased by 134.65 MVA. The total increase in the length of the medium voltage distribution network in 2018 is 357.10 km, while the low voltage network has increased by 312.90 km in the same period.

The significant investment into the distribution system automatisation at all voltage levels over the last several years has led to the considerable increase in the number of facilities and elements of the distrbution system which are included in the remote monitoring and control systems (RMC). At 110/X kV substations, as the most important elements of the distribution system, out of the total of 189 facilities from this category, 177 are included in RMC, and it is expected that the remaining 12 substation will be adjusted and included in the mentioned system. As for 35/X kV substation and switching stations, 331 out of the total 594 are included in RMC. The process of automatisation of the elements of the remaining part of the distribution system within the EPS Distribucija is in a considerable progress as well, so that 1,124 different elements/facilities (substation 20(10)/0.4 kV, reclosers and busbar sectionings), which are distributed throught the network, are currently included in RMC.

During 2018, a total of 567 metering points were displaced across the entire EPS Distribucija as part of activities undertaken to reduce non-technical electricity losses.

Implemented activities related to the download of measuring devices and distribution boards in the facilities of existing customers, ie manufacturers connected to the distribution network according to the plan adopted by AERS are presented in more detail in chapter 3.7.3.

Maintenance activities for power facilities (regular preventive audits and overhauls) are carried out in accordance with the monthly purchase orders of EPS Distribucija according to PE EPS. A number of activities could not be carried out during 2018, mainly due to lack of materials, but also due to vehicle shortage issues. However, this represents a small part of the total activities carried out to maintain the distribution system. In addition to the planned work on the regular maintenance of the facilities, there were also significant engagements for corrective and interventional elimination of the deficiencies. The total number of corrective interventions at all voltage levels in 2018 was 98,712.

3.4. Security Assessment of Transmission and Distribution System Operation

The main guideline in the construction of the transmission and distribution network is the "n-1" criteria, according to which failure of any transmission line does not lead to a reduction in the supply of electric power to customers. Radially powered system users in which this criterion is not fulfilled are mostly in rural and mountainous areas at the distribution level.

3.4.1. Security Assessment of Transmission System Operation

Indicators of discontinuity of delivery in the transmission network which are monitored and calculated are the following:

- Power failure – undelivered power [MW] – total failed power on all measuring points where supply was interrupted,
- ENS [MWh] – total undelivered electricity which amounts to total undelivered electricity during all interruptions,
- ENS [%] – a share of undelivered electricity in total delivered electricity,
- AIT [min] – average interruption duration in minutes, a quotient of undelivered electricity and average power.

Indicators of discontinuity in delivery within the transmission network calculated in such a manner for the period 2013 – 2018 are given in Table 11.

Table 11: Indicators of discontinuity in delivery within the transmission network in the period 2013 – 2018 [12]

Interruptions		Power failure – undelivered power [MW]	ENS [MWh]	ENS [%]
2013	Planned	161	618	0.002
	Unplanned	1,770	747	0.002
	Total	1,931	1,365	0.004
2014	Planned	115	110	0.0003
	Unplanned	1,905	3,496	0.0104
	Total	2,020	3,605	0.0107
2015	Planned	359	1,543	0.0046
	Unplanned	2,292	1,659	0.0049
	Total	2,351	3,202	0.0095
2016	Planned	167	547	0.0016
	Unplanned	1,693	1,317	0.0039
	Total	1,860	1,864	0.0055
2017	Planned	306	1,496	0.0044
	Unplanned	1,980	1,418	0.0042
	Total	2,286	2,914	0.0086
2018	Planned	350	1,552	0.0024
	Unplanned	1,059	826	0.0013
	Total	1,409	2,378	0.0037

In 2018, the indicators for unplanned interruptions are significantly better compared to the previous year, in terms of undelivered electricity and power failure. Indicators were reduced to almost half of last year's values. Indicators for planned interruptions are worse, but at the level of the previous five-year average. The increase in power failure, and undelivered electricity due to planned interruptions, is the result of planned works on the transmission system, connection of new elements of the transmission system and overhaul of existing elements.

In 2018 average duration of unplanned interruption amounted to 27.29 minutes, while planned interruption amounted to 13.42 minutes. Total average duration of supply interruption in 2018 amounted to 40.72 minutes [17].

3.4.2. Security of Distribution System Operation

The indicators for the estimation of discontinuity of delivery in the distribution network are the following:

- SAIFI [number of interruptions/user] – average frequency of interruptions per each user, calculated as a quotient of the cumulative number of interruptions and total number of users and
- SAIDI [min/user] – average duration of interruptions in minutes per user, calculated as a quotient of cumulative duration of interruption and total number of users.

Table 12 presents indicators of continuity of supply in the distribution system for the period 2013-2018.

Table 12: Indicators of continuity of supply in the distribution system [12], [18][6]

SAIFI [number of interruptions/user]	2013	2014	2015	2016	2017	2018
Total	8.78	10.53	9.25	8.11	8.38	7.99
Unplanned	6.45	8.09	6.73	6.05	6.42	6
Planned	2.34	2.44	2.52	2.06	1.97	1.99
SAIDI [min/user]	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Total	723,72	1.283	1.029	810	917	811
Unplanned	400.9	850	542	458	578	441
Planned	322.83	433	487	352	338	369

In 2018, indicators of continuity of supply for unplanned interruptions in the distribution system in Republic of Serbia there was a slight improvement compared to the previous year. The average frequency of unplanned interruptions was 6 interruptions per user, while the average duration of unplanned interruptions was reduced from 578 to 441 minutes per average user. The average frequency of planned interruptions is slightly increased to 1.99 interruptions per user, and the average duration of planned interruptions were also increased by about 30 minutes, from 338 to 369 minutes.

3.5. Mechanisms of Congestion Management in Transmission and Distribution Systems

3.5.1. Mechanisms of Congestion Management in Transmission Systems

Congestion in a transmission system is the phenomenon when on the market there is a greater demand for transmission capacity than offered. It is the situation during the auction of capacities when the total value of required capacities on a border, for a given direction and for a given auction period exceeds the value of available transmission capacity [17].

Allocation of cross-border transmission capacity is a mechanism for eliminating congestion between control areas of the neighbouring transmission system operators. At the border of the control area, EMS JSC allocation of cross-border transmission capacity is performed in the form of explicit auctions (a market method through public tender for the allocation of available transmission capacity for a predefined border, direction and time period). There are two types of auctions [17]:

- Joint auctions in which the transmission system operator allocates all available cross-border transmission capacity between two control areas,
- EMS JSC as Serbian Transmission System and Market Operator organizes yearly, monthly and weekly auctions for 50% of the total available cross-border transfer capacity on borders with Albania and Montenegro. Neighbouring TSO organizes auctions for 50% of the total available cross-border transfer capacity.

EMS JSC was conducting allocation of cross-border transfer capacity on its own control area borders during 2018 in the following manner [17]:

[6] Data for 2013 are taken from AERS documentation [11], and for 2014-2018 from EPS Distribucija documentation [18].

- From 2015 joint auctions for transmission capacity allocation are organized on Serbia - Bosnia & Herzegovina border. Annual and monthly auctions are organized by EMS JSC and daily auctions and intraday allocations are organized by NOSBIH (B&H TSO).
- From 2013 joint auctions for transmission capacity allocation are organized on Serbia - Romania border. In 2018 daily auctions are organized by EMS JSC, annual and monthly auctions and intraday auctions are organized by Romanian TSO CNTEE Transelectrica S.A.
- From 2014 joint auctions for transmission capacity allocation are organized on Serbia - Bulgaria border. Annual and monthly auctions are organized by ESO (Bulgarian TSO) and daily auctions are organized by EMS JSC On Serbia - Bulgaria border intraday capacity allocations were not conducted due to technical problems of the Bulgarian TSO.
- From 2011 joint auctions for transmission capacity allocation are organized on Serbia - Hungary border. In 2018 annual and monthly auctions are organized by MAVIR ZRt (Hungarian TSO), while daily auctions and intraday capacity allocations are organized by EMS JSC.
- From 2014 joint auctions for transmission capacity allocation are organized on Serbia - Croatia border. Annual, monthly and daily auctions are organized by JAO S.A. (Joint Allocation Office S.A.) from Luxembourg, and intraday auctions was organized by EMS JSC
- From 2018 on the border between Serbia and Macedonia, a joint allocation of the right to use the available transmission capacities is organized. In 2018, EMS JSC was responsible for organizing daily auctions, as well as for implementing the intraday allocation of cross-border transmission capacity. The annual and monthly auctions were organized by MEPSO (Macedonian transmission system operator).

3.5.2. Mechanisms for Congestion Management in Distribution Systems

Congestion in a distribution system means that during the electricity transfer by distribution system in a given work mode, an overload of a branch distribution network occurs (of a line or transformer) or violation of voltage limitations in distribution network nodes.

Congestion management in distribution system includes the following actions to remove congestion causes:

- Change of distribution grid topology,
- Cancellation of planned and suspension of ongoing works,
- Regulation of voltage with transformers 110/X kV,
- Temporary pre-adjustment of protection, which allows increase of power line transfer capacity,
- Coordinated implementation of management actions with neighboring distribution systems operators in order to restore normal operation,
- Limitation of production of the power plants that are connected to the distribution system.

Note: The distribution system of the voltage level less than 110 kV work as a radial one. Alternative power directions are used when the need arises.

3.6. Measures for Covering Peak Demand and Insufficient Amount of Provided Electricity

In case of endangered safety of supply to end customers due to insufficient supply in the market or the occurrence of other extraordinary circumstances, the Government shall prescribe the measures for restriction of electricity supply, or special conditions for import or export of electricity, the manner and conditions for the formation and control of prices, the obligation of supply exclusively to particular users, or special conditions for performing energy-related activities with the minimum disturbance of the energy market in the region (Energy Law [1]).

In order to cover peak consumption, in the event that one or more suppliers do not provide enough electricity, the transmission system operator is obliged to provide the missing amount of electricity.

The transmission system operator shall take the following actions:

- Include the contract on system services,
- Include contracts on energy in cases of accidents,
- Draw up daily plans of PE EPS work,
- Balance the system in real time.

In order to provide system services, EMS JSC with users of the transmission system made the contract for the provision of ancillary services, which includes primary reserve, secondary reserve, the third reserve, capacity for voltage regulation and capacity for establishment of transmission system after the collapse.

The amount of reserves is regulated by the Electricity Transmission Grid Code [8], based on the technical requirements in force in the interconnection Continental Europe. Details regarding the values of frequency containment reserve, frequency restoration reserve and reserve replacemet are given in chapter 3.1.3.

By drawing up a daily work plan of electric energy system, the transmission system operator shall combine data of market players and then consider whether the suppliers have provided sufficient level of energy to supply the contractual reserve capacities based on their own demand forecasts. The transmission system operator reserves the spare capacity based on its own forecast of consumption. If this is not the case, the transmission system operator shall take the necessary measures, i.e. plan to engage the reserve capacities in the balancing mechanism or shall use the emergency power supply.

Balancing of electric energy system in real time is carried out through the activation of secondary and tertiary reserves. In this way, a balance is achieved between production, consumption and agreed cross-border exchanges in electricity. In addition to the contractual amount of spare capacities, the balancing mechanism includes all production capacities not engaged by the work plan, but which are available for production. If the country capacities are not enough to cover the consumption, the energy transmission system operator shall activate the emergency energy.

There are times when in spite of all measures, the required amount of electrical energy cannot be provided. In these cases, voltage reductions can be implemented in distribution system, by implementing voltage reductions on the low voltage side of the 110/X kV control transformers to a value of 5% less than the nominal voltage. In these cases, it can reduce the consumption by up to 200 MW. If that is not enough, the transmission system operator shall start limitation of electricity supply in accordance with the Energy Law and the Electricity Transmission Grid

Code. The size of interconnection, as well as good connections with neighbouring transmission systems, make space for the national transmission system operator to be in a lower deficit for a shorter period of time.

3.7. Realization of Planned Construction of New Generation, Transmission and Distribution Facilities

3.7.1. Generation

In 2018, the significant increase in installed capacity in wind and small hydropower plants should first be emphasized. Based on the available data, new 247.28 MW were installed in wind farms and 40 MW in small hydropower plants. These processes continue in 2019 and in the years to come. It is important to point out the beginning of the realization of the construction of TPP Pančevo, as well as the preparation of documentation for several more gas power plants in the Republic of Serbia.

In the same period, the construction of block no. 3 in the TPP Kostolac B of 350 MW is continued, with the completion of construction of VI ECS systems on the Drmno surface mine, which is necessary to increase the annual production of coal from 9 to 12 million tons. The revitalization of hydroelectric power plants and thermal power plants within PE EPS has continued with success, and in the first place it refers to HPP Đerdap 1 generator A2, Zvornik hydropower unit A3, TENT A block A4, which were completed during the last year, which is detailed in the chapters 3.10 and 3.3.1. During 2018, activities related to the revitalization of HPP Potpeć, HPP Bistrica, Vlasinska HPP and Đerdap 2 are continued. These activities include preparation of technical and tender documentation. For these and a number of other projects see chapter 3.10.

3.7.2. Transmission

The Energy Law defines that transmission system operator is obliged to prepare and submit to AERS a ten-year development plan of the Republic of Serbia and three-year investment plan in the transmission system for every year. Et the end 2018, EMS JSC prepared and submitted to AERS the Development Plan of the Republic of Serbia transmission system for the period 2019-2028 [22] and Investment Plan in the Transmission System for the period 2019-2021. Council of AERS has approved mentioned documents он 17.10.2019.

Core activity of the Investments department in 2018 was the organisation and management of investment construction project, expansion, refurbishment and modernisation of the existing of transmission facilities (high-voltage substations and high voltage transmission lines. In addition, the investment activities included the realization of a significant number of procurements, as well as the implementation of connection projects.

The most important final operations in this period are [17]:

- Works on reconstruction and adaptation of sections of transmission line 2x110 kV between Beograd 3 - TPP Kostolac, which will continue in 2019.
- In 2018 implementation of the part of the 2x110 kV between Valjevo 3 - Zvornik feeder was performed around the industrial zone in Loznica (about 1.5 km). Works on sections B, G, H (about 32.3 km) were also started. The completion of the activities is planned for 2020.

- The work is finished for the transmission line 110 kV between Kraljevo 1 - Kraljevo 2 at substation Kraljevo 6 (Ribnica) has been completed. A transmission line 3.5 km long was built to connect the Ribnica substation to the transmission system.
- The works on the introduction of the transmission line 2x110 kV between Beograd 9 - Stara Pazova in substation Krnješevci have been completed. An 8.7 km long transmission line was built to connect the Krnjesevci substation to the transmission system.
- Construction works on the 110 kV transmission line between Bela Crkva - Veliko Gradište (34 km). A building permit was obtained, an application was approved and a contract for the execution of works was signed.
- Reconstruction works for 2x110 kV transmission line between Bor 1 - Bor 2. A building permit was obtained, an application was approved and a contract for the execution of works was signed.
- Works on the introduction of the 400 kV transmission line between Beograd 8 - Drmno in the substation Smederevo 3. A contract for the execution of works was signed and an application for a building permit was submitted.
- The reconstruction of all 110 kV fields in substation 400/220/110 kV Smederevo 3 has been completed. This significantly increased the safety, reliability and quality of power supply to consumers in the area of Smederevo and beyond.
- As part of the extension and reconstruction of the substation 220/110 kV Srbobran in substation 400/220/110 kV, the works on the reconstruction of all 110 kV transmission lines have been completed and two new transmission lines have been equipped, with the upgrade of the fourth bus segment. The reconstruction of the 110 kV connecting field has been completed and the replacement of the main and auxiliary bus systems with two new main bus systems has also been completed. Work has also begun on the unbundling of the 110 kV transmission line for connection to the Srbobran substation.
- During 2018, eight 220 kV fields were reconstructed at substation 400/220 kV Obrenovac. This ended activities of the replacement the complete high-voltage equipment and protection and management systems at the facility. Since more than 45% of the total electricity produced in Serbia is transmitted through this substation, the completed works are significante. This reconstruction significantly increases the reliability and security of electricity supply not only in the area where TS Obrenovac is located, but through whole Serbia.
- As part of the reconstruction of the substation 220/110/35 kV Kruševac 1, works were carried out to replace the T4 energy transformer (31.5 MVA) with the reconstruction of the 110 kV and 35 kV transformer fields. The T3 transformer (110/35kV), 31.5 MVA was put into operation in December 2018, with associated fields. The replacement of the T3 and T4 power transformers is of great importance for increasing the reliability and safety of the power supply in this area, since the installed power of the replaced transformers was 2x20 MVA, and the transformers were in operation from 1960 and 1968. During 2018, all 110 kV fields were reconstructed (equipment was replaced in 10 fields).
- During 2018, works on the construction of the 220/110 kV Bistrica substation have also been started. The works are carried out in accordance with the agreed dynamics and they are planned to be completed by the end of 2020.

- Construction of the 110 kV cable between substations Beograd 17 - Beograd 23 (Autokomanda) has also been started, cable and cable accessories have been purchased and work is expected to be completed in 2019.
- An application and documentation were submitted for obtaining a building permit for 110 kV cable lines between substation Beograd 1 - Beograd 6, Beograd 23 - Beograd 45, Kruševac 1 - Kruševac 3.
- New three switching substation for wind power connection (Čibuk 1, Kovačica and Alibunar) have been put into operation.
- Activities on obtaining a Building Permition, the contractor and the commencement of works on the second phase of the Belgrade Waterfront project were intensively carried out. It is the same for the construction of cable lines between substations Beograd 23 - Beograd 45 and Beograd 45 - TETO Novi Beograd. A building permit was obtained for the cable line 110 kV between Beograd 45 - TETO Novi Beograd.

During 2018, EMS JSC participated in activities related to the construction of the Trans-Balkan Corridor for Electricity Transmission [17]:

- Section 1 - During 2018, activities were underway to obtain the operating permit for the 2x400 kV Pančevo 2 - Romania border, whose construction was completed at the end of 2017.
- Section 2 – transmission line 400 kV between substations Kragujevac 2 - Kraljevo 3, with voltage level rise in substation Kraljevo 3 at 400 kV. Obtained a building permit for the extension of swiching substation 400 kV in substation Kraljevo 3, building permit for the transmission line, as well as a solution for construction works on equipping one 400 kV field in substation Kragujevac 2. A consultant has been selected and confirmed by the bank to participate in the project. Tender documentation was prepared for the qualification procedure for the selection of contractors.
- Section 3 - 2x400 kV transission line between substations Obrenovac - Bajina Bašta, with a voltage rise in the substation Bajina Bašta to 400 kV - A project scope has been completed and approved by KfW Bank. In 2018, the Government has made the decision to prepare a strategic environmental impact assessment and spatial plan of the special purpose area. The plan is under development, and its adoption by the Government is expected in the second half of 2019. EMS JSC submitted an application for a WBIF donation for this section in November. A decision about the donation is expected in late 2019;
- Section 4 - 2x400 kV Interconnecing lines between Serbia, BiH and Montenegro - A WBIF grant of 800,000 EUR has been approved for the preparation of missing technical documentation (Project for a building permit and project for construction), as well as for the renewal of the Feasibility Study for Section 3 and Section 4, in which techno-economic and financial analyzes will be carried out again. The scope of work for the preparation of this technical documentation has been completed and is currently in the final stage of harmonization between the transmission system operators of Serbia, Montenegro and BiH. The decision on the share of loans, the size of the grant and EMS JSC's own funds in the total investment value, as well as the start of the project implementation, will be made on the basis of the results of the Feasibility Study.

As part of the investment activities, the necessary permits were obtained [17]:

Authorization decisions for the performing works on facilities:

- Substation 400/220/110 kV Pančevo 2, reconstruction,
- Substation 110/35 kV Beograd 4, substation 220/110 kV Beograd 17 - adaptation, replacement of transformer T4 (110/35 kV) and equipment in the corresponding transformer fields,
- Substation 220/110/35 kV Požega, reconstruction - replacement of transformer T2 110/35 kV with increase of installed power of the substation,
- Substation 400/220/110 kV Novi Sad 3, adaptation - equipping of field E18.

Usage permissions for:

- Installation of the third transformer 400 MVA in the substation 400/220kV Obrenovac,
- Reconstruction of substation 400/220/110 kV Niš 2,
- Construction of Tsubstation 400/110 kV Vranje 4.

These realized investment activities and investments planned for realization in 400 and 110 kV networks, as well as daily actions at the level of operational management, in 2018 EMS JSC continued activities to reduce energy losses in the network.

3.7.3. Distribution

In line with the Energy Law [1], distribution system operator is obliged to prepare and submit to AERS an annual plan for development of distribution system for a period of at least five years, which should be harmonized with plan for development of transmission system and requirements for connection to distribution system. Development of mentioned development plan is in progress.

Energy Law [1] prescribes that the distribution system operator, in addition to the development plan, should adopt a plan for the take-over of measuring devices, measuring boxes, installations and equipment in measuring boxes, connection lines and other devices that are part of the connections in the buildings of existing buyers or producers, for each year. This obligation for the period 2018 - 2020 and Report on the implementation in the period 2015 - 2017 has been fulfilled by distribution system operator and delivered to AERS in November 2018. In 15th November, 2018 AERS council issued a Decision on the approval of the plan [19]. Energy Law (Article 404) [1] prescribes that all these devices should be taken over by distribution system operator by the end of 2020 at the latest. Acquisition of measuring points by distribution system operator and technological improvement of measuring infrastructure will ensure the smooth functioning of market and a better offer in electricity market [1]. Based on the Report about the realization of the plan for the taking over measuring points for 2018, it was concluded that EPS Distribucija did not carry out these activities in accordance with the plan, since during 2018 only 6.56% of the planned measuring points were taken and none of the planned measurement points for aking over from the manufacturer.

In order to increase the security of energy supply investment investment activities as well as other activities were aiming at the completion of initiated investments and new investments in network expansion, revitalisation or replacement of existing old-fashioned equipment in the distribution network, especially transformer stations 110/X kV/kV transferred from EMS JSC as well as other measures in terms of modernisation of operations and business activities.

The following works were either completed or initiated within the distribution systems [18]:

- Commissioning of substations 110/35/10 kV Kopaonik and TS 110/10 kV Kraljevo 6 (Ribnica).

- Construction of 239 transformer stations on the medium-voltage level was completed, with total installed capacity of 134.65 MVA.
- Construction of 357.10 km of medium-voltage distribution network was completed.
- Construction of 312.9 km of low voltage distribution network was completed.

The replacement of meters in the distribution companies with more modern models is planned. PE EPS is preparing a project on the modernisation of the system for electricity distribution and supply so as to provide monitoring, protection and automates optimisation of the work of all system parts and installations between system users, power plants, network and connected facilities. Compared to 2018, there is great delay in project realization.

The primary goal of distribution system operator is to improve the measurement system for users whose facilities are connected to the medium voltage network, and for users whose objects are connected to the low voltage network, those with active and reactive energy and monthly maximum power. Smart grids and measurement systems will enable high reliability and quality level of delivered electricity. They will stimulate better consumption management and more dynamic electricity market, as well as considerate reduction of technical and commercial losses.

With the investment activities in 2018 (increased grid capacity, replacement of invalid meters, dislocation of metering points), better control over electricity theft and increasing of the collection rate, the distribution system operators initiated the trend of reduction of energy loss in grids. However, that activities was not sufficient and they did not match the level of losses and the need to cut the losses to an acceptable level in technical terms.

3.8. Planned Electricity Consumption and Production / Method of Providing the Missing Quantities in the next Five-Years Period

3.8.1. Realized Consumption and Production

Preliminary data for the realized electricity balance for 2018 show significant differences in the structure of the produced energy compared to the previous year. The encouraging data is certainly resoult of the increase in hydropower plants by approximately 1,641 GWh. This data is the result of new capacity and better hydrology. As a result of exceptionally good hydrological conditions, production of PE EPS hydro power plants increased by about1.570 GWh last year. Production in TPP was increased by just over 50 GWh and, to a lesser extent, in thermal power plants.

Data relate to production from coal-fired power plants are next. The balance of the TENT was 82.2%. This represents a further decrease in production compared to 2017 when the balance in this branch was realized with 88.6%. In the previous year, the realization of the balance of TPP Kostolac was down 1.4% in relation to the plan and compared to 2017 it was down 7.6%. One of the significant reasons for such result is the small planned shutdown of power plant operation in the TPP Kostolac during 2017. This resulted in a total decrease in production in thermal power plants of PE EPS compared to the balance by 3.686 GWh or 13.8%. The realization is smaller compared to the previous year (according to PE EPS data by approximately 1.286 GWh).

Comparison of the data shows that the results of a very good hydrological year in energy terms were reduced by poor production of thermal power plants. However, thanks to the work of new renewables and other sources mentioned in PE EPS and beyond, according to preliminary data, the Republic of Serbia achieved gross production greater for about 1,300 GWh, with approximately over 300 GWh more were available for final consumption where the largest increase can be spotted in the household, industry and construction sectors.

When it comes to net imports and exports, 2018 is significantly better than the previous year. Namely, for 2018 this ratio is negative and amounts to -218 GWh, which is 660 GWh more favorable than in 2017 (when the ratio was -878 GWh).

From all of the above it is quite clear that the basic analysis must be directed towards a large drop in production in TPP. First of all, the annual planning function of this production in the last few years is not good, which is reflected in the growing differences between planned and realized (this indicates that the planned input parameters for coal quality and specific coal consumption for each of thermo blocks of TENT A and TENT B need to be corrected). This practice has continued, as in the plan for 2019, PE EPS anticipates the production of 25.926 GWh of coal in TPP, which is three billion kWh more than in 2018. The wrong planning in one segment can lead to completely different results, and in other segments the purchase and sale of electricity (in the function of balance sheet optimization and balancing) achieved by PE EPS in the previous year show. Sales are completely insignificant, amounting to only 0.4% compared to the balance sheet, which is 0.5% compared to the previous year. In contrast,, purchases have increased to 350.1% from the previous year, and it is higher from the balance sheet by 425.5%. The excellent hydrological situation and significantly higher production of HPPs did mitigate the overall poor result..

By presenting certain basic data from coal production, one cannot quite perceive the fact of a fall in electricity production. In fact, for the years 2017 and 2018, the MB Kolubara emphasizes the realization of coal balance with 98% in each year, which cannot be brought into proportion (have in mind that MB Kolubara is the dominant supplier of coal to power plants of the TENT branch) with the realization of the TENT of 88.6, ie 82.2%. Therefore, the presentation of coal data in tonnes is proven to be overridden and should not serve as a baseline for evaluating branch performance. Slightly better information that provides insight into the processes is the thermal power of the coal produced. For the previous year, it was approximately 91% for MB Kolubara (while the average thermal power of coal supplied was less by 9.3% compared to the balance sheet). This is 9% less than the balance sheet, but this data is almost twice less than the underperformance in electricity production. This mismatch requires a deeper analysis to determine whether this percentage difference is related to the operational unpreparedness of thermal power plants (which is, among other things, see chapter 3.3.1), or whether other effects are at stake. When it comes to these other effects, from the PE EPS energy production sector they pointed to the problem of high ash content in coal supplied. Also, although there are underachieves in electricity production in the TPP Kostolac is significantly smaller than in the TENT, it is necessary to determine whether this negative trend in the last few years is due to systemic problems on the land (coal is better than what is being balanced, but quantitatively realized only 84%) or it is a reflection of a specific but quickly solvable problem. It would be very bad for Serbia's energy stability if the trend of aggravation results continued in this branch.

It is also important to point out that the excavation of the coal at the Kolubara branch had also one underachievement in 2018, which was also the case with previous years. This time, the deficit is 3.763 million m^3 of solid mass. This is 5% less than the balance sheet, while in Kostolac this reduction is 11%, which is almost 9 million cubic meters of solid mass. It is evident that there are various accumulated problems in the mining sector that cumulatively lead to poor trends and a decline in electricity production in the thermo-sector. Tables made from official documents of PE EPS, regarding production and specific consumption of coal and liquid fuels, show total production in TPP PE EPS over the last decade with the exception of 2012 and 2014, which are excluded from consideration due to extreme weather and natural conditions, which are then recorded and which had a direct impact on production.

The following facts, recorded by the expert services of PE EPS, contribute to the overall difficult picture regarding the current production of coal-fired TPPs, as well as closer perspectives in this area. In all coal deposits in the past year, there was a decrease in the total amount of 616.1 thousand tons, or 40%. At the same time, TPP operation has become more inefficient and expensive as specific coal consumption has reached a new maximum and now stands at 1.59 t/MWh, which is 12.7% more than planned. The consumption and specific consumption of TPP fuel oil (mazut) in the previous year are also poor. The consumption of fuel oil (mazut) jumped by 15% in absolute terms compared to the previous year and now amounts to 40,771 tons. Specific mazut consumption is growing even more as TPP production is down compared to 2017. It has now reached 2 t/GWh, an increase of 20% over the previous year.

Table 13 presents electricity balance in the Republic of Serbia for the period from 2013 until 2018.

Table 13: Balance of Electricity from 2013 to 2018 [16], [26]

	2013 [GWh]	2014 [GWh]	2015 [GWh]	2016 [GWh]	2017 [GWh]	2018 [GWh]
Gross production	**39,877**	**34,061**	**38,299**	**39,343**	**37,043**	**37,426**
Hydro power plants	10,852	11,617	10,783	11,520	9,752	11,393
Thermal power plants	28,620	22,073	27,133	27,191	26,414	24,975
Combined heat and power plants	202	75	53	140	291	351
Other power plants	202	295	330	491	585	707
Total import (including transit)	**4,077**	**7,008**	**6,303**	**5,068**	**6,549**	**6,400**
Total export (including transit)	**6,614**	**5,445**	**7,221**	**6,990**	**5,724**	**6,284**
Losses	**5,500**	**5,163**	**5,169**	**4,808**	**4,806**	**4,532**
Consumption in the energy sector including own use of TPP and HPP	**4,937**	**4,302**	**5,138**	**5,280**	**5,270**	**3,898**
Hydro power plants	60	90	86	91	82	86
Pump	1,007	898	1,090	1,029	938	
Термоелектране	2,581	2,017	2,529	2,565	2,586	2,466
Combined heat and power plants	42	22	18	25	42	51
Industrial plants	25	32	26	33	37	42
District heating plants	170	80	97	218	193	171
Oil and gas production	234	82	93	91	87	89
Refineries		236	257	243	255	261
Coal mines	604	541	570	600	590	603
Coal transformation	214	217	282	313	366	40
Other		87	90	72	94	90
Energy available for final consumption	**26,903**	**26,158**	**27,073**	**27,333**	**27,792**	**28,047**
Final consumption	**26,903**	**26,158**	**27,073**	**27,333**	**27,792**	**28,047**
Industry+Construction	7,079	7,156	7,423	7,731	7,861	8,734
Transport	478	336	351	352	358	375
Households	14,146	13,802	14,062	13,931	14,165	13,415
Agriculture	301	298	317	314	319	341
Other users	4,899	4,566	4,920	5,005	5,089	5,183

3.8.2. Method of Providing the Missing Quantities in the next Five-Years Period

According to Strategy [2], electricity consumption growth in relation to the reference year (2010) is predicted to be around 5.7% by 2020, ie 10.5% by 2025 and 16.3% by 2030.

Ongoing activities are expected to meet future electricity needs in the medium term (see sections 3.3.1, 3.10 and 0). As in these chapters have already been analyzed in detail, it is expected that some of the oldest thermoblocks with low utilization and high emission of harmful substances will be withdrawn from use. At the same time it is shown in what ways the missing energy from these sources is expected to be replaced by other sources. According to Strategy [2] and Program [1], construction of a large number of wind and small hydropower plants has already been completed, some TPPs and HPPs have been revitalized and new CHPs have been started.

3.9. Security Supply Forecast for the Next Five to Fifteen Years

The national transmission system operator shall be obliged to guarantee, with the appropriate national institutions, the appropriate security of electricity supply. Security of supply is defined as the ability of the power system to meet consumption needs at any time. For assessment of production adequacy in the Republic of Serbia EMS JSC has so far used the modified methodology of the ENTSO-E (for making the long-term reports of adequacy) [20].

The integration of a large number of generating capacity in the category of renewable energy sources, end of process for forming the internal electricity market at EU level, new technologies for energy storage, and the response of demand side management and constant changes in energy policies require permanent modification ENTSO-E methodology for the assessment of conformity production and consumption of electricity in the short and longer term. One of the main changes compared to the classic method of conformity assessment of production and consumption, which is valorized by the moment of maximum consumption in the power system, is the need to consider other scenarios of electricity consumption because of the unpredictable production of some types of renewable energy sources, actually loading of transmission system at selected times other than the moment of maximum load. At this point a safety assessment is carried out in two typical cases:

- Winter maximum and
- The summer maximum.

These typical cases of load forecast are part of the ten-year plans of the member of ENTSO-E, which is updated every year. Similarly, using two scenarios of electricity generation in order to better evaluated the extent of uncertainty in the prediction of future production capacity and evaluate the risk of security of supply in the forecasting period: scenario of realistic development of production and conservative scenario that individually prepare transmission system operators based on the plans of electricity producers who are planning connection to the transmission system.

Conservative scenario includes additional investments in production capacities, which are considered certain (already being implemented construction or in which the purchase of equipment can not fail). As for the phasing out of production capacity, most likely the plan of release will be adopted, which is not only based on the official data of individual producers, but also takes into account information about the age of some production facilities.

For the load forecasts in this scenario the best national estimate available to the transmission system operator is adopted, taking into account the maximum expected rise in consumption based on available development plans of electrical networks.

Scenario of realistic development of production, in addition to production capacity covered by conservative scenario, includes the planned investment on production capacity, which can be considered sufficiently probable according to the belief of the transmission system. Also, if there is no official information on the exit of a unit from the system, the scenario of realistic development of production consider it available in the forecasting period (at the old production capacity is calculated on the extension of life expectancy). The load is predicted in the same manner as in conservative scenario. For scenario of realistic development of production, during forecasts of new production capacity, it is necessary to take into account the national targets for the participation of renewable energy sources, as well as stimulating measures that work in this direction. However, the transmission system operator has to make a realistic forecast of future production capacity, even if defined national goals were not met. In the context of the assessment of conformity of production and consumption of electricity gives the estimate of transmission capacity for export and import of electricity.

A conservative scenario function is to assess the lack of capacity in production at a national (and European) level in order to satisfy future consumption. Scenario of realistic development of production function is to assess whether the expected level of investment in production capacity are sufficient to meet future consumption.

Of course, in order to adequately assess the possibility of meeting the projected consumption with the planned production, need for the reserve production, expected outages and repairs of production units, capacity in which the forecasting period can not be used for various other reasons must be taken into account.

In assessing the compliance of the production capacities, tables in a format such shown in Table 14 and Table 15 (relating to the period of 2018-2028 for the Republic of Serbia) need to be filled. Based on the data presented in Table 14 and Table 15 following can be concluded:

In the Republic of Serbia, in 2028, compared to the current situation, the installed capacity connected to the transmission system will increase in the amount of:

- Scenario of realistic development of production - 1,105 MW
- Conservative scenario - 1,252 MW.

For the winter peak regime in the realistic scenario, the remaining production capacity is negative until 2019, and after that it is positive until the end of the observed period (Table 14). The lowest value is forecast for 2018 (-168 MW), while the values after 2019 range between 280 MW and 670 MW.

The conservative scenario for the winter peak regime is more critical, so the remaining production capacity is negative until 2019, as well as 2028 (Table 15). This is the result of peak load growth.

Therefore, in periods when the residual production capacity is negative, electricity will need to be imported. The value of the available import capacity is sufficient to allow undisturbed imports of electricity.

As for the summer peak regime, it is not critical in any scenario (Table 14 and Table 15). Values of the remaining production capacity range from 920 MW to 1.600 MW.

Table 14: Indicators of compliance of production and consumption of electricity in scenario of realistic development of production for the Republic of Serbia [22]

Winter maximum				
National energy data (MW)	**2018**	**2020**	**2025**	**2028**
1. Fossil Fuels (2+3+4)	4,010	4,431	4,168	4,168
2. Lignite	3,910	4,218	3,955	3,955
3. Gas	100	182.9	182.9	182.9
4. Waste	0	30	30	30
5. Renewable Energy Sources (Wind power plants)	325	828.1	1,216	1,216
6. Hydro power (7+8+9)	2,955	2,998	3,011	3,011
7. Run-of-river hydro power plant	1,969	2,012	2,025	2,025
8. Storage hydro power plant	372.1	372.1	372.1	372.1
9. Pumped storage plants	614	614	614	614
10. Total (1+5+6)	7,290	8,257	8,395	8,395
11. Unusable installed capacity	238	607	891	891.4
12.Ancillary services reserve	380	380	380	380
13. Overhauls	200	0	0	0
14. Forced outages	399	431	326	326
15. Unavailable Capacity (11+12+13+14)	1,217	1,418	1,597	1,597
16. Reliable Available Capacity (10-15)	6,073	6,839	6,798	6,798
17. Peak load	6,135	6,305	6,446	6,511
18. Remaining power capacity	-62	534	352	287
19. Simultaneous Importable Capacity for Adequacy	3,744	4,588	5,688	5,688
20. Simultaneous Exportable Capacity for Adequacy	4,289	4,889	5,859	5,859
21. Minimum power transfer capacity	728.99	825.68	839.53	839.53
Summer maximum				
National energy data (MW)	**2018**	**2020**	**2025**	**2028**
1. Fossil Fuels (2+3+4)	4,095	4,506	4,243	4,243
2. Lignite	3,984.7	4,292.7	4,030.2	4,030.2
3. Gas	110	182.9	182.9	182.9
4. Waste	0	30	30	30
5. Renewable Energy Sources (Wind power plants)	325	828.1	1,216.1	1,216.1
6. Hydro power (7+8+9)	2,955	2,998	3,011	3,011
7. Run-of-river hydro power plant	1,969.3	2,012.2	2,025.2	2,025.2
8. Storage hydro power plant	372.1	372.1	372.1	372.1
9. Pumped storage plants	614	614	614	614
10. Total (1+5+6)	7,375	8,332	8,471	8,471
11. Unusable installed capacity	402	744	1,093	1,093
12.Ancillary services reserve	380	380	380	380
13. Overhauls	814	676	636	636
14. Forced outages	329	379	357	357
15. Unavailable Capacity (11+12+13+14)	1,925	2,179	2,466	2,466
16. Reliable Available Capacity (10-15)	5,450	6,153	6,005	6,005
17. Peak load	4,407	4,568	4,772	4,881
18. Remaining power capacity	1,043	1,585	1,233	1,124
19. Simultaneous Importable Capacity for Adequacy	3,832	4,676	5,776	5,776
20. Simultaneous Exportable Capacity for Adequacy	3,742	4,342	5,312	5,312
21. Minimum power transfer capacity	737.51	833.2	847.05	847.05

Table 15: Indicators of compliance of production and consumption of electricity in conservative scenario of production for the Republic of Serbia [22]

Winter maximum				
National energy data (MW)	**2018**	**2020**	**2025**	**2028**
1. Fossil Fuels (2+3+4)	4,010	3,910	4,168	4,168
2. Lignite	3,909.5	3,909.5	3,955	3,955
3. Gas	100	0	182.9	182.9
4. Waste	0	0	30	30
5. Renewable Energy Sources (Wind power plants)	178.5	698.1	1,216.1	1,216.1
6. Hydro power (7+8+9)	2,955	2,998	3,011	3,011
7. Run-of-river hydro power plant	1,969.3	2,012.2	2,025.2	2,025.2
8. Storage hydro power plant	372.1	372.1	372.1	372.1
9. Pumped storage plants	614	614	614	614
10. Total (1+5+6)	7,143	7,606	8,395	8,396
11. Unusable installed capacity	131	512	891	891
12.Ancillary services reserve	380	380	380	380
13. Overhauls	200	0	0	0
14. Forced outages	399	391	326	326
15. Unavailable Capacity (11+12+13+14)	1,110	1,283	1,597	1,597
16. Reliable Available Capacity (10-15)	6,033	6,323	6,798	6,799
17. Peak load	6,049	6,354	6,658	6,827
18. Remaining power capacity	-15	-31	140	-29
19. Simultaneous Importable Capacity for Adequacy	3,744	4,588	5,688	5,688
20. Simultaneous Exportable Capacity for Adequacy	4,289	4,889	5,859	5,859
21. Minimum power transfer capacity	714.34	760.59	839.53	839.53
Summer maximum				
National energy data (MW)	**2018**	**2020**	**2025**	**2028**
1. Fossil Fuels (2+3+4)	4,095	3,985	4,243	4,243
2. Lignite	3,984.7	3,984.7	4,030.2	4,030.2
3. Gas	110	0	182.9	182.9
4. Waste	0	0	30	30
5. Renewable Energy Sources (Wind power plants)	178.5	698.1	1,216.1	1,216.1
6. Hydro power (7+8+9)	2,955	2,998	3,011	3,011
7. Run-of-river hydro power plant	1,969.3	2,012.2	2,025.2	2,025.2
8. Storage hydro power plant	372.1	372.1	372.1	372.1
9. Pumped storage plants	614	614	614	614
10. Total (1+5+6)	7,229	7,681	8,471	8,471
11. Unusable installed capacity	270	628	1,093	1,093
12.Ancillary services reserve	380	380	380	380
13. Overhauls	814	598	636	636
14. Forced outages	329	341	357	357
15. Unavailable Capacity (11+12+13+14)	1,794	1,946	2,466	2,466
16. Reliable Available Capacity (10-15)	5,435	5,735	6,004	6,004
17. Peak load	4,414	4,595	4,902	5,081
18. Remaining power capacity	1,021	1,140	1,102	923
19. Simultaneous Importable Capacity for Adequacy	3,832	4,476	5,776	5,776
20. Simultaneous Exportable Capacity for Adequacy	3,742	4,342	5,312	5,312
21. Minimum power transfer capacity	722.86	768.11	847.05	847.05

3.10. Investments in Capacity for the Production of Electricity

As a signatory to the Treaty of establishment of the Energy Community, the Republic of Serbia has commited, among other things, to apply the provisions of the Directive of Large Combustion Plants 2001/80/EC in accordance with the deadlines defined by the Treaty itself, that is, until 01.01.2018.

The Directive refers to combustion plants with a power of greater than or equal to 50 MWth (all thermal power plants within PE EPS are in the category of large furnaces, that is, they have power greater than 50 MWth). The aim of the Directive is to reduce emissions of polluting substances from large combustion plants into the air.

The Ministerial Council of the Energy Community adopted two following Decisions on October 23th in 2013:

- Decision D/2013/05MC-EnC EnC for the rules of implementation of the Directive of Large Combustion Plants (Decision D/2013/05MC-EnC LCP Directive on implementing rules)
- Decision D2013/06/MC-EnC for the introduction of the Industrial Emissions Directive 2010/75/EC (Decision D/2013/06/MC-EnC on the Introduction of the Industrial Emissions Directive).

By Decision D/2013/05MC-EnC it is enabled for the contries that are signatories of the Treaty of establishing the Energy Community to use two mechanisms for the implementation of the Directive of Large Combustion Plants, which are defined within the Directive itself, as follows:

- The implementation of the National Emission Reduction Plan (NERP) in period from 01.01.2018. to 31.12.2027. The implementation of NERP has a purpose to harmonize emissions from existing combustion plants with emission's limit values - ELV defined by the Industrial Emissions Directive by the 31.12.2027.
- Implementation of the plant limited operation mechanism, so-called opt-out mechanism (20,000 hours of work between 2018 and 2023). After the expiration of the opt out period, the plant should be either shut off or must be harmonized with the ELV for new plants based on the Industrial Emissions Directive.

In order to improve environmental protection in accordance with the obligations under the Energy Community Agreement, in the sector for the production of fossil fuels, it is planned that emissions of sulfur dioxide, nitrogen oxides and powdered substances are reduced to the prescribed emission limit values defined by the said regulation [23]. The issue of emission to the prescribed limit values is part of the National Emission Reduction Plan in accordance with the Decision of the Ministerial Council of the European Union E3 D/2013/05/MC-EnC and D/2013/06/MC-EnC. The implementation of the National emission reduction plan is planned in the period January 1, 2018 - December 31, 2027. However, these environmental commitments have their two downsides. Firstly, they are very expensive and involve primarily foreign technology, and secondly, they increase the consumption of electricity for their own needs, thereby reducing the available energy for the market and the available power at the transmission threshold.

On the reduction of the available power on the border of transmission will also be affected by the projects for the construction of a flue gas desulphurization plant on thermal power plants that will remain in operation after 2023. This facility for TPP Kostolac B was completed in July 2017 (the value of the project is approximately 130.5 million dollars), and for the TENT A3-A6 are in progress (contract for the implementation of the facility was signed in September 2017, and the completion date is 48 months). Realization of this facility is expected for TENT B. According to the available technical data, the own consumption of desulphurization facility will affect the increase in 5-6% in own consumption of the blocks that remain in, or approximately 1.1 TWh per year. This is supported by the project in the TPP Kostolac B, where for the needs of the desulphurization plant it was necessary to install two additional transformers with a power of 2x25 MVA.

In order to implement the mentioned directive and ensure the realization of the goals defined by the Strategy [2] and the Program [3] from 2017 until year 2023, as well as the balancing of energy deficits resulting from the withdraw of blocks and own consumption of desulphurization plants, the construction and entry into operation of several larger production capacities is planed.

The construction of seven wind farms with total installed capacity up to 500 MW with an estimated annual production of 1,317 GWh (Alibunar, Malibunar, Plandište 1, Kovačica, Čibuk 1, Kosava and Kostolac). The start of work on some more wind farms such as Košava 2 has been announced.

When it comes to construction the situation is as follows:

- The Alibunar wind farm 42 MW has been completed and commissioned. The contractor and also the company that participated as a financier in the volume of 25% is the Belgian company Elicio. The total investment was 80 million € and the work was completed in September 2018.
- The Malibunar wind farm 8 MW has been completed and commissioned. The value of the project was 14 million € and the wind farm has been in full operation since 2018. Expected production is 25 GWh per year, which roughly meets the consumption of 7,200 households.
- Košava wind farm is being built by the Italian company MK Fintel Wind - Fintel energy, which already has two wind farms completed in Serbia - Kula and La Piccolina. Completion is expected in the second half of 2019, with a total investment value of 120 million €. The installed capacity is 69 MW housed in 20 equal turbines.
- Kovačica wind farm was built by Israeli company Enlight Renwable Energy. It is a plant of 38 turbines with an installed capacity of 105 MW, which should provide energy to 65,000 households. The trial run began at the end of the 2018 (approximately one third of installed capacity), with a total investment value of 190 million €.
- Čibuk 1 wind farm was built by Vetroelektane Balkana, which is owned by companies from the US, Emirates, Finland and Germany. The investment value of the project is up to 300 million €, and it is a plant with 37 turbines with an installed capacity of 158.4 MW. The pilot operation of this wind farm began in the 2018 and is expected to supply about 113,000 households.
- Košava 2 wind farm should also be constructed by the Italian company MK Fintel Wind - Fintel Energy. There are 19 wind generators with a total power of 47 MW. The start of the work is announced for 2019.

The plan is to complete and commission the Unit B3 at TPP Kostolac B with an installed capacity of 350 MW and an estimated annual production of 2,200 GWh in 2022.

Production from these new capacities, including TPP Pančevo, should increase total estimated electricity production for 4,500 GWh. In this way, the production from the plant witch outage is planned, due to the end of their exploitation period, would be successfully substituted.

In addition to the steam-gas CHP Pančevo and wind farms that are especially important for meeting the goals related to renewable energy sources, the realization of the construction of the new unit B3 in thermal power plant Kostolac B will be of great importance, which will contribute to the increase of production capacities and thus to the improvement of energy stability in the Republic of Serbia. The project also includes the extension of the Drmno surface mine, that is, the increase the coal production from 9 to 12 million tonnes per a year. The value of the TPP Kostolac B3 project is 715.6 million $ (about 81,100 million of RSD). The project is financed from two sources: 85% of the project value will be financed from the loan of the Chinese Export-Import Bank under preferential terms with the guarantee approved by State; the rest of projet value is provided from the funds of PE EPS (15%). The deadline for realization of the project is 58 months. TPP Kostolac B3 unit meets all environmental protection standards prescribed by the laws of the Republic of Serbia. The realization of these construction is of great importance for the development of the energy sector of the Republic of Serbia due to the reliable and secure supply of energy products and energy as well as the establishment of conditions for reliable and safe operation and sustainable development of the energy sector in general.

In addition to the construction of new capacities, the continuation of the hydro power plants revitalization with the increase of the power delivered to the transmission system is planned:

- Aggregates G3 and G4 in HPP Zvornik with new installed power of 2x31.4 MW (power increase 7.4 MW by aggregate). Unit G3 completed the test run on 10/01/2019. (the revitalization of this unit started on January 11, 2018, and the test run on December 11, 2018) and during this period it worked at the order of the dispatcher and achieved the required power of 31.4 MW. The last phase of the revitalization of the HPP Zvornik (revitalization of G4 aggregates) will be done during 2019 with the expected effects as on the previous ones.
- G2 unit at HPP Đerdap 1 entered revitalization on 09/03/2018. It is expected to increase its capacity by 15 MW with newly installed capacity of 205 MW, as well as in the case of previously revitalized units. The expected completion of the revitalization of Unit A2 is November 2019. Completion of the total revitalization (including the last non-revitalized Unit G3) is expected in early 2021.
- Aggregates G1, G2 and G3 in HPP Potpeć with new installed power of 3x19 MW (power increase 2 MW by aggregate) with new aggregate G4 - 13 MW.
- In 2018 (from 03/03/2018 to 30/07/2018), a revitalization of the A4 unit in TENT A for 150 days was carried out, which was planned for the previous year. This capital overhaul is considered to have increased the nominal installed power of the unit from 308.5 MW to 332.7 MW (or at the threshold from 280 MW to 305 MW). Completely new high- and medium-pressure turbines were installed, while the low-pressure turbine also replaced the larger part and the smaller part (outer cylinder) was adapted to the new elements. The new turbine was designed to work in thermal mode, with a maximum console of 200 MVt, and during the revitalization specially was had in mind, withdrawal of blocks A1 and A2 from the sistem. Together, they have not been used for a very long time becouse the delay of their revision and life extension for another 100,000 hours. The total value of the revitalization was 53 billion €.
- HPP Bistrica with new installed power of 2x57 MW and aggregates in HPP Vlasina with new installed power of 137 MW (power increase 8 MW in total), etc.

Among other activities the following should be highlighted:

- Beginning of the project of reconstruction of the ash system on TENT A, and in parallel with it the realization of the project for construction of new ash cassettes, as emphasized in section 3.3.1.
- Feasibility Study and Preliminary Design for Revitalization of units A1 and A2 at TENT A were completed and adopted by the Expert Council of the PE EPS in December 2017. The study predicts the extension of the unit life for the next 100,000 operating hours, including the possibility of working in accordance with environmental regulations. The tender for the selection of contractors is expected to be completed in 2019. The preliminary value of these revitalizations is 230 million € (including the implementation of all environmental measures). Units A1 and A2 in TENT A were commissioned in 1970.
- The feasibility study and preliminary design of units A1 and A2 in TPP Kostolac A have been completed. Based on the three-year business plan of PE EPS for the period 2018 - 2020, it is seen that the operation of this power plant is being harmonized with the National Emission Reduction Plan (NERP), and that the implementation of the "on going investments" mechanism is planned in this regard. This means that PE EPS is planning a desalination project at this site, and so far it only has its own funds for the activity. This indicates that the currently decision is that the units of TPP Kostolac A1 (started in 1967) and A2 (started in 1980) will not be withdrawn. Indirectly, this was supported by the investment of expanding the Drmno mine from nine to 12 million tons of coal, which would not have economic justification in case of simultaneous commissioning of TPP Kostolac B3 and withdrawal of this two blocks.
- Construction of a dock on the Danube at the Kostolac A TPP was completed at the begining of 2019. The value of the works was 15.8 million $, and the purpose of the dock was to accept limestone, as well as equipment for the construction of block 3 at TPP Kostolac B, and on the other hand, the shipment of 157,000 tons of ash and 105,000 tons of gypsum per year.
- The construction of a flue gas desulphurisation plant on A3-A6 units in TENT A has started. The deal is worth 167 million € and is being implemented under the agreement of the Government of the Republic of Serbia and Japan. Under this agreement, PE EPS and the Japan Agency for International Cooperation (JICA) signed a loan agreement to finance the project. The consortium that will implement the project are Japan Corporation ITOC HU, Mitsubishi Hitachi Power System Europe and MPP Jedinstvo from Sevojno.
- In August 2018, a tender was launched to evaluate the feasibility of the construction of Kolubara B. A special review should be given to another project which, for one of the objectives, also has the reduction of atmospheric pollution in thermal power plants on the one hand, as well as the improvement of coal supply as an important condition for the quality operation of thermoenergetic blocks, on the other. It is about the project "Enhancing environmental protection in the Kolubara mining basin", which should ensure safe and uninterrupted coal supply, as well as rational management of natural resources, while reducing atmospheric pollution. Actually, PE EPS representatives signed two loan agreements for this project: with the European Bank for Reconstruction and Development (EBRD), in July 2011, the value of 80 million €; and the German Development Bank (KfW) worth 65 million € with an additional 9 million € donation. This second contract was signed in October 2012. PE EPS provides 27.6 million € from its own funds, so the total project value is approximately 181.6 million €. This project envisages the procurement of new equipment that should provide secure supply of lignite

of uniform and prescribed quality for the needs of thermal power plants and compliance with regulations in the field of environmental protection.

Project A - purchase of a new system for overburden removal on the surface mine Fild C (rotary excavator with power of 6,600 m3/h, transporters with line width B = 2000 mm and a storage capacity of 8,500 m3 / h and power supply) was realized from the loan funds of the EBRD Bank. The works on this project were completed at the end of 2016.

The original plan implied the completion of this investment in the first half of 2016, but the realization has not yet been completed. For the purposes of the previous Security of Supply Statement, expert services of PE EPS provided information that work was expected to be completed by the end of 2018, but this did not happen. The possible new date for the completion of the "green project" is the third quarter of 2019. Among the mentioned projects those who are ecological stand out. They are highly investmentally positioned and their realization is in full progress. The mentioned projects enable the retention of existing capacities in the system and the placement of energy from the PE EPS power plants on the regional market, as they provide the necessary environmental conditions in accordance with the EU directives. One such project is the construction of a wastewater treatment plant at TPP Kostolac B. Contracts for equipment and works worth a total of more than 5.4 million € were signed during 2018, obtaining a building permit and realization are planned for 2019.

3.11. Development Plan and Investments in Transmission System for the next Three to Fifteen Years

Development of transmission capacities includes reconstruction of existing and construction of new transmission capacities so that a balanced, sustainable and timely development of the transmission system is achieved, with the aim of connecting new conventional and renewable sources of electricity, as well as the facilities of other users of the transmission system.

Strategic and developmental importance at the national, regional and pan-European levels in the period up to 2025 and 2030, have two groups of projects in the field of electricity transmission [3].

The first group of projects includes projects of reinforcement of lines that connect transmission system of Republic of Serbia with neighbouring transmission systems and further integration of the transmission system of the Republic of Serbia in regional interconnection. These projects enable the implementation of the following strategic goals in the field of electrical energy: development of electricity market at national and regional level, increase of transmission capacity/corridors via Republic of Serbia, which have regional and pan-European significance, enabling net export of electricity and providing secure supply of electricity for domestic market.

The second group of projects includes projects for further development and reconstruction of the existing transmission network in order to ensure a secure supply of transmission system users and placement of produced electric energy. These projects enable the implementation of the following strategic goals in the field of electrical energy: providing secure supply of electricity for domestic market and development of electricity market at national and regional level.

The first group of projects includes the project "Trans-Balkan corridor", which implementation is on-going and it has predominantly regional character. The second group consists of projects of the reconstruction of existing 110 kV power lines which are at the end of their life cycle, as well as the construction of new lines which solve the problems of unsecure, a radial supply of individual substations 110/X kV.

The "Trans-Balkan corridor" project is included in Single Project Pipeline, Projects of Energy Community Interest (PECI), Projects of Common Interest (PCI) (section Resita - Pančevo), Western Balkan Investment Framework project list (WBIF) and list of project within investment framework of Western Balkan Six (WB6 list) (section Kragujevac 2 - Kraljevo 3 and upgrade of Kraljevo 3 substation), list of project within CESEC and it consists of two phases [3].

The "Trans-Balkan corridor - Phase 1" consists of four sections:

- Construction of double 400 kV overhead line (OHL) TS Pančevo 2 - TS Rešica - 68.3 km, 27.36 millions € (own funds EMS JSC);
- Construction of single 400 kV OHL TS Kragujevac 2 - TS Kraljevo 3 with increase of voltage level in TS Kraljevo 3 at 400 kV - 60 km, 29.6 millions € (eight millions € own funds EMS JSC, 6.6 millions € donations from WBIF, 15 millions € credit from KfW);
- Construction of double 400 kV OHL TS Obrenovac - TS Bajina Bašta with increase of voltage level in TS Bajina Bašta at 400 kV - 109 km, 58.95 millions € (pre-accession EU funds);
- Construction of double interconnection line 2x400 kV Serbia - Bosnia and Herzegovina - Montenegro - 84 km, 40.8 millions € (pre-accession EU funds).

Sub-projects (sections) of Phase 1 of the "Trans-Balkan Corridor" project have been included in the EMS JSC investment plan

The "Trans-Balkan corridor - Phase 2" includes a number of projects for construction of new 400 kV power lines. These subprojects are in the development phase, that is, in the study phase, and no decision has yet been made to enter the investment plan.

Regarding project of the reconstruction of existing 110 kV power lines, it must be considered that over 2,000 km of 110 kV OHL of transmission network was built more than 50 years ago. Although in the meantime, some of them were reconstructed, these are the replacement of worn conductors, and very rarely replacement of pillars. A large number of power lines is built on concrete pillars and passes affected routes, which results in a reduction of indicators of supply reliability. To ensure a satisfactory level of reliability of the 110 kV power transmission grid it is necessary to implement phases reconstruction of this network in the future. It is planned to reconstruct annually about 40 kilometres of 110 kV OHL by the end of 2023, that is, a total of 280 kilometres during Program implementation [3].

3.12. Investment and Development Plan of the Distribution System for the next Three to Five Years

Basic function of the planned projects in the field of electricity distribution is to increase the level of reliability of power supply of electricity customers, reduce the losses of electricity and optimize the use of the distribution network [3].

In order to achieve stated strategic goals, projects can be divided into two groups: projects that introduce modern technologies that enable the improvement of operation and the reduction of losses in the distribution system and projects of reconstruction and reinforcement of the distribution network in order to improve the reliability of supply and reduce electricity losses in the distribution network [3].

The first group of projects includes "Improving metering infrastructure" and "Distribution network automation". The second group of projects consists of the "Project of reconstruction of TS 110/X kV at the end of their life cycle" and "Project of construction of new TS 110/X kV". The total investment value of the four projects is around 277 millions €.

The aim of the project "Improvement of metering infrastructure" is the replacement of worn-out metering infrastructure and implementation of modern systems for remote reading and load management, and information systems that allow the use of the data collected. The project is being implemented in phases, through the replacement of electric meters and implementing the system in areas where advance preparation and screening of the existing situation is carried out. Currently, documentation has been prepared and made available for replacing indirect, semi-indirect and direct metering groups in the area of a complete distribution network and the replacement of the meters for a total of about 50,000 households and 25,343 indirect metering group that will be incorporated into the TS X/0.4 kV. Also, the documentation was prepared for the implementation of an information system that will allow remote reading, load management and use of data obtained in this way.

The aims of project "Distribution network automation" are: improving the reliability of supply of customers, shortening the duration of interruptions, the protection of vulnerable customers (public services, hospitals, processing industry, which are sensitive to power failure), increasing the level of manipulation of medium voltage networks, improving the utilization of existing equipment through equalization of annual load diagram by remote control of load, i.e., changing the way of supply through the use of remote control in the medium voltage network. The project will be implemented through the installation of new disconnection elements in the medium-voltage network (reclosers and disconnectors) to be controlled remotely, by installing software for remote control of the existing disconnection equipment, by installing new TS X/0.4 kV with ring main unit switching equipment, by installation of ring main unit switchgear equipment in the existing TS X/0.4 kV, by installation of SCADA systems and their integration into existing dispatch control centres.

The project of reconstruction of TS 110/X kV at the end of their service life aims to increase safety of operation and security of supply and increase the efficiency of the distribution of electricity at 110 kV voltage level. By the end of 2023, the reconstruction of 28 TS 110/X kV is planned to be completed, the reconstruction of three TS 110/X kV (Paraćin 3, Ćićevac and Kuršumlija) is planned to be underway and necessary spatial planning and technical documentation for three TS 110/X kV (Ristovac, Pirot 2 and Vlasotince) is planned to be prepared. The reconstruction of other mentioned TS (older than 40 years), which is necessary in order to increase safety of operation and security of supply and increase the efficiency of the distribution of electricity at 110 kV voltage level, will start after 2023.

The goal of the project of construction of new TS 110/X kV is to increase security of supply and increase the efficiency of electricity distribution. The process of constructing new TS 110/X kV that take over the function of an uneconomically loaded middle voltage network, solve the problem of insecure power from the existing TS 110/X kV and TS 35/X kV, high losses and low voltage conditions in the medium voltage network intensified in the previous 5-10 years, and will continue in the next ten years due to the large number of buildings whose construction is necessary. It is planned that the construction of 32 TS 110/X kV will be completed and that the required spatial planning and technical documentation will be prepared by the end of 2023. It is also planned that the licenses for three TS 110/X kV (Boljevac, Leskovac 5 and Stara planina) will be provided by the end of 2023.

In addition to the mentioned activities in the distribution part of the system, special attention will be paid to the continuation of implementation of environmental measures, which include the storage and shipment for processing of old transformer and motor oil, then solving problems related to the repair and replacement of transformers filled with PCB oils in accordance with legal obligations, as well as development of new technologies and solutions that prevent or minimize negative environmental impact.

3.13. Regional, National and European Goals of Sustainable Development, Including International Projects

Republic of Serbia has adopted, signed and ratified the agreement on the establishment of the Energy Community [24]. Thus, as one of its priorities, it defined the establishment of a regional electricity market and its integration into the EU energy market. Such a market should provide significant investments in this sector and contribute to the economic development and stability of country and region. Market functioning must be regulated by the legal framework and actions of European Union in the field of electricity, as well as environmental protection, competitiveness, use of renewable energy sources and energy efficiency. Construction of new power plants and gas interconnections will position Republic of Serbia as an important country for energy transit. Full implementation of European Union actions in the Republic of Serbia is an obligation defined by the Energy Law [1], Strategy [2] and the Program [3].

All national goals, activities and measures in the energy sector are fully in line with the objectives of Energy Strategy of European Community and European Union strategy, which implies creating a competitive and integrated energy market, attracting investment in the energy sector and ensuring safe and sustainable energy supply. Key elements of sustainable development in Republic of Serbian energy market are: energy efficiency, renewable energy sources and environmental protection and reduction of impacts on climate change.

In order to develop regional, national and European goals of sustainable development and integration into energy market of European Union, two groups of projects in the Republic of Serbia can be identified: projects whose realization is planned and certain in the coming mid-term period, and projects that potentially can be actual in the period after 2023.

National and regional projects whose realization is in progress or those planned in the medium term [3]:

- Project "Trans-Balkan corridor". Project, which consists of two phases in which is being implemented more subprojects of building new 400 kV power lines (in the 1st stage four sections is carried out) and connecting and switching substations, enables an increase in transmission capacity of the transmission network of Serbia, the replacement of worn-out 220 kV network, easier connection of production and storage capacities of electricity and better integration of the electricity market. One section of the project is already completed (double line 400 kV between Serbia and Romania, currently operating at 110 kV), one is under construction (line 400 kV TS between Kragujevac 2 - TS Kraljevo 3 with increase of voltage level in TS Kraljevo 3 at 400 kV) and for others it is process of preparation for spatial-planning and technical documentation. The project "Trans-Balkan corridor" is included in Single Project Pipeline, Projects of Energy Community Interest (PECI), Projects of Common Interest (PCI) - section Resita - Pančevo, and on Western Balkan Investment Framework project list (WBIF) and list of project within investment framework of Western Balkan Six (WB6 list) - section Kragujevac 2 - Kraljevo 3 and upgrade of Kraljevo 3 substation. Estimated investment of Phase 1 is about 156.56 millions €.
- The project of construction of new thermo-unit in TPP Kostolac B3 (installed capacity of 350 MW), with expansion of existing mine, according to all EU standards for environmental protection. Power placement of new B3 unit into transmission system of electrical energy will be carried out through the existing 400 kV switching station located in immediate vicinity of new unit. The value of the project TPP Kostolac B3 is 715.6 millions $ and completion period is 58 months. The project is financed from two sources: 85% of the project will be funded by a loan from the Chinese EKSIM bank under

preferential conditions approved by the government guarantee, and the residue is provided from the PE EPS (15%).

- Project for the construction of new wind power plants at the territory of the Republic of Serbia up to 500 MW. The project implements more private investors and it is of strategic importance for the Republic of Serbia for achieving the objectives defined for the share of renewable energy in gross final energy consumption of the Republic of Serbia. For most subprojects technical documentation is prepared, or in the final stages, and for all power plants awarded with the temporary status of privileged producers construction permition was issued. Construction of the first wind farms is expected to begin during 2017. Estimated investment of project is about 706 millions €.
- The project of environmental protection in the sector of the electricity production from PE EPS's power plants. The project includes thirteen subprojects intended for reduction in emissions of harmful gases SO_2 and NO_x, their reduction in permissible limits, resolving the problem of ash handling, waste storage and treatment of waste water in locations of particular generating capacity in PE EPS. For some sub-projects planning and technical documentation is prepared, while for some is in the preparation phase. Estimated investment of project is about 535.7 millions €.

Potential national and regional projects whose realization is not certain in the medium term [2]:

- The project of construction of TPP Kolubara B installed capacity for 2x375 MW. Estimated investment of project is about 1.5 billions €. According to information from PE EPS, the construction of only one 350 MW unit is currently under consideration.
- The project of construction of HPP Velika Morava installed capacity for 147.7 MW. Estimated investment of project is about 360 millions €.
- The project of construction of HPP Ibar installed capacity for 117 MW. This project is significant because it will enable employment of local population and improve the infrastructure (new projects), increase the use of renewable energy in accordance with the standards of European Union and increase the social standard. Estimated investment of project is about 300 millions €.
- The project of construction of HPP Srednja Drina installed capacity for 321 MW. Estimated investment of project is about 819 millions €.
- The project of construction of PSHPP Bistrica installed capacity for 4x170 MW. New HPP will be part of the system of Lim HPPs. Estimated investment of project is about 560 millions €.
- The project of construction of PSHPP Đerdap 3 installed capacity for 2x300 MW. Estimated investment of project is about 400 millions €.
- The project of construction small hidro power plants at 191 locations with total installed capacity of 387 MW. Estimated investment of project is about 500 millions €.

4. NATURAL GAS

Energy Law [1] stipulates conditions whereby entities can perform energy-related activities. An energy-related activity can be performed by a public enterprise, business entity or other legal entity or entrepreneur having a license for performing the energy-related activity, unless otherwise prescribed by the Law.

Energy-related activities according to the Energy Law [1] in natural gas sector are: natural gas transmission and natural gas transmission system management, natural gas storage and natural gas storage facility management, natural gas distribution and natural gas distribution system management, natural gas supply and public natural gas supply.

Energy regulated activities are: natural gas transmission and natural gas transmission system management, natural gas storage and natural gas storage facility management, natural gas distribution and natural gas distribution system management and public supply of natural gas. Energy-related activities of natural gas supply are performed in accordance to the open market principles.

AERS is the competent body that regulates the price of natural gas for public supply, determines the price of access to the natural gas transmission and distribution system, and determines the price of access to the natural gas storage. Energy entities that perform regulated energy activities calculate regulated prices and adopt the act on prices and submit them to the AERS for approval.

The Law on Public Enterprises regulates activities of public interest in several business activities one of which is energy-related activity. The Energy Law [1] regulates activities of public interest in energy sector, as well as obligations of the public supply.

The Energy Law [1] defines energy activities of general interest in the field of natural gas, such as: transmission and natural gas transmission system management, natural gas storage and natural gas storage facility management, natural gas distribution and natural gas distribution system management, and public supply of natural gas.

The Republic of Serbia is a signatory to the Treaty establishing the Energy Community, on the basis of which it pledged to apply the Acquis Communautaire in the field of natural gas.

With the adoption of the Energy Law in December 2014 [1] the third energy package of directives from the field of natural gas was transposed into the legislation of the Republic of Serbia.

The Energy Law stipulates that as of January 1, 2015 all end-consumers of natural gas have the right to freely choose a supplier on the market.

In order to ensure security of supply of end consumers it is stipulated that households and small customers whose all facilities/objects are connected to the natural gas distribution system, if they do not choose another supplier, are entitled to public supply at regulated prices. Small consumers of natural gas are the final customers whose annual consumption of natural gas are less than 100,000 m^3 and whose facilities/objects are all connected to the natural gas distribution system. In addition to PE Srbijagas another 32 energy entities have a license to perform activities of public service.

The right to last resort supply of maximum duration of 60 consecutive days, has the end consumer of natural gas, which is not eligible for public supply in the case of bankruptcy or liquidation of the supplier, previously supplied above mentioned consumer; after the termination or revocation of the license of the supplier who had previously supplied customer; it has not found a new supplier after the termination of the supply contract with the previous supplier, unless the contract termination is the consequence of the non-payment obligation of the buyer. The government according to the public tender procedure assigned public company PE Srbijagas for supplier who will perform the last resort supply.

According to the public tender the government assigned PE Srbijagas as a supplier for publicsuppliers of natural gas. The Energy Law [1] stipulates that until the establishment of acompetitive natural gas market in the Republic of Serbia the government, according to the publictender procedure, determines the supplier which will supply natural gas public suppliers, at theirrequest, under the same conditions and at the same prices.

4.1. Natural Gas Market

In the natural gas sector, there is bilateral market functioning. Natural gas market participants include: producer (NIS JSC), suppliers (62 companies have been licensed, while 28 is active), public suppliers (32 companies), final customers (269,380 using regulated supply and 1,515 in the open market), transmission system operators "Transportgas Srbija d.o.o. Novi Sad" (Transportgas Srbija)[7] and "Yugorosgaz-Transport d.o.o. Niš" (Yugorosgaz-Transport)[8], distribution system operators (32 active companies) and storage operator UGS Banatski Dvor.

The Transmission Network Code [34]-[37] regulates the method in line with which the transmission system operator administers transactions in the natural gas market and regulates more closely the rights and obligations of market participants who use the natural gas transmission system.

In 2018, three companies with the license for gas supply (PE Srbijagas, NIS JSC and Cestor Veks JSC) and gas producer (NIS JSC) dealt with wholesale. In this market, natural gas is purchased and sold directly among market participants based on sales contracts. During 2018, trade was functioned mutually between suppliers, and between suppliers and natural gas producer.

The Energy Law [1] prescribes that the Government appoints the supplier of public suppliers until a competitive market is established. According to the Energy Law the supplier of public suppliers has to offer natural gas to all public suppliers (including the one within the same legal entity as the supplier itself) under the same conditions and at the same price. In previous period, PE Srbijagas Novi Sad was the supplier of public suppliers [12].

For the trading in the retail market, and for the supply of final consumers with natural gas in the Republic of Serbia, 62 companies are licensed for operation in the open market (during 2018, 28 actually performed this activity). There are 32 public suppliers that are in the same time district system operators. During 2018, the largest share (85.4%) of natural gas quantities (1,881 million m^3) was sold in the open market. The last resort supply was used by 18 customers in the same period, and their share was 0.2% (3.5 million m^3). The share of households and small customers (with annual natural gas consumption of up to 100,000 m^3 with all their facilities connected to the natural gas distribution system) in the retail market was 14.6% [12]. Analysis of the trend of natural gas selling structure in the retail market, after market liberalization in 2015 (Table 16), shows that the ratio between selling in the open market and in the regulated market is roughly constant (85%:15%). The consumption of NIS JSC from its own production and the

[7] In November 2018, the Supervisory Board of Public Enterprise Srbijagas made the Decision on the basis of which transmission system operator Transportgas Srbija started operating on November 22, 2018.

[8] On the session of July 15, 2019, in line with the Energy Law and AERS regulations, the Council of the Energy Agency of the Republic of Serbia (AERS) has adopted a Decision on revocation of the certificate issued to the Yugorosgaz-Transport d.o.o. Niš by the Agency Decision of June 20, 2017 [12].

consumption of HIP Azotara (independent import of 51 million m3) were not the subjects of trade on the Serbian gas market and therefore, they are not presented in Table 16.

In 2018, within the transmission system, out of 64 metering points for final customers, suppliers were switched on one metering point. The quantity of delivered gas at that metering point was 148 million m^3, and it represents 16.6% of the total supply to customers connected to the transmission system Table 16. This was the first realized supplier switching on the transmission system after two years.

On the distribution level, suppliers were switched on 57 metering points, where 24.8 million m^3 were delivered. It amounts to 1.7% of natural gas quantities delivered to final customers on the retail market [12]. Rules on Supplier Switching were adopted in 2015 and since then valid data about supplier switching exist (Table 16). After a significant decrease in the quantity delivered by switched suppliers in 2017, the growth is again visable in 2018.

Table 16: Natural gas sale in period from 2012 to 2018, in million m^3 [12]

		2012.	2013.	2014.	2015.	2016.	2017.	2018.
Open market	mill. m^3	324	649	804	1,514	1,712	1,917	1,881
	%	16.2%	34.3%	40.6%	85.3%	85.6%	85.4%	85.4%
Regulated market	mill. m^3	1,680	1,243	1,178	261	289	329	321
	%	83.8%	65.7%	59.4%	14.7%	14.4%	14.6%	14.6%
Supplier switching in transmission system	mill. m^3	-	-	-	95	-	-	148
	%	-	-	-	19.8%	-	-	16.6%
	Metering points	-	-	-	3	-	-	1
Supplier switching in distribution system	mill. m^3	-	-	-	4	74	21	24,8
	%	-	-	-	0.3%	5.1%	0.9%	1.7%
	Metering points				10	22	85	57

Natural gas in the Serbian market origins from indigenous production and from import. Most of natural gas quantities are provided through import from the Russian Federation based on the long-term contract, and, if necessary, from other sources under short-term contracts. Long-term contract between "Gazprom Export d.o.o." (Gazprom Export) and "Yugorosgaz a.d. Belgrade" (Yugorosgaz JSC) for natural gas supply from Russian Federation to Republic of Serbia was signed in March 2013. This contract is valid until the end of December 2021. The new Annex to the contract stipulates that in the period from October 15th to December 31st, 2019, the natural gas quantities over daily contracted quantities can be taken (around 6 million Sm^3) with price adjustments.

The contract defines the method of forming the prices of delivered natural gas (based to "oil formula") and the supply regime. The supply regime includes the takeover of nominated – available quantity of natural gas.

4.2. Transport System

A natural gas transmission system is a network for natural gas transmission comprising a network of pipelines with design pressure exceeding 16 bar, except for supply gas pipelines, as well as compressor stations, block stations, metering and regulating stations, and metering stations at all points of delivery from the transmission system, other energy entities, electronic communications and information system and other infrastructure necessary for natural gas transmission, including line-pack (hereinafter: the natural gas transmission system).

During 2018, the transmission network length was extended for 5 km (Table 17). Transportgas Srbija is the transmission system operator over 95% of transmission system network, while Yugorosgaz-Transport[9] is the transmission system operator over the remaining 5%.

Table 17: Overview of the length of the transmission system network in Serbia in period 2013 – 2018 (km) [12]

Year	2013.	2014.	2015.	2016.	2017.	2018.
Length of network (km)	2,398	2,423	2,423	2,423	2,459	2,464

Basic technical characteristics of the transmission systems of Transportgas Srbija and Yugorosgaz-Transport are given in Table 18.

Table 18: Basic technical characteristics of transmission systems of Transportgas Srbija and Yugorosgaz-Transport [12]

Technical characteristics of the transmission system	Transportgas Srbija	Yugorosgaz-Transport
Capacity (mil. m^3/day)	≈ 18	≈ 2,2
Pressure (bar)	16–75	16–55
Length (km)	2.339	125
Nominal diameter (mm)	DN 150–DN 750	DN 168–DN 530
Compressor stations	1	-
Compressor station, power, (MW)	4,4	-
Number of entries into the transmission system :	13	1
1.From another transmission system	1 (Horgoš)	1
2.From production fields – domestic gas	11	-
3.From the storage	1	-
Number of exits from the transmission system	248	5
Metering and regulating stations on transmission system exits	245	5
Overtaking stations	2	-
Entry into Yugorosgaz transmission system	1	-
Interconnector towards Bosnia and Herzegovina	1	-
Natural gas storage	1	-

Transmission system operators were obliged to provide automatic collection and processing of the data on natural gas flows with collecting interval of 24 hours or shorter for all delivery points from the transmission system. Such metering and data acquisition equipment is necessary for

[9] On the session of July 15, 2019, in line with the Energy Law and AERS regulations, the Council of the Energy Agency of the Republic of Serbia (AERS) has adopted a Decision on revocation of the certificate issued to the Yugorosgaz-Transport d.o.o. Niš by the Agency Decision of June 20, 2017

market functioning and development. So far, it has been installed in all exits on the system that is operated by Yugorosgaz-Transport and on 66% of the total number of exits from Transportgas Srbija transmission system [12]. Considering that at the end of 2017, this equipment was installed on 65% of the total number of exits from Transportgas Srbija transmission system, it can be stated that there were no significant activities in this field during 2018. However, adequate metering and data acquisition equipment were installed on exits with larger capacities, so the share of measured natural gas is over 66%.

The main disadvantage and weakness of the transmission system is one connection with the neighboring systems that enables and provides import of necessary quantities of natural gas. The connection (overtaking station) is located in Kishkumdorozmi (Republic of Hungary), and the gas is imported via the Hungarian transmission system from the Russian Federation under a long-term contract with Gazprom Export.

The Republic of Serbia has two interconnections with gas pipeline systems of neighboring countries (one entry and exit point):

- Hungary - Serbia (Kishkundorozhma) - entry point and
- Republic of Serbia – Bosnia and Herzegovina (Zvornik) - exit point

Both interconnections are a part of Transportgas Srbija transmission system, while there is no gas pipelines connected with the transmission systems of neighboring countries within the Yugorosgaz-Transport transmission system.

4.2.1. Assessment of Transmission System Reliability

The assessment of the reliability of transmission system operation is doing based on indicators of the quality of natural gas delivery and supply. Energy entities collect data on these indicators in a systematically and uniformly in accordance to the Rules on Monitoring Technical and Commercial Indicators and on Regulating Quality of Electricity and Natural Gas Delivery and Supply [39], and inform the AERS on this issue once a year.

Reliability of transmission system operation is monitored by recording number and duration of interruptions in the delivery within transmission. Interruptions are sorted out to planned, unplanned and interruptions caused by force majeure.

Interruption within the transmission system of Transportgas Srbija from 2015 to 2018 are presented in Table 1. In the same period, on the transmission system of Yugorosgaz-Transport, there were no natural gas delivery interruptions.

Table 19: Interruptions within Transportgas Srbija transmission system by causes [12]

TSO Transportgas Srbija	Interruption causes					
	Planned interruptions		Unplanned interruptions		Vis major	
	Number	Duration (min)	Number	Duration (min)	Number	Duration (min)
2015	0	0	5	36	0	0
2016	7	2,649	0	0	0	0
2017	15	10,980	2	720	0	0
2018	7	5,460	0	0	0	0

During 2018, all interruptions were planned. The reasons for interruptions were being maintenance and relocation of pipelines.

4.3. Distribution System

A natural gas distribution system is a distribution network of natural gas comprising a network of pipelines, regulation, metering and regulation, and metering stations at all points of delivery from the distribution system, other energy facilities, electronic communications, information another infrastructure necessary for distribution of natural gas with maximum operating pressure not higher than 16 bar, including line-pack.

According to the Energy Law [1], a distribution of natural gas is a regulated activity.

In 2018, the length of the distribution network in Serbia has increased for 1,461 km (without connections), or for 8.6% km, thus creating the preconditions for connection of new customers [12]. The largest percentage of the increase in network length was in DSO Loznica-Gas d.o.o. where the length of the network increased by 37.9%. PE Srbijagas is in charge for 52.4% of the total distribution network in the Republic of Serbia [12]. The increase in distribution network length within this company was 16.45%.

The length of the distribution network is presented in Table 20.

Table 20: Length of the distribution network in Serbia in 2013 – 2018 [12]

Year	2013.	2014.	2015.	2016.	2017.	2018.
Length (km)	15,839	16,363	16,532	16,653	16,961	18,422
Number of delivery points	261,000	261,000	262,500	267,000	270,626	276,518

The number of active connections (delivery points) within distribution networks amounts 276,518, and in comparison to the previous year, it has been increased for 5,892 connections (2.18%) [12].

4.3.1. Assessment of Distribution System Reliability

The assessment of the reliability of distribution system operation can be done based on indicators of the quality of natural gas delivery and supply. Energy entities collect data on these indicators in a systematic and uniform manner in accordance with the Rules on Monitoring Technical and Commercial Indicators and on Regulating Quality of Electricity and Natural Gas Delivery and Supply [39] and inform the AERS on this issue once a year. Based on the AERS Annual Report for 2018 [12], it is evident that this system of data collection is not fully operating. Out of a total of 276,518 delivery points, data about interruptions are collected from 183,591 delivery points (66.4%).

The reliability of distribution system operation is assessed by parameters of system reliability - number and duration of interruptions of delivery within a distribution. These parameters are monitored and registered separately as planned and unplanned interruptions in natural gas delivery. Based on these parameters, indicators of continuity of delivery from distribution systems are calculated as follows [39]:

- SAIFI [number of interruptions/user] - average frequency of interruptions per user; It is calculated as a quotient of the cumulative number of interruptions and the total number of users.

- SAIDI [min/user] - average duration of interruptions per user; It is calculated as a quotient of cumulative duration of all interruptions and the total number of users.

Summary data about reliability parameters of distribution system operation and indicators of continuity of delivery for the period 2015-2018 are presented in Table 21 and Table 22. Data are related to planned and unplanned interruptions and are sorted out in accordance with interruption causes. Maximal values of SAFI and SAIDI indicators registered in individual distribution systems are also presented.

Table 21: Unplanned interruptions within distribution systems - Summary indicators [12]

Interruption cause	Year	Number of interruptions	SAIFI	Maximum reached SAIFI	SAIDI	Maximum reached SAIDI
			Number of interruptions/user		min/user	
Delivery reduction from upstream system	2015	0	0	0	0	0
	2016	6	0	0.12	0.10	34.14
	2017	0	0	0	0	0
	2018	0	0	0	0	0
Gas leak	2015	58	0.02	0.11	1.70	10.15
	2016	84	0.04	2.00	6.3	15.85
	2017	37	0.02	0.13	3.33	23.71
	2018	39	0.01	0.07	1.15	9.44
Third party	2015	219	0	0.15	0.09	75.88
	2016	183	0.02	0.54	3.86	710.00
	2017	259	0.03	0.04	3.80	16.44
	2018	230	0.06	1.00	9.37	154.62
Inadequate network capacity	2015	0	0	0	0	0
	2016	0	0	0	0	0
	2017	0	0	0	0	0
	2018	0	0	0	0	0
Other reasons	2015	0	0	0	0	0
	2016	0	0	0	0	0.07
	2017	3	0.01	0.3	3.79	168.14
	2018	1	0.00	0	0.02	0.18
Total	2015	277	0.02	0.15	1.79	75.88
	2016	273	0.06	2.00	10.26	710.00
	2017	299	0.06	0.3	10.92	168.14
	2018	270	0.07	1.07	10.54	164.24
Lithuania	2013.	-	0.0045	-	1.53	-
Netherlands	2013.	-	0.0067		1.01	

Table 22: Planned interruptions within distribution systems - Summary indicators [12]

Interruption cause	Year	Number of interruptions	SAIFI	Maximum reached SAIFI	SAIDI	Maximum reached SAIDI
			number of interruptions/user		min/user	
Cause within a system connected to it	2015	0	0	0	0	0
	2016	5	0	0.03	0.21	6.98
	2017	4	0.039	1.62	12.93	873.20
	2018	2	0.02	0.09	15.31	61.03
Administrative interruption	2015	0	0	0	0	0.16
	2016	2	0	0.55	0.04	0.65
	2017	5	0.032	0.3	14.81	127.62
	2018	2	0.01	0.46	0	0
Operator's interruption	2015	22	0.03	1.00	4.38	540.00
	2016	27	0.11	0.31	104.85	631.92
	2017	51	0.040	1.00	14.72	360.00
	2018	62	0.06	1.00	27.36	540.00
Uncategorized interruption	2015	32	0.02	0.11	1.80	12.30
	2016	32	0.01	0.11	1.57	12.13
	2017	44	0.004	0.03	2.02	16.55
	2018	74	0.02	0.17	3.43	28.37
Total	2015	54	0.05	1.00	6.18	540.00
	2016	66	0.12	0.55	106.67	631.92
	2017	104	0.11	1.62	44.49	873.20
	2018	140	0.11	1.72	46.11	629.4
Lithuania	2013.	-	0.26	-	26.97	-
Netherlands	2013.	-	0.027	-	5.10	-

To have a full understanding about the reliability of distribution systems operation in the Republic of Serbia, data about SAIFI and SAIDI indicators for two EU countries (Lithuania and the Netherlands), with the same method for indicators calculation applied, are also presented in Table 21 and Table 22 [27]. It can be noticed, for unplanned interruptions, that both indicators are significantly lower than in the case of Republic of Serbia. This means that there are significant possibilities for improvement of system operation, and that is necessary to undertake technical and organizational measures for reducing unplanned interruptions within distribution systems.

Considering "Gas leak" and "Third party" as dominant causes for unplanned interruption, it is clear that the key activities that should be undertaken are related to better maintenance of systems and better coordination with utility companies. Considering planned interruptions, difference is not so significant, but it shows that it is possible to reduce duration of planned interruptions. Maximal SAIFI and SAIDI indicators are significantly higher than average values. This shows significant variation in reliability of operation of different distribution systems, and the need for some distribution systems to take adequate actions to eliminate primarily the cause of unplanned interruptions.

In Table 23, summary data about reliability indicators of distribution system operation for 2015-2018 period are presented.

Table 23: Summary continuity indicators of distribution systems

Type of interruptions	Year	Number of interruptions	SAIFI [number of interruptions/user]	SAIDI [min/user]
Planned	2015	277	0.02	1.79
	2016	66	0.12	106.67
	2017	104	0.11	44.49
	2018	140	0.11	46.11
Unplanned	2015	54	0.05	6.33
	2016	273	0.06	10.26
	2017	299	0.06	10.92
	2018	270	0.07	10.54
Total	2015	331	0.07	8.12
	2016	339	0.18	116.93
	2017	403	0.17	55.41
	2018	410	0.18	56.65

It can be observed, from Table 23, that the number of interruptions grew during the observed period from 331 interruptions during 2015 to 410 interruptions in 2018. However, the interruption structure is more favorable. The share of unplanned interruptions in 2015 was 84%, while in 2018 this share decreased to 66 %.

Values of continuity indicators of distribution systems (SAIFI and SAIDI) in 2018 are worse than in 2017. The difference is not big, but it indicates the need for undertaking activities related to preventive maintenance, better coordination, etc. Data for 2015 are significantly better than data for the 2016-2018 period. However, objectively it can be assumed that the better results in 2015 were the consequence of inexperience in data collecting and processing, and were not the consequence of significant, additional problems in operation of distribution systems in the following years.

4.4. Storage of Natural Gas

Underground gas storage (UGS) Banatski Dvor was commissioned in November 2011, and it is located on the depleted gas deposit whose capacity was amount to 3.3 billion m^3 of natural gas. Gazprom Export nad PE Srbijagas are the storage owners [43]. Total area of the storage amounts to around 54 km^2. The available capacity of the underground storage is currently 450 million m^{3}of natural gas.

The underground gas storage has 30 wells, different by purposes, equipment and period of drilling. Out of total number, 18 wells are used for natural gas injection and withdrawal; one is used for injection of reservoir water, while 11 are observation and monitoring wells. The gas injection/withdrawal line is equipped with an installation for gas processing (separators, filters), measuring and safety equipment, and equipment for gas dehydration and regeneration of glycol.

Compressor station comprises of two compressor installations (gas motor, compressor, cooler). Compressors have two stages of compression; inlet pressure is 30-35 bar and outlet pressure is 150 bar. One compressor has the power of 2.5 MW and it has been in operation since 2006, while the other compressor has the power of 3.5 MW and it has been in operation since 2010.

Maximal daily withdrawal capacity is 5 million m^3/day and it is limited by the capacity of the line for gas dehydration. Maximal technical injection capacity is 2.7 million m^3/day, and it is defined by the capacity of parallel operation of both compressors. There is no backup compressor in the case of malfunction of any of compressors.

History of underground storage operation in period 2012-2018 is given in Table 24.

Table 24: Data about UGS Banatski Dvor operation in period 2012-2018 (million m^3) [12]

	2012.	2013.	2014.	2015.	2016.	2017.	2018.
Injected	389	342	284	228	197	240	273
Withdrawn	161	268	353	113	254	227	270
Own consumption	-	7	5	3	3	3	3
Delivered to transmission system	-	266	352	113	254	227	299
Cushion gas (at the end of year)	353	530	530	530	530	530	530
Commercial gas (at the end of year)	328	402	333	448	391	404	375
Maximal daily injection	2.48	2.5	2.7	2.4	2.6	2.4	2.6
Maximal daily withdrawal	3.94	4.2	4.2	2.8	4.95	5.1[10]	5.0

Bidirectional gas pipeline Gospođinci – Banatski Dvor enables unhindered and full connection of the underground gas storage with the transmission system. The basic data on this gas pipeline are as follows:

- length 42.5 km
- nominal diameter DN 500
- maximum working pressure: p_{max}=75 bar
- maximum gas flow:
  - withdrawal from UGS Banatski Dvor Q=415,000 m^3/h (10 million Sm^3/day) and
  - injection into UGS B.Dvor Q=230,000 m^3/h (5.5 million Sm^3/day).

Currently, Republic of Serbia should have enough natural gas for 30 days of supply interruption, while there would be a 13.7% shortfall of imported gas in order to meet needs for 90 days [28]. Of course, these results are relative, as the daily (as well as hourly) withdrawal capacity is limited, and consumption over that limit could not be satisfied (regardless to available gas in storage). Also, these results are only valid for a single season. Without additional supply routes,

[10] Technical capacity of underground storage is defined at a temperature of 20˚C and a pressure of 1.01325 bar, while values of maximal injected and withdrawn quantities are defined at a temperature of 15˚C and a pressure of 1.01325 bar, reduced to lower calorific value of H_d=33,338.35 kJ/m^3.

Serbia would not be able to fill underground storage, which would reflect on the next year's gas supply.

The extending of a capacity of underground storage (the second phase of development) to 800 million m^3 is planned.

4.5. Security of Supply

4.5.1. Planned Production and Consumption of Natural Gas and a Way for Ensuring Gas Supply for the Upcoming Five Years Period

Natural gas is the third most used primary energy source in the Republic of Serbia, after coal and oil. Its share in the total primary energy supply in 2018 was 14.77% [26]. Gross inland consumption in 2018 amounted 2,632 million m^3, 1% lower compared to 2017 [12], [26]. Growth of consumption, noticeable for the period after 2014 (Table 25), was stopped, and the decrease in consumption has occurred, primarily because of a significant decreasing in non-energy consumption.

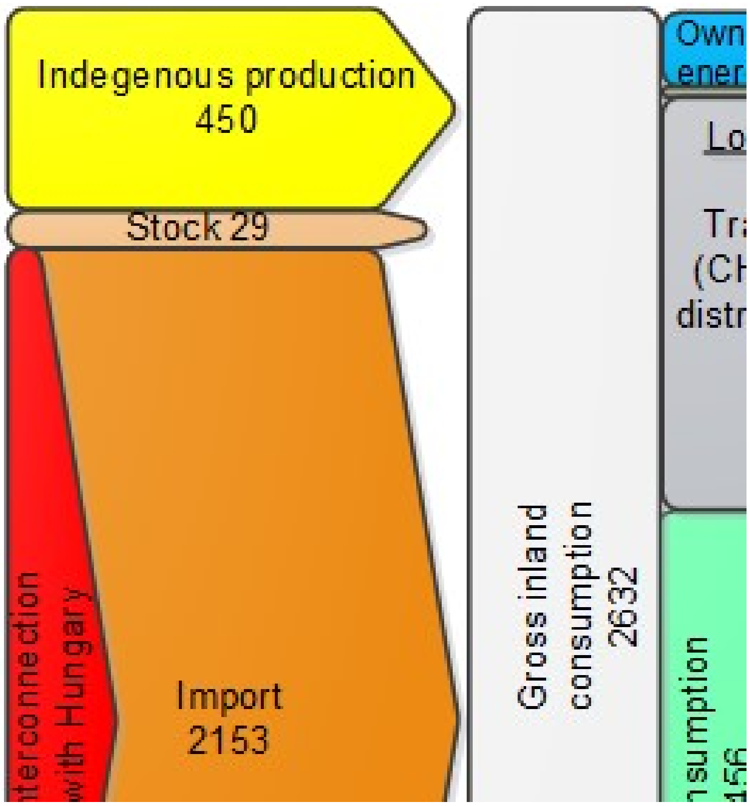


Figure 2: Supply and consumption structure of natural gas in 2018, in million Sm^3 [26] [11]

[11] https://www.stat.gov.rs/media/4782/bilans-prirodnog-gasa-2018-prethodni-podaci.pdf

Table 25: Balance of Natural Gas for the period 2010-2018, in thousands Sm^3 [16]

Year:	2010.	2011.	2012.	2013.	2014.	2015.	2016.	2017.	2018.[12]
Primary production	387,183	508,161	533,511	531,188	557,179	572,502	523,229	489,085	449,567
Import	1,967,753	1,747,520	1,789,756	1,887,480	1,394,659	1,740,221	1,795,226	2,182,632	2,153,385
Stock changes	0	133,729	-216,108	-74,500	68,795	-114,511	56,850	-12,800	29,458
International bunkers	-27,343	0	0	0	0	0	0	0	0
Gross inland consumption	**2,327,593**	**2,389,410**	**2,107,159**	**2,344,168**	**2,020,633**	**2,198,212**	**2,375,305**	**2,658,917**	**2,632,410**
Transformation input	**805,480**	**904,808**	**826,160**	**774,997**	**856,098**	**885,174**	**886,884**	**920,464**	**942,349**
CHP	*95,173*	*153,786*	*146,795*	*70,436*	*27,391*	*20,064*	*46,582*	*94,992*	*115,978*
Autoproducers	*203,910*	*184,245*	*132,134*	*205,803*	*216,384*	*164,998*	*144,646*	*136,587*	*149,740*
District heating plants	*506,397*	*566,777*	*547,231*	*498,758*	*480,844*	*563,451*	*566,640*	*565,657*	*536,915*
Refineries	-		-	-	*131,479*	*136,661*	*129,016*	*123,228*	*139,716*
Consumption in the energy sector	**60,274**	**54,242**	**93,736**	**159,932**	**183,560**	**209,707**	**180,986**	**202,241**	**197,345**
Loses	**20,943**	**5,746**	**11,847**	**16,328**	**18,194**	**11,433**	**22,544**	**36,101**	**36,705**
Final consumption	**1,440,896**	**1,424,614**	**1,175,405**	**1,392,911**	**962,981**	**1,091,898**	**1,284,891**	**1,500,111**	**1,456,011**
Final Non-Energy consumption	**271,435**	**283,532**	**21,496**	**13,4365**	**114,252**	**157,658**	**292,077**	**425,526**	**197,386**
Final Energy consumption	**1,169,461**	**1,141,082**	**1,153,909**	**1,258,546**	**848,729**	**934,240**	**992,814**	**1,074,585**	**1,258,625**
Industry	*759,313*	*732,730*	*760,460*	*88,9452*	*485,888*	*543,083*	*550,089*	*578,938*	*720,005*
Transport	*12,623*	*14,054*	*4,459*	*9,486*	*8,833*	*11,204*	*6,502*	*5,309*	*21,001*
Households	*270,412*	*266,653*	*244,232*	*218,528*	*179,000*	*189,822*	*210,678*	*240,938*	*243,982*
Agriculture	*18,330*	*17,448*	*20,670*	*19,543*	*32,207*	*20,713*	*28,953*	*22,564*	*23,506*
Public and commercial sector	*108,783*	*110,197*	*124,088*	*121,537*	*142,801*	*169,418*	*196,592*	*226,836*	*250,131*

Natural gas production of in the Republic of Serbia is being realized in Vojvodina area. NIS JSC is the only company in Serbia dealing with the exploration and production of natural gas. Natural gas is extracted from 78 wells, while the main gas fields are as follows: Međa, Martonoš, Itebej, Torda Plitko, Miloševo[13]. After preparation process which makes produced gas applicable to final customers, produced gas is delivered via 11 points into the transmission system (98% of

[12] https://www.stat.gov.rs/media/4782/bilans-prirodnog-gasa-2018-prethodni-podaci.pdf

[13] https://www.nis.eu/lat/o-nama/delatnosti/istrazivanje-proizvodnja

produced quantity) while 2% of produced gas is delivered via 4 points into the distribution system [12].

Inland production was enough to meet 17.08% of gas demand in 2018, while the rest was supplied by import from the Russian Federation in line with the long-term contract and other contracts. There were no imports from other sources [12]. For consumers in the Republic of Serbia, natural gas from Gazprom Moscow is acquired by Yugorosgaz JSC. In 2017 and 2018, gas was imported entirely from the Russian Federation, while all imported gas was supplied via the Hungarian transport system [12]. The majority was imported based on the long-term contract, while the rest 135 milion m^3 was imported based on other contracts [12]. The volume of gas supplied based on the other contracts included 51 milion m^3 imported by HIP Azotara Pančevo for own purposes [12].

Total indigenous production of natural gas in 2018 amounted 449.5 million m^3, which was 8.3% less than in 2017 [26]. After the period from 2011 to 2015, when gas production had significant growth, production has been constantly decreased.

In the upcoming period continuation of declining trend of production is expected, since gas fields are characterized by high utilization coefficients, amounts of conventional resources and balance reserves are small, while a level of geological exploration is relatively high [2]. Projections of indigenous production up to 2023 are given in Table 26.

Table 26: Projection of indiginous production, in thousands m^3 [3]

Year	2019.	2020.	2021.	2022.	2023.
Production	425,924	397,369	364,912	343,522	322,353

In the Energy Sector Development Strategy [2] two scenarios of natural gas consumption were considered: reference scenario and scenario with implementation of energy efficiency measures. Both scenarios foresee an increase of gas consumption, both for transformation input (CHP gas facilities, increase of gas share in district heating plants and autoproducers) and for final consumption (Table 27). Besides the expected increase of total gas consumption, the Strategy also envisages an increase of the share of natural gas in primary energy mix to 16% by 2030.

Table 27: Projections of natural gas consumption, in thousand Sm^3 [2]

	Reference scenario			**Scenario with implementation of energy efficiency measures**		
	2020	**2025**	**2030**	**2020**	**2025**	**2030**
Transformation input	916,771	1,027,286	1,113,940	777,372	907,980	973,285
Final consumption	1,935,266	2,255,508	2,622,217	1,780,797	2,073,410	2,430,072
Losses	38,931	46,466	54,002	36,420	42,699	48,978
Total	**2,890,969**	**3,329,261**	**3,790,158**	**2,594,588**	**3,024,089**	**3,452,334**

Following the projections of gas consumption presented in the Strategy [2], PE Srbijagas has determined the total yearly volume of natural gas to be transported by the transmission system for the period from 2017 to 2026 [29]. The assessment of needed quantities was performed as the base for the Plan of the transmission system development for the period 2017-2026 [29]. Table 28 presents data for planed transmission in the next four years, i.e. up to 2023. Estimates of quantities for the DSO needs and for the needs of the final consumers connected to the transmission system were done based on historical data for the period 2011 – 2015, results of a survey conducted with DSO and end consumers connected to the transmission system, as well as the Strategy projections [2]. Data given in Table 28 are corrected, compared to data presented in [29], for UGS Banatski Dvor and overtaking station Pojate. Corrections were made based on the extension of milestones for UGS Banatski Dvor given in the Program [3] and based on the proposed projections of gas transmission by the Transmission Development Plan of Yugorosgaz-Transport [30].

Table 28: Estimation of natural gas quantities to be transmissed in the period 2019- 2023, in million Sm^3

	2019.	2020.	2021.	2022.	2023.
Overtaking station Pojate (according to Yugorosgaz-Transport)	48.8	51.2	53.7	56.4	58.7
Distributers	1,267	1,271	1,275	1,279	1,283
CHP	190	190	190	190	190
End consumers connected to the transport system	466	468	471	473	475
UGS Banatski Dvor	500	500	500	500	500
Production on the transmission system	311	269	247	223	203
Own use	2	3	3	3	3
Transmission without cross border transmission	**2,784.8**	**2,752.2**	**2,739.7**	**2,724.4**	**2,712.7**
Overtaking station for cross border transmission (for Bosnia and Herzegovina)	226	327	378	379	380
Total transmission including cross border transmission (million Sm^3)	3,010.8	3,079.2	3,117.7	3,103.4	3.092,7

In the upcoming period consumption of natural gas will be governed by various factors related to energy sector (price of natural gas, infrastructure development, prices of other energy sources, etc.), factors related to general economic and social development (GDP growth, purchasing power of the population, implementation of environmental regulations, demographic indicators, structure of industrial production, etc.). Significant effect on natural gas consumption could have changes related to large industrial facilities, significant natural gas consumers (e.g. Azotara Pančevo, MSK Kikinda), as well as realization of projects in the energy sector (e.g. the construction of CHP Pančevo or heat supply of Belgrade from TPP "Nikola Tesla A"). However, if there is no significant change in the structure of natural gas consumption in the future, further increase of import dependency can be expected. It could rise from 82.9% in 2018 to around 90% by 2025, due to expected decline in domestic natural gas production.

The long-term contract between Gazprom export and Yugorosgaz JSC, on the supply of the Republic Serbia with natural gas from Russia, valid by the end of 2021, guarantees supply of 2 billion Sm^3 of natural gas per year. It is rational to assume that additional needs of natural gas in the period up to 2023 could be met by import from the Russian Federation. Alternative and probably more expensive options are supply from the North Stream, leasing transmission capacities in Germany, Austria and Hungary, or purchasing in the market in Hungary. After completing of the interconnection with Bulgaria the possibility of supplying from this direction (Russian Federation, Azerbaijan, LNG therminal in Greece etc) could be analyzed. Also, the new project related to conection of Bulgaria and Hungary via Serbia could provide new supply route from Russian Federation or the Turk Stream.

The available capacity of interconnector with Hungary for the needs of consumers in Serbia (11 million m^3/day, utilization rate of interconnectors of 90%) allows annual imports of about 3.6 billion m^3, which is significantly more than 2.224 billion m^3 imported in 2018, or 1.93 billion m^3 of average annual imports in the period 2008-2018 [12], but also more than the projected annual gas needs until 2023. In 2018, the utilisation rate of the entry firm capacity on Serbian-Hungarian border of 540,000 m^3/hour was 51.53% (21.57% in 2017). The highest daily quantity withdrawn into the transmission system on the Serbian-Hungarian border amounted to 11.39 million m^3/day, out of which 9.66 million m^3/day were intended for customers in Serbia and the rest for were intended for Bosnia and Herzegovina [12]. Natural gas consumption is uneven, depends on the season, thus capacity utilisation is considerably lower during summer.

4.5.2. Measures to Cover Peak Demand or Shortfalls of Suppliers

Transmission network codes [34]-[37] regulate actions regarding allocation of capacity and overload management, as well as managing actions in cases of disturbances in the transmission system.

In the case of the peak load demand when a sum of the required entry/exit capacities is greater than the total capacity, the transmission system operator determines to each applicant the capacity proportionally to the required capacity. Also, the operator of the transmission system has the right to limit or cut off interruptible capacity at entry/exit, if announced natural gas quantities for the next day are greater than the technical capacity for an entry/exit of the system.

The transmission system operator limits interruptible capacity, with the minimal number of interruptions, considering the amount of the missing capacity, the frequency and the duration of interruptions in the previous period and the integrity of the transmission system.

Any case when one or more suppliers is not able to provide enough natural gas (shortfall), according to the Transmission system code, is treated as a Market Disruption, or a situation in which the security of supply of end customers is jeopardized. The shortfall can be a consequence of general shortage of natural gas or other extraordinary circumstances, which due to insufficient supply can cause a pressure drop in the transmission system and jeopardize operation of the transmission system.In the event of a general shortage of natural gas, the transmission system operator undertakes measures for limiting natural gas delivery, based on a Plan for consumption limiting, after the Government adopts a decision on the application of such measures. If a Customer[14] refuses to implement the supply limitation plan, the operator of the transmission system shall limit or cut of supply of the Customer. The transmission system is obliged to inform the Customers and the competent authorities about planned and expected interruptions in natural gas supply in advance and in time, unless it is necessary to undertake immediate measures to ensure safe and undisturbed functioning of a part or the whole transmission system.

Detailed instructions for acting in aforementioned and other situations that influence or can influence functioning of the natural market in Republic of Serbia and affect or can affect security of supply are given in the Emergency Plan For Safegurarding Of Security Of Natural Gas Supply [41].

[14]Energy entity, gas producer, or end user that made a contract on natural gas transmission.

An experience from previous crisis (gas supply cut in 2009, sanctions of the international community in the 1990s) indicate that in such situations is necessary to require fuel switch of end-users who have such options, considering environmental effects caused by gas supply interruption of industrial users, and necessary coordination with other energy systems (primarily electric power system).

4.5.3. Quality and Maintenance of Infrastructure

Maintenance of the transmission system and other energy infrastructure under the jurisdiction of the Transportgas Srbija is carried out in accordance with the Transmission Network code [34]-[36], approved by the AERS. Requirements for ensuring proper maintenance to be fulfilled during the design and construction of gas stations, as well as the complete procedure related to the adoption and implementation of a Maintenance Program for the next gas year are stipulated by proper rules. A Maintenance Program should contain a list of entrances/exits that would be affected by a scheduled maintenance, an estimated period of entrance/exit capacities reduction, a level reduction for each capacity and a description of planed activities. Maintenance Program prescribes monthly, quarterly, semiannual and annual inspections of installations. Upon the inspection, proper activities should be undertaken in the identified parts of the infrastructure.

Table 29 shows number and duration of planned activities on maintenance of the transmission system in the period 2015-2018. In this period activities were dedicated to relocation of some sections of pipeline, repairing of perceived damage, replacement of some installation parts, etc. During the maintenance activities total interruption of gas transmission through some sections occurred, thus maximum envisaged duration per activity was 3 days.

Table 29: Activities on maintenance of transmission system

	2015	2016	2017	2018
Total	3	5	6	1
Envisaged duration (in days)	6	12	10	2

For ensuring secure supply, maintenance of the transmission system, which has been successively built (some sections had been built 50 years ago) has a crucial importance (Table 30). By analyzing results, obtained from the transmission system examination by an intelligent pig, it was determined that pipelines were in good condition and all damages with defect depths that amount 70% or more of a thickness of the pipe wall were fixed [29]. Based on the undertaken activities for repairing of pipelines damages, it was found that outer damages were mainly caused by pipe corrosion (due to damage on insulation, poor installation of insulation, etc), while inner damages were characteristic for gas pipelines that transported domestic gas.

Table 30: Age of the transmission system [29]

Age	More than 50 years	30-50	20-30	10-20	1-10	Total
Length (km)	170	819	618	260	236	2103
Share (%)	8	39	30	12	11	100

The plan is to test gas pipelines every 10 years and, based on obtained results, to determine the dynamics of future investments in the transmission system.

The transmission system and other energy infrastructure under the jurisdiction of Yugorosgaz-Transport are maintained according to the Guidelines for Gas Installations Maintenance and the adopted Maintenance Program for the next gas year, in accordance with the Transmission Network code [37], approved by the AERS. A Maintenance Program prescribes monthly, quarterly, semiannual and annual inspections of installations. If needed appropriate measures should be undertaken upon the inspection. In the period 2017-2019, five inspections were carried out by the Emergency Management Sector of the Ministry of Interior, and no irregularities related to fire protection were found. It was found that the state was in accordance with provisions of the Law on Fire Protection, the Law on Flammable and Combustible Liquids and Flammable Gases and the Law on Explosive Substances, Flammable Liquids and Gases. In 2015 examination of the transmission pipeline at rivers and waterfalls crossings was performed by a PCM method (Pipeline Current Mapping). The PCM method is an indirect method for detecting outer corrosion of underground gas pipelines. The conducted testing indicated a completely satisfactory condition of pipelines, which was expected since the transmission system was built in the past 20 years using pre-insulated pipes and a system of cathodic protection was installed.

Maintenance of distribution systems shall be performed in accordance with the Distribution Network codes, which each distribution system operator shall submit to the AERS[15].According to the codes, each distribution system operator adopts the Maintenance Program for the next gas year no later than 1st May, considering, as possible proposals of users and operators of related distribution systems. The maintenance program contains activities that affect reduction of distribution capacity, and include activities on connection to the distribution system, testing, repairing, replacement, re-commissioning, development and extension of the system, as well as preparatory and final works.

4.5.4. Incentives for New Investment in Exploration, Production, Transportation and Storage of Natural Gas

New infrastructural facilities of the gas pipeline system, i.e. interconnectors or natural gas storage facilities may, upon a request, be exempted from the right of access by the principles of transparency and non-discrimination under the following conditions:

- that investments in the new infrastructural facility increase competitiveness in the market and safety of supply;
- that the risk of investments in new infrastructural facilities is such that the investments will not occur unless the exemption is approved;
- that the new infrastructural facilities are owned by a natural or legal person that performs business operations within another legal person separated from the system operator within which the new infrastructural facilities will be constructed;
- that users of the new infrastructural facility bear the expenses of the facility exploitation;
- that the exemption does not prevent competition, efficient functioning of the internal natural gas market and efficient operation of the regulated system to which the new infrastructural facilities are connected.

[15] https://www.aers.rs/Index.asp?l=1&a=94.3

The exemption is also applied in a case of a considerable increase of the capacity of existing infrastructural facilities and modification of this infrastructure ensuring development of new sources of natural gas supply.

In a case of interconnectors, an exemption act may be applied after consultations with other countries to which construction of an interconnector has an impact, or after consultations with relevant regulatory bodies.

Currently, in the Republic of Serbia, there are no incentive measures for new investments in research, production, transport and storage of natural gas

For new investments in the transmission system, as a special case of incencitive can be considered the Act on exemption of the new interconnector for natural gas [12], approved to Gastrans d.o.o. Novi Sad:

- the exemption from the obligation to apply the principles of the third party access (general rules of capacity distribution and general rules for natural gas transmission) specified in and regulated prices from the Article 283 paragraph 1 of the Law [1],
- the exemption of ownership unbundling obligation, the Article 224 of the Law [1], of the future pipeline which will pass throuhg Serbia and be conected to Bulgarian and Hungarian national transmission systems[16].

4.5.5. Plans for the Construction of Energy Facilities to Ensure the Security of Natural Gas Supply

Security of supply is related to ensuring and delivering natural gas to customers in required quantity in timely manner. Security off supply is improved by diversification of supply routes and sources and by construction of gas storages. Assessment of security of supply can be done by system availability indicator (N-1). It indicates the daily operational flexibility of natural gas infrastructure and its ability to respond to consumption requirements under extreme conditions. The indicator is calculated as follows:

$$(N-1) = \frac{E_{pm} + P_m + S_m - I_m}{D_{max}} \times 100\ [\%]$$

where:

D_{max}	total daily consumption on a day with the highest gas demand with the probability of occurrence once in 20 years [Sm^3/day],
Epm	sum of technical pipeline capacities, gas quantities that can be transported over existing interconnections in a day [Sm^3/day],
Pm	daily indigenous natural gas production [Sm^3/day],
Sm	maximum daily withdrawn quantities from underground storage [Sm^3/day],
I_m	maximum daily capacity of the largest gas supply infrastructure [Sm^3/day].

[16] The Act was issued by the Council of the Energy Agency of the Republic of Serbia on 1st October 2018.

Transmission system, in terms of infrastructure and from the standpoint of security of supply, is considered as satisfactory if the capacities of the entrances to the system are enough to meet total demand for natural gas, in a case of interruption of the largest infrastructure that has entrance to the transmission system, during the day with exceptional high natural gas demand with the probability of occurrence once in 20 years. This corresponds to values of (N-1) indicator higher than 100%.

For the gas network system of the Republic of Serbia values of the input parameters for calculating (N-1) indicator for 2018, are as follows:

E_{pm} = 15 million Sm^3/day (technical daily entrance capacity at Horgoš) [29], [44][40]

P_m = 0.745 million Sm^3/day [44][40],

P_m = 5 million Sm^3/day (UGS Banatski Dvor),

I_m = 15 million Sm^3/day (technical daily entrance capacity at Horgoš),

D_{max} = 17.274 million Sm^3/day (consumption recorded on February 9th, 2012[17]) [29].

Calculated value of (N-1) indicator for 2018 is: **(N-1) = 33.26%.**

The calculated value, significantly lower then desired 100%[18] cannot be considered as satisfactory and clearly indicates that any deviation from the standard of operation of the gas pipeline system can cause serious consequences for the supply of the market [44][40]. Bearing in mind the predicted decline of indigenous production, the value of this indicator is expected to decline unless new interconnections with the neighboring transmission systems are introduced or the capacity of underground gas storage is extended [31].

The key energy objects planed to be constructed for ensuring and increasing security of supply are as follows:

Gas interconnector for the transmission of natural gas whose route passes through the territory of the Republic of Serbia and crosses the state border, to connect with adjacent transmission systems in the Republic of Bulgaria and Hungary

In 2018, activities on a project of a main gas pipeline through Serbia, with a technical capacity of 13.88 billion m^3 and a length of about 400 km to connect with adjacent transmission systems in the Republic of Bulgaria and Hungary, were initiated [43].The New Interconnector has one entry point – entry point "Zaječar" on the border Serbia-Bulgaria, and four exit points, being: (1) exit Paraćin, (2) exit Pančevo (3) exit Gospođinci (municipality Žabalj) (4) exit Horgoš on the border Serbia-Hungary at the teritory of city Kanjiža. A projected pressure at the entry and the exit points is 7.4 MPa, maximum allowed operational pressure is in a range 6.4 to 6.6 MPa at the entry point, from 6 MPa to 6.6MPa at the exit point Paraćin and in a range 6.5 MPa to 6.6MPa at the exit points Horgoš, Pančevo and Gospođinici. By the realisation of this project the infrastructural standard N-1 of security of supply would be fulfilled, since it would reach 114% [43].

[17]Data from PE Srbijagas; In the AERS Report for 2012 [12] is reported "In 2012 there was no problem with congestions, even in February when the lowest temperatures were recorded with the probability of occurrence once in twenty years ... ".

[18] According to the European Commision Report [33], from EU states only Bulgaria (35.2%) and Portugal (88,3%) have. the values of the (N -1) indicator lowe then 100%

Gas interconnection project Serbia – Bulgaria, the main gas pipeline MG-10 Niš - Dimitrovgrad (border with Bulgaria)

Realization of this project will increase security of supply ((N-1) = 66.5%), and make possibility for supplying from Russia and other supply routes: South corridor (Azerbaijan, LNG from terminals in Greece, etc). According to Program [3] this interconnection should be introduced by 2021.

Gas interconnection project Serbia - Croatia, main gas pipeline MG 08 Gospođinci (Futog) - Sotin (Croatian border)

Realization of this project will increase security of supply ((N-1) = 56.99%) and make possibility for opening supply routes from northern Africa, Italy via Croatia, or from foreseen LNG terminal in Croatia. According to Program [3] this interconnection should be introduced after 2023.

Gas interconnection project Serbia - Romania, pipeline Mokrin - Arad (border with Romania)

Additional entrance to the system will increase security of supply ((N-1) = 58.73%), increase reliability and create possibility of gas purchasing from other sources (from Romania or from transcontinental supply routes). Also, this project will have impact on unloading the main pipeline Horgoš - Batajnica. According to Program [3] this interconnection should be introduced after 2023.

Project for increasing the capacity of the Underground storage Banatski Dvor

This project envisages an upgrade of the underground gas storage in Banatski Dvor from current capacity of 450 million m^3, to capacity of 800 to 1 billion m^3 with maximum technical capacity of production of 9.96 million m^3/day (415,000 m^3/h) and maximum technical capacity of injection of 5.52 million m^3/day (230,000 m^3/h). By the project realization available gas quantities will significantly increase, especially in days with the highest loads ((N-1) = 61.97%). According to Program [3] this project should be completed by 2023. Since the project for the UGS Banatski Dvor construction was done as a mining project, the extension project should be a supplement to the existing mining project.

An additional impact of the underground gas storage capacity extension on security of supply would be an increase of the system's resilience to longer, total supply cuts from other transmission systems.

Project of Belgrade heating from the Thermal Power Plant Nikola Tesla A

This project includes reconstruction of turbines' blocks A3-A6, i.e. modification of turbines'operation in the regime of heat supply, construction of pipeline Obrenovac-Beograd and connection to the existing district heating system of Belgrade. By the realization of this project annual gas consumption would decrease for 120-150 million m^3 starting from 2021, which would have positive implications on the security of supply ((N-1)=37.6%) [44][40].

By realization of the projects envisaged in the Program [3] by 2023 (interconnection with Bulgaria and extension of UGS Banatski Dvor), the value of (N-1) indicator would increase to 93.81%, while realization of all projects envisaged in the Program [3] (all aforementioned projects exept the interconnector that connects the transmission systems of Bulgaria and Hungary) would lead to N-1 value of 155.12 [44][40].

In addition to the key infrastructural projects, it is necessary to continue with activities on the construction of the transmission system in order to ensure secure supply of some areas of the

Republic of Serbia. The projects planned to be constructed in the upcoming period are as follows:

Main pipeline MG 01/II Itebej - Beograd Jug

Main single line pipeline of approximate length 130 km and diameter 610 mm should increase reliability of the Republic of Serbian transmission system by unloading the pipeline Kikinda-Pančevo.

Main pipeline Batajnica - Velika Plana – Niš

Main pipeline with length of 116+161 km and diameter DN 700 should increase reliability of the Republic of Serbian transmission system by connecting pipeline Niš -Dimitrovgrad and Batajnica.

Main single line pipeline RG 11-02 Leskovac - Vladičin Han - Vranje

Main pipeline of length 70.7 km, diameter 323.9 mm and maximal operation pressure of 50 bar; First section of the pipeline from PJC "Leskovac" to MMRS "Vlasotince" of 7.2 km and MMRS "Vlasotince" (5,000 m³/h) were put into operation in 2013. Construction of 6 block stations, 2 main metering and regulating stations (MMRS "Vladičin Han/Surdulica" 5,000 m³/h, MMRS "Vranje" 10,000 m³/h) should be done.

This project is aimed to extend the national transmission network to south part of Serbia (area of Južna Morava) to municipalities Vlasotince, Vladičin Han, Surdulica and the city of Vranje, and provide opportunities for further development of gas system toward Bujanovac and Preševo, as well as for interconnection with transmission system of the Republic of Macedonia. Activities on Project RG 11-02 have been stoped until the issue of Yugorosgaz-Transport certification, which would determine the ownership of the main gas pipelines, will be resolved.

For ensuring secure supply in the long term period, proper paining of the gas system is of the great importance. Based on the Energy Law [1], energy entities in charge for gas transmission and management of the transmission system are obliged to submit ten-year development plans of the transmission system to the AERS for approval. Transportgas Srbija hasn't submitted its ten years development plan [12]. In 2019, Yugorosgaz-Transport has submitted a "Plan of Yugorosgaz-Transport transmission system development for the period 2019-2028" [30], which was approved by the Council of the Energy Agency in August 2019 [12].

4.5.6. Preventive Action Plan and Emergency Plan for ensuring the security of natural gas supply

The Government ha adopted the Preventive Action Plan for Safeguarding the Security of Natural Gas Supply [44][40] and the Emergerncy Plan for Safeguarding the Security of Natural Gas Supply [41] in 2018.

The Preventive Action Plan Plan for Safeguarding the Security of Natural Gas Supply includes risk assessment in terms of achieving security of supply, as well as measures to mitigate the identified risks that refer to the necessary transport capacity to meet the total demand for natural gas and to provide supplies to certain groups of final customers of natural gas. The Preventive Action Plan was prepared in accordance with the Article 315 of the Law on Energy [1] and in accordance with the article 5 of Regulation (EU) no 994/2010 of the European Parliament and of the Council of 20th October 2010 concerning measures to safeguard security of gas supply and repealing the Council Directive 2004/67/EC [38]. The Preventive Action Plan included risk assessment prescribed by the article 9 of Regulation (EU) no 994/2010, preventive measures for elimination of defined risks and the responsibilities of the Competent Authorities and energy entities concerning safeguarding the security of natural gas supply.

For safeguarding secure supply, the main indentified risks are related to the natural gas supply disruption scenario at Horgoš entrance, and to disruption of supply from the Banatski Dvor underground storage.

In order to mitigate identified risks and ensure safe gas supply, the following measures and activities are detremined by the Preventive Action Plan :

- establishing interconnections with the countries in the region, construction of a new direction of natural gas supply, expansion and construction of new storage capacities, as well as realization of other projects that influence the reduction of consumption of natural gas in accordance with the Energy Strategy [2] and the Regulation on the establishment of the Program for the implementation of the Energy Development Strategy of the Republic of Serbia by 2025 with projections until 2030 for the period from 2017 to 2023 [3];
- establishment of operational reserves of energy products in accordance with Article 345 of the Law [1];
- ensuring required natural gas reserves in accordance with Article 346 of the Law [1];
- establishing regional cooperation in crisis situations

The Emergerncy Plan for Safegurarding of Security of Natural Gas Supply in order to ensure the security of natural gas supply which identifies measures, energy entities that will be in charge of ensuring the security of the transmission system operation and the security of supply of certain groups of end customers, the volumes and capacity of natural gas in case of a general shortage of natural gas.

The Emergency Plan is prepared in accordance with the article 315 of the Energy Law [1] and in accordance with the article 10 of the Regulation (EU) no 994/2010 and it is based to defined three levels of crisis occurred by the natural gas shortage:

- Level 1 - Early Warning: when there is concrete, serious and reliable information that an event may occur which is likely to result in significant deterioration of the supply situation and is likely to lead to the Level 2 or Level 3 being triggered.
- Level 2 - Alert Level: when a supply disruption or exceptionally high gas demand occurs which results in significant deterioration of the supply situation, but the market is still able to manage that disruption or demand without the need to resort to non-market measures.
- Level 3 - Emergency Level: a situation of exceptionally high gas demand, significant supply disruption or other significant deterioration of supply and in the event that all relevant market measures have been implemented but the supply of gas is insufficient to meet the remaining gas demand so that non-market measures have to be additionally introduced with a view, in particular, to safeguard supplies of gas to protected customers.
- The Emegency Action Plan has defined the roles and responsabilities of energy entities in the natural gas sector, industrial consumers, as well as their interaction with relevant authorities. Also, the competence of responsible institutions (the Government, the Ministry in charge for the energy issues, the Special Working Group established by the Ministry, Directorate for Commodity Reserves of the Republic of Serbia) and coplanies (Transportgas Srbija, natural gas suppliers, Public Enterprise Elektroprivreda Srbije, AD

Elektromreža Srbije, major natural gas customers, natural gas transmission, i.e. distribution system operators, natural gas storage facility operator and energy entities engaged in the production of electricity and/or combined production of power and/or heat) have been detremined. This plan defined detailed procedures that should be carried out for the each level of crises, including schemes of information flows. Mechanizms for cooperation with other countries for each level of crises are determined, obligations for gas companies related to reporting for each level of crises and the list of predifined activities for securing gas supply in the event of crises are defined.

5. CRUDE OIL AND PETROLEUM PRODUCTS

Pursuant to the Energy Law [1], licensed energy activities in the petroleum and biofuel sector are:

- Production of petroleum products
- Transport of oil through pipelines
- Transport of petroleum products through petroleum product pipelines
- Trade in oil, petroleum products, biofuels and compressed natural gas
- Trade in motor and other fuels at the stations for supplying fuel into vehicles
- Storage of oil, petroleum products, biofuels and compressed natural oil
- Production of biofuels
- Production of bioliquid
- Blending of biofuels with fuels of oil origin
- Trade in fuels outside stations for the supply of means of transport

The energy activity may be performed by public company, business entity, i.e. any legal entity or entrepreneur which is in the possession of license for energy activity performance.

Transportation of crude oil through oil pipelines and petroleum products through product pipelines represent the energy activities which are defined as the activities of general interest by the Energy Law. They are carried out in accordance with this law and the law regulating the position of public companies. The rest of the above said energy activities are performed in compliance with the market principles.

Persuant to the Energy Law, no license is required for the energy activity of oil transport, oil derivatives and biofuels by other forms of transport, but the activity is important for the topic of security of supply and will be dealt with in the following text.

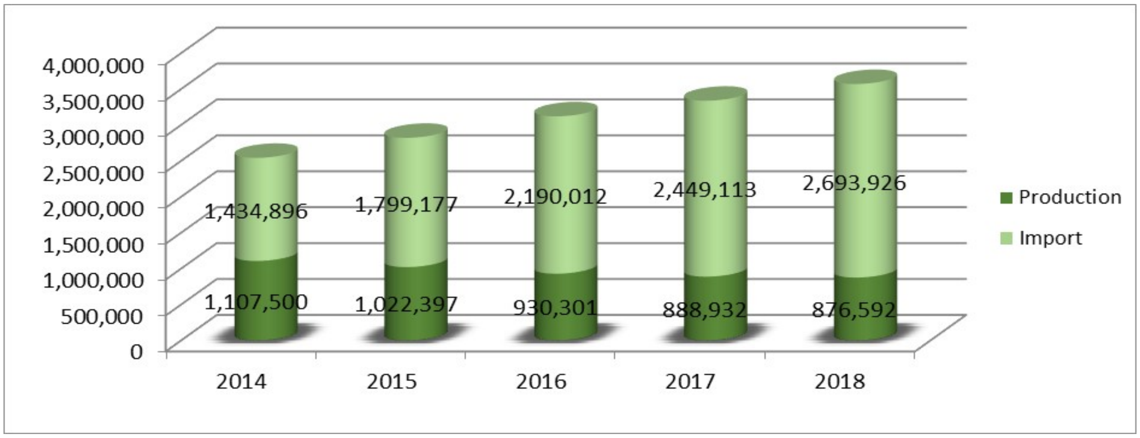
5.1. Production, Import, Export an Consumption of Crude Oil and Petroleum Products

5.1.1. Crude Oil

The necessary amount of processed crude oil is provided from import (over 70%) and a smaller part from domestic production from 63 oil fields and about 666 oil production wells. The largest number of oil fields is located in Vojvodina, in the region of Bačka (Velebit, Turija), of North Banat (Kikinda), of Central Banat (Zrenjanin) and South Banat (Jermenovci, Janošik) including oil fields in the region of Stig around Požarevac (Sirakovo, Bradarac, Maljurevac) [44].

The production and processing of crude oil in Serbia is carried out by NIS JSC and in recent years it is the only responsible for import in the Serbian market.

NIS JSC also owns the concession on a single block in Angola where is produced about 4,2 million tonnes of crude oil from 1985 to today. The oil produced in Angola (about 30,000 tonnes) is not included in the Energy Balance of the Republic of Serbia [16].



Crude oil (in tonnes)	2014	2015	2016	2017	2018
Production	1,107,500	1,022,397	930,301	888,932	876,592
Import	1,434,896	1,799,177	2,190,012	2,449,113	2,693,926
Total	2,542,396	2,821,574	3,120,313	3,338,045	3,570,518

Figure 3: Comparative review of production and import of crude oil (in tonnes) in the last five years [26]

Domestic production of crude oil is decreasing in 2017, while simultaneously deficient quantities are provided by an increase in imports, which in 2017 amounted to 2,449,113 tonnes (Figure 3). In 2018, the production retains a slight downward trend, but the import volume increases to a value of 2,693,926. The energy balance for 2019 predicts a slight increase (1.5%) or 890,000 tons of production.

All imported crude oil is mostly transported through oil pipeline of PE Transnafta that enters Republic of Serbia from Croatia near Bačko Novo Selo as a continuation of the Adriatic oil pipeline that begins in Omišalj (in the north - west of the island of Krk in Croatia), continues to Novi Sad and then to Pančevo. The other aspects of the transport of crude oil such as rail and waterways transports are not represented. In previous years a specified amount of about 200,000 tonnes was shipped via rail tankers from Romania.

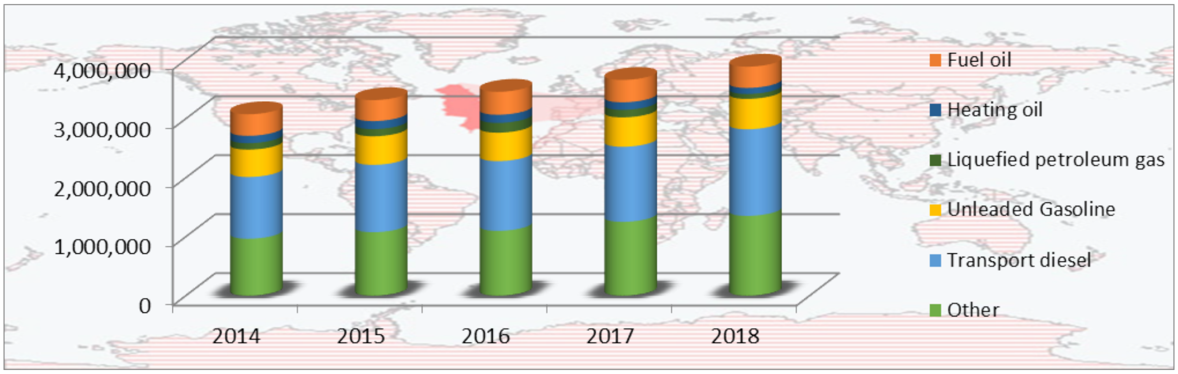
The oil produced from domestic oil reservoirs is shipped from gathering stations through oil pipelines to Novi Sad Oil Refinery and further on refining to Pančevo Oil Refinery, and certain percentage (<10%) is transported by road tankers to Pančevo Oil Refinery.

5.1.2. Derivatives of Crude Oil

The supply of petroleum products is carried out from import and from domestic processing of crude oil, obtained from the Pančevo Oil Refinery. The Pančevo Oil Refinery within NIS JSC does processing of crude oil, while the liquefied petroleum gas is produced in Gas Refinery Elemir and in the installations of former Hipol JSC now "Standard gas d.o.o. Novi Sad" (Standard gas) [12].

The quantities of produced derivatives in 2017 (Figure 4) amounted to 3,660,589 tonnes, while in 2018 they amounted to 3,885,334 tonnes, which represents an increase of 6.14%. Pančevo Oil Refinery in 2017 decreesed the production of liquefied petroleum gas by 23.3% compared to 2016, while in 2018 was decreese of 35.1% [26].

The derivatives produced in the Pančevo Oil Refinery are shipped by using rail tankers, watercrafts (river tankers, barges, hovercrafts) and road tankers. The transport of petroleum products through petroleum product pipelines does not work because there is no built petroleum product pipelines network.



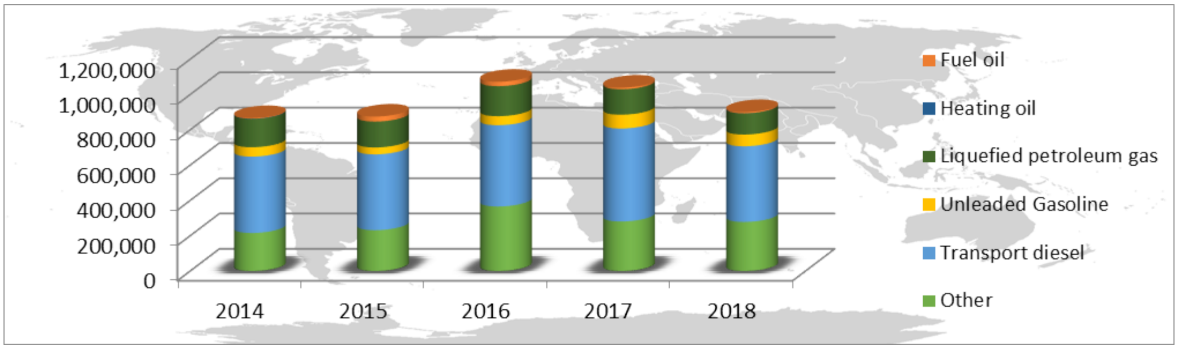
Production of petroleum products (in tonnes)	2014	2015	2016	2017	2018
Transport Diesel	1,047,495	1,142,290	1,182,882	1,273,116	1,469,062
Unleaded Gasoline	464,115	484,090	482,068	498,624	515,702
Liquide petroleum gas	108,986	121,117	165,768	127,210	82,555
Heating oil	124,999	136,723	138,514	128,275	102,948
Fuel oil	365,944	355,142	388,871	379,519	360,515
Other products	967,266	1,078,359	1,101,009	1,253,845	1,345,552
Total	3,078,805	3,317,721	3,459,112	3,660,589	3,885,334

Figure 4: Production of petroleum products – comparative review of 2014 to 2018

In 2017, the trend of import are stagnat (Figure 5), and the imported amount of derivatives was 1,039,632 tonnes, while in 2018 it is at a lower level and amounts to 932,450 tonnes. Motor fuels in 2017 registered an increase in imports of about 10%, while in 2018, there was an decrease of about 13.7%.

Analyzing the structure of imported derivatives it results that the highest amount of imported products is the amount of euro diesel imported mostly from Hungary, Bulgaria and Romania. The gasoline has been imported from Hungary, Austria and Romania [26].

Regarding to the supply of derivatives from import, the amounts are delivered by vessels (barges, river tankers) along the rivers of the Danube and Sava, then by rail tankers and the rest by road tankers.



Import of petroleum products (in tonnes)	2014	2015	2016	2017	2018
Transport Diesel	432,832	429,627	460,612	526,685	458,085
Unleaded Gasoline	53,084	39,168	50,924	78,457	68,462
Liquide petroleum gas	160,635	146,665	170,261	143,933	119,947
Heating oil	1,260	36	0	122	591
Fuel oil	3,156	28,191	24,810	9,071	6,610
Other products	216,261	232,037	366,352	281,364	278,755
Total	867,228	875,724	1,072,959	1,039,632	932,450

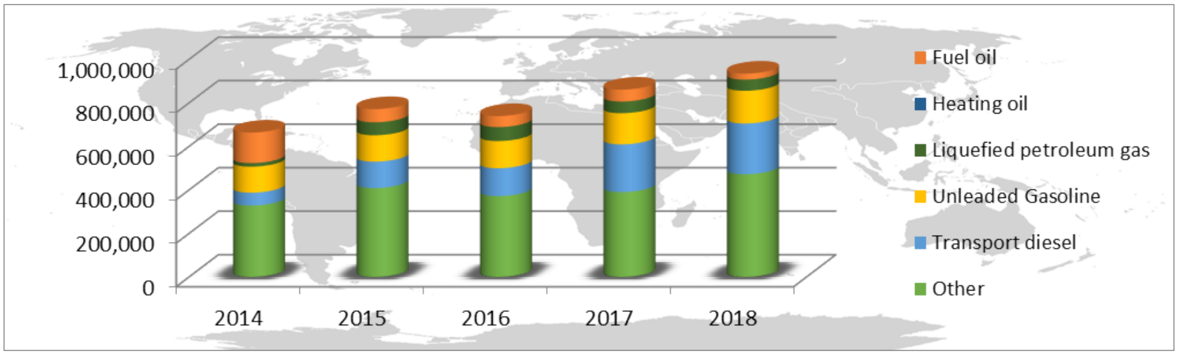
Figure 5: The import of petroleum products (in tonnes) – comparative review of 2014 to 2018

In 2017, the export of derivatives (Figure 6) increased to an amount of 861,221 tonnes, which represents a increase of 16.4%, while in 2018 it was at the level of 935,699 tonns. The increase of motor fuels export is particularly significant. In 2018, the Republic of Serbia's total export was 434,912 tonnes of motor fuels which is almost 4.5% more than in the previous year or 37.1% more than 2016. The most prevalent was diesel with 233,235 tonnes, which is 6.3% more than in the previous year, followed by gasoline with 150,290 tonnes, which is 5% more than 2016. From other petroleum products, the bitumen export of 281,954 tonnes is significant, as well as the export of liquefied petroleum gas, which represents an decreese of 4.1% with an amount of 51,387 tonnes compared to 53,573 tonnes [26].

The export of petroleum products is performed by placement of diesel fuel in the bunker stations at three locations along the river Danube: Novi Sad and Prahovo, and in the middle of 2015 NIS JSC has put into operation a new bunker station in Belgrade for the supply of ships in domestic and foreign transport.

In Smederevo there is also a bunker station built for supplying of only domestic vessels in the country. In 2018, 16,968 tonnes of diesel were placed on the market at the bunker stations, while 14,333 tonnes were in the previous year. Compared to 2016, when it was 19,830, there was a decrease of 14.4% [26].

In May 2018, amendments were made to the Law on Ports and Navigation on Inland Waterways, which made the area of the bunker stations for the supply of ships clearly regulated.

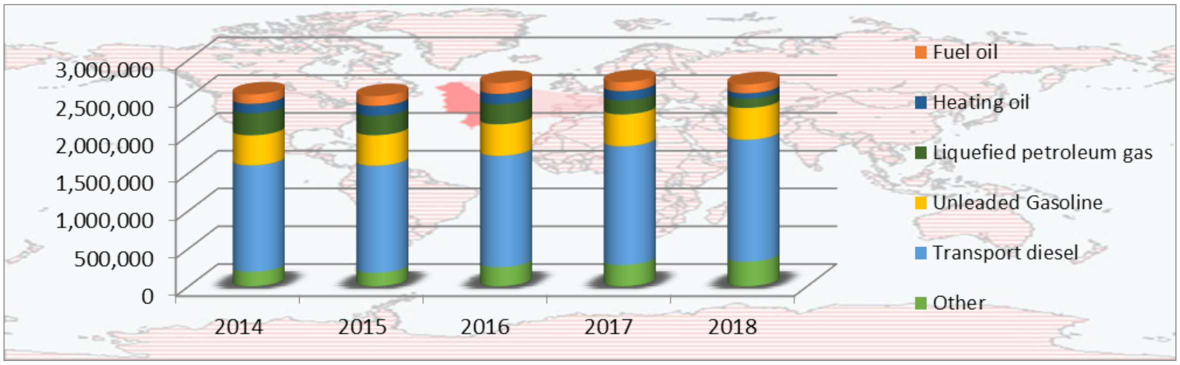


Export of petroleum products (in tonnes)	2014	2015	2016	2017	2018
Transport Diesel	59,328	121,464	128,116	219,504	233,235
Unleaded Gasoline	119,607	121,138	125,044	143,094	150,290
Liquide petroleum gas	16,393	59,647	64,010	53,573	51,387
Heating oil	0	2	1	17	1
Fuel oil	140,132	60,493	50,516	54,642	28,326
Other products	328,452	409,012	372,017	390,391	472,460
Total	663,912	771,756	739,704	861,221	935,699

Figure 6: Export of petroleum products (in tonnes) – comparative overview for the period 2014 - 2018

Final consumption for energy purposes for 2017 (Figure 7) is at the level of 2,703,729 tonnes (an increase of 0.5% compared to 2016), while in 2018, it increased by 1.6% and amounted to 2,733,905 tonnes.

In the structure of final consumption of derivatives for 2018, the industry participates with 13%, traffic from 77%, and other sectors with 10%.



Consumption of petroleum products (in tonnes)	2014	2015	2016	2017	2018
Transport Diesel	1,408,752	1,416,856	1,474,142	1,571,130	1,643,371
Unleaded Gasoline	395,298	401,172	415,720	419,822	421,808
Liquide petroleum gas	295,413	259,989	269,114	187,168	124,080
Heating oil	123,634	130,287	135,238	122,571	102,514
Fuel oil	122,784	126,962	141,238	116,868	112,804
Other products	196,154	183,014	256,278	286,170	329,328
Total	2,542,035	2,518,280	2,691,730	2,703,729	2,733,905

Figure 7: Consumption of petroleum products (in tonnes) - Comparative review for the period 2014 – 2018 [26]

5.2. Security of Supply of Oil and Petroleum Products

5.2.1. Balance of Oil and Petroleum Products for Year 2018 – Plans

The balance of crude oil, petroleum products and biofuels includes production, import and export of crude oil, refining of crude oil in refineries, and production, import, export and consumption of petroleum products.

Energy Balance of the Republic of Serbia for 2019 [26] is mostly determined in accordance with the realization and assessment by the end of 2108. The exact amount of all energy products can be seen only at the end of 2019.

According to the Energy Balance [26] the supply of crude oil and semi-finished products for processing in refineries will be provided from domestic production in the amount of 0.890 million tonnes (25%), while the import will provide an additional amount of required crude oil and semi - finished products in the amount of 2,561 million tonnes (75% of total needs) [26].

The processing of domestic and imported crude oil from the stock as well as components for processing (semi - finished products) will be carried out in Pančevo Oil Refinery.

In 2019, the processing of crude oil and semi-finished products is planned in an amount of 3.633 million tonnes while the domestic production of petroleum products is planned in the amount of 3.619 million tonnes [26].

In the structure of planned oil production the largest part will belong to a production of diesel with 33.3%, then production of petrol with 14.1%, heating oil 10.4%, liquefied petroleum gas 5.3% and other products 36.9% [26].

Having in mind the overall need for petroleum products in 2019, including the planned domestic production of petroleum products, the rest of the required amount of about 0.950 million tonnes will be supply from the import [26].

In 2019 it is planned to export 0.800 million tonnes of petroleum products. The final consumption of petroleum products in 2019 is planned to be about 3,363 million tonnes, of which 0.6 million tonnes are for non - energy purposes, while 2.763 million tonnes are for energy purposes. In this structure of final consumption of petroleum products for 2019, the industry participates with 12%, the transport with 79% and other sectors with 9% [26].

In a long-term framework the consumption of peroleum products is planned in compliance with the Strategy [2].

Table 31: Projection of consumption to 2030 [2]

Consumption	Product	unit	Period (year)		
			2020	2025	2030
Primary energy Consuption	Crude oil and semi-finished products	thousands tonnes of oil equivalent	3,822	4,049	4,312
Final Consuption	Petroleum products	thousands tonnes of oil equivalent	3,368.8	3,595.6	3,853.1

5.2.2. Measures to be Taken in Case the Security of Oil and Petroleum Products Supply is Threatened

Concerning the security of supply, the area of oil is regulated by the Law on Commodity Reserves [45], which regulates the conditions for the formation, financing, disposition, use and renewing of the oil and oil derivatives emergency stocks, provision and maintenance of storage, as well as the operation and management of the emergency stocks and storage facilities on the territory of the Republic of Serbia as well as the Energy Law, which created the Energy Resources Management Board, as an administrative body within the Ministry in charge of energy, for performing executive and professional tasks relating to the required reserve of oil and petroleum products and natural gas reserve requirement.

Long-term, medium-term and short-term programs for the formation of required reserves have been adopted [45].

The Republic Directorate for Commodity Reserves, in accordance with the Law, stores in its reservoirs the obligatory reserves of oil derivatives, manages the construction of new and reconstruction of the existing storage capacities of the Directorate financed from the budget of the Republic of Serbia [26].

In accordance with the above, an application for a building permit was submitted by the Republic Directorate for Commodity Reserves for the construction of 2 x 20,000 m3 of reservoir space for oil derivatives at a warehouse in Smederevo.

In 2018, the Energy Reserve Directorate completed the construction of a vapor recovery unit (VRU) at the warehouse of the Commodity Reserve Directorate in Požega. Technical acceptance of the facility is expected.

Also, the Energy Resources Management Board performs annually the selection of contractors for the qualitative and quantitative analysis of derivatives as well as the selection of the insurance company for the insurance of goods in storage.

Considering that the previously concluded option contracts have expired, the new procurement of option contracts has been completed, in accordance with the existing financial and public procurement plan in 2017, for 50,000 tons of Euro diesel and 10,000 tons of unleaded motor gasoline. This is the number of days in 2017 doubled.

By the end of 2018, the Management Board of the Ministry in charge of energy for the purpose of forming obligatory reserves, purchased crude oil (16,000 tonnes), around 43,000 tonnes of diesel, 5,000 tonnes of heating oil – low sulfur - special NSG-S and 3,000 tonnes of motor gasoline. Also, in 2018, the procurement of about 8,700 tonnes of euro diesel was made.

At the end of 2018, mandatory reserves were formed at 19 days of average daily consumption.

In accordance with the adopted Rulebook on Establishment of the Annual Program for Formation and Maintenance of Required Reserves of Petroleum and Petroleum Products for 2019 (Official Gazette of the RS, No. 33/2019) for 2019, it is planned to increase the number of days to 23.

The Energy Law [1] prescribes that in case of customers security of supply is threatened due to insufficient supply in the energy market or the occurrence of other extraordinary circumstances, the government can issue the document to approve the change of limit values of certain characteristics of the quality of oil derivatives that can be put on the market in the Republic of Serbia for the period of maximum six months. Measures may last as long as the circumstances for which they are prescribed are, or until the consequences of such circumstances are eliminated [1].

The law determines that the Energy entities performing the activity of oil derivatives production and oil, oil derivatives, biofuels and compressed natural gas trade are obliged to provide the operational reserves of oil derivatives that are equal at least to 15 days of its average selling in the previous year. The operational reserves of oil derivatives and coal used in the case of short-term disruptions in the market, caused by breakdowns and other unforeseen circumstances that endanger the safety of operation of individual parts of the energy system or the energy system in whole [1].

5.3. Technical and other Requirements that Liquid Fuels of Oil Origin and Liquefied Oil Gas Must Fulfil

Persuant to Article 337 of the Energy Law [1], petroleum products and biofuels set on the market have to complete the conditions arranged by the regulations for quality of liquid petroleum fuels and biofuels, by the regulations for protection of the environment and other regulations related to the market of petroleum products and biofuels [47], [48], [49].

Technical and other requirements for liquid fuels of oil origin used as motor fuels for the internal combustion engines and energy fuels which are the subject of trade on the market of the Republic of Serbia as well as the method of conformity assessment of liquid fuels are regulated by the Rulebook on Technical and other Requirements for Liquid Fuels of Petroleum Origin (Official Gazette of the RS, no. 111/15, 106/2016, 60/17, 117/17, 120/17 - corection and 50/18, 101/18) [50].

Since enacting of the Rulebook on Technical and other Requirements for Liquid Fuels of Petroleum Origin in 2012 the significant progress in conformity of the quality of fuels with the European requirements has been achieved. Trade of leaded gasoline is forbidden on the market, the quality of unleaded motor gasoline must fulfil all requirements of SRPS EN 228 Standard and the quality of diesel fuel must fulfil all requirements of SRPS EH 590 Standard (with the exception of gas oil 0.1 for starting of tractor engines, working machines and railway vehicles, as well as the vessels with diesel engines, which contain sulphur of maximum 0.10% (m/m)).

The Energy Law [1] prescribes that in case when there is a security risk of supplying customers because of insufficient supply on the market of energy and fuels or in case of other extraordinary circumstances, the Government can approve with the amendment the modification of limits for some quality characteristics of petroleum products that could be put on the market of the Republic of Serbia for a maximum period of 6 months. The extents could last as long as the circumstances for which they are prescribed, concerning the duration of consequences.

With the modifications of the Energy Law from 2012, the legal basis for compulsory marking of petroleum products is established, with the purpose of reduction of illegal petroleum products market and since December 1, 2013 the Regulation on Marking of Petroleum Products (Official Gazette of the RS, no. 51/2015, 5/2017) is being applied [51].

The legal base for monitoring of petroleum products quality is determined by the Energy Law from 2014 [1] which is in accordance with SRPS EN 14274 Standard and since 1st December 2015 the Regulation on Monitoring of Petroleum Products and Biofuels Quality (Official Gazette of the RS, no. 97/2015, 5/17, 8/17 - corection and 119/17, 102/18) is being applied.

The monitoring of the quality of oil derivatives is carried out in accordance with the Annual Program for monitoring the quality of oil derivatives, which is an integral part of the Ordinance on the content and manner of implementation of the annual program for monitoring the quality of oil derivatives and biofuels. The said Rulebook for the current year, in accordance with the Regulation, shall be adopted by the Minister in charge of energy affairs no later than March 31 of the current year. In the period from 1 January of the current year until the adoption of the Annual Monitoring Program, the Annual Monitoring Program is adopted for the previous calendar year.

Implementation of marking and monitoring of petroleum products and biofuels quality had the significant contribution in reduction of illegal market, the income growth from excises and taxes in the budget of the Republic of Serbia, in consumers' protection, as well as the fulfillment of internationally undertaken obligations regarding implementation of the Directives 2016/802/EC (which replaced the Directive 1999/32/EC) and 98/70/EC.

5.4. Data on Oil Infrastructure

5.4.1. The Refineries in Novi Sad and Pančevo

Crude oil refining in the Republic of Serbia is carried out in Pančevo Oil Refinery, which is belonging to NIS JSC.

The Pančevo Oil Refinery has been put into operation in 1968 by launching the first complex of plants with primary processing capacity of 1.32 MTA and with the release of other secondary plants in 1969; the refinery reached the design capacity of 4.8 MTA. Engineering for this plant was prepared by company SFI/Lummus France.

Located in Pančevo, near the Danube River at distance of about 2.5 km and at distance of about 15 km from Belgrade on the surface of about 160 hectares. The pipeline connection is connected to its own harbor on the Danube.

The crude oil can be transported to the oil refinery by pipeline, waterways, rail tankers and road tankers. Thanks to its refining capabilities, Pančevo Oil Refinery can practically process all types of crude oil and produce fuels - liqufied petrol gas, petrol, diesel fuel, jet fuel, heating oil and bitumen and petrochemical products. The capacity utilization is over 60% and storage facility has a capacity of 700,000 m^3. Since 2014, all domestic and imported crude oil is processing with a total processing of about 3 MTA [52].

Shipping products from the Pančevo Oil Refinery are transported by barges, road and rail tankers while the supply of HIPP is done through product pipelines.

Adjacent to Pančevo Oil Refinery there is "HIP-Petrohemija a.d. Pančevo" (Petrohemija JSC), which consists of plant for pyrolysis of primary petrol to produce ethylene, factory "Etilen".

The Refinery provides most of the raw material for this plant, so the pyrolysis petrol which returns to the Refinery is very rich in aromatic hydrocarbons, especially in benzene. The crude primary petrol from Refinery to Petrohemija JSC and the pyrolysis petrol from Petrohemija JSC to Refinery are transported through petroleum products pipelines.

In recent years the constant modernization of the Refinery has expanded its primary and secondary capacities.

The construction of a new refinery plant is under way, which will enable the increase in the production of liquefied petroleum gas, all types of gasoline and diesel, which will start operating in 2019.

The location of Pančevo Oil Refinery is very good, from the standpoint of the market and traffic capabilities; however, on the grounds of environmental protection in Pančevo and the environment, the key drawback is the wind rose, which greatly contributes to the increase of pollutants and unpleasant effects on the population of the Town of Pančevo and surrounding villages.

Novi Sad Oil Refinery presents a complex of refining and auxiliary factory plants for refining of oil and petroleum products, tank, transport - manipulative, research and laboratory facility and other accompanying facilities. It is located in the industrial zone of Novi Sad, located directly on the Danube and the navigable DTD channel. The refinery was put into operation in 1968, with designed capacity of refining 3 MTA.

In recent years, the refinery mostly processed the domestic oil of Velebit type using production capacity of only 0.5 MTA.

Reservoir capacities have been reoriented and now they are a warehouse crude oil terminal.

5.4.2. Oil Pipeline Managed by PE Transnafta

PE Transnafta performs the energy activity of transportation and management of transportation system. PE Transnafta performs the energy activity of general interest, supplying the Novi Sad and Pančevo Oil refineries with crude oil. The pipeline with a total length of 154 km stretches from the Croatian border on the Danube river through Novi Sad and Pančevo. This pipeline continues to JANAF, which departs from the port of Omišalj on the island of Krk in Croatia and across the Sisak Refinery, their last block stations Sotin and river Danube enters Serbia. The first block station is in Bačko Novo Selo, and the pipeline via terminals PE Transnafta with the Novi Sad Oil Refinery extends until the Pančevo Oil Refinery (via measuring station of PE Transnafta). The imported crude oil is transported through all stations along the route, and the domestic oil trough local route from Novi Sad to Pančevo. The pipeline infrastructure is represented by: terminal in Novi Sad with a storage capacity of 2x10,000 m^3 and a pumping station, eight block stations along the pipeline, measuring station with Pančevo Oil Refinery, cathodic protection system and supervisory control system of oil pipelines.

The oil pipeline is divided into two sections:

- DN-1 (Bačko Novo Selo - Novi Sad, a length of 63.3 km in diameter of 660 mm, pressure classes ANSI 300 transportation capacity 9 MTA, 1000 m^3/h.) with 38 crossings of watercourses, 20 road crossings, 6 railway crossings, 3 dams, 2 swamps and 5 pipelines.
- DN-2 (Novi Sad - Pančevo, a length of 91 km in diameter of 457 mm, pressure classes ANSI 400, transport capacity 6 MTA) with 95 crossings of watercourses, 17 road crossings, 4 railway crossings, 6 dams and 3 pipelines

Total average volume of transport - approximately 3 million tonnes/year [53].

5.4.3. Oil Pipelines Managed by NIS JSC

For domestic transport of crude oil to the Novi Sad Oil Refinery, the oil pipelines which are managed by NIS JSC and by which the crude oil is transported from the dispatching stations are in function. It's about the oil pipeline from the delivery station "Kikinda Field" to the delivery station in Elemir in a length of 42.9 km, a pipeline from the delivery station in Elemir to Novi Sad Oil Refinery in a length of 39.5 km with a diameter of 257.4 mm, which is used for delivery of oil type "Kikinda" as well as the pipeline from the delivery station "Nadrljan" to Novi Sad Oil Refinery in a length of 86.4 km, a diameter of 203.3 mm and with a capacity of 0.5 MTA [44][40].

5.4.4. Petroleum Product Pipelines in the Republic of Serbia

The infrastructure for the transport of petroleum products through pipelines in the Republic of Serbia does not exist. Technically speaking, the product pipelines exist only between Petrochemical complex and Pančevo Oil Refinery for transport of semi-products and the product pipelines through which were transported ethylene and propylene to the Romanian border and further to Solventum in Romania.

The total length of the pipeline is about 65 km in the Republic of Serbia and about 50 km through Romania and it consists of two parallel product pipelines: Ethylene in a diameter of 168.3 mm and Propylene in a diameter of 114.3 mm, which is not in function at the moment.

PE Transnafta has initiated the project System of product pipelines through Serbia. The concept of product pipeline system means that the fully supply of the market of Serbia and partly supplying of peripheral areas of surrounding countries (Croatia, Hungary, Bulgaria) is carried out from the Pančevo Oil Refinery. Starting from Pančevo as a center of supply of derivatives, the product pipeline system routes branch out to Novi Sad, Sombor, Belgrade and Niš, over Smederevo and Jagodina. In these cities, there would be located the terminals with appropriate storage capacities, pumping stations (secondary and main pumps) and with measuring points for commercially measurement of received and delivered quantity of motor fuel. Each of the terminals will be equipped with a plant for collection of volatile hydrocarbon and aromatic components from the storage tank.

PE Transnafta performed all the planning and design of technical documentation Feasibility Study and Preliminary Design and Assessment of environmental impact for the route section Pančevo - Novi Sad and Pančevo - Smederevo.

The construction project for the construction of the section Pančevo-Smederevo is in final phase of preparation.

5.4.5. The Terminals for Crude Oil

Crude oil storage tanks are located on the route of the crude oil pipeline, more precisely at terminals of PE Transnafta in Novi Sad and at the Terminal Novi Sad within the Novi Sad Oil Refinery and Pančevo Oil Refinery owned by NIS JSC.

PE Transnafta Terminal has four tanks for crude oil, in volume of 10,000 m^3 each, out of which two are in the function of transport and two are intended for storage.

NIS JSC at the Terminal in Novi Sad Oil Refinery has storage tanks capacity of cca 140,000 m^3 for storage of crude oil. All tanks has been reconstructed in the last three years. Also on dispatching stations Kikinda Field, Tisa and Nadrljan there are storage tanks in the function of local transport of crude oil in the capacity of over 70,000 m^3 [44][40].

In Pančevo Oil Refinery there are storage tanks for technological processes of total capacity of about 700,000 m^3 [44][40].

5.4.6. Storage of Petroleum Products

The storage capacities in the Republic of Serbia are in dispose of Republic Directorate for Commodity Reserves (approx. 180,000 m^3) PE Transnafta (approx. 74,000 m^3) as well as the companies performing the energy activity of crude oil, petroleum products and biofuels storage and trade of crude oil, petroleum products, biofuels and compressed natural gas.

In 2018 there were in total 21 licenses for storage of crude oil, petroleum products and biofuels.

Among the companies that are in dispose of licensed storage tanks for storage of crude oil and petroleum products, the largest capacities has NIS JSC (100,000 m^3). It is followed by PE Transnafta, Naftachem and Mitan oil. These four entities represented in total about 80% of entirely licensed storage capacities in 2018 [54].

In 2018 there were in total 48 licenses for trade of crude oil, petroleum products, biofuels and compressed natural gas.

Among the companies that are in dispose of licensed storage tanks for trade of crude oil and petroleum products, far the largest capacities are in dispose of NIS JSC It is then followed by PE Transnafta, Lukoil, Naftachem, Mitan oil, EKO Dunav, Miletić Petrol, Speed d.o.o. and VML, which together with NIS JSC own approx. 90% of total licensed capacities.

Petrol LPG in Smederevo and Standard gas, Energreen MTV and Hipol JSC in Odžaci have also significant capacities for liquefied petroleum gases [55].

5.4.7. Stations for Motor Fuels Supply of Vehicles - Number and Locations of Petrol Stations

Motor fuels and other fuels trade at stations for supply of means of transportation is the retail trade in terms of regulations by which the trade section is regulated. Retail sale of petroleum products in Republic of Serbia is performed by companies in ownership by domestic and foreign companies, which dependent entities are registered in Serbia.

In 2018, the number of licensed business entities which are engaged in retail sale is 448 and this is a increase of 22 compared to 2017 when this number was 426 [12].

This is due to the construction of new transportation supply stations as well as the continued leasing of NIS stations a.d. Novi Sad and Lukoil to new tenants, which increased the number of market participants.

In 2017, the Ordinance on Technical Standards for the Safety of Fire and Explosions of Fuel Supply Centers in Road Transport, Small Craft, Smaller Commercial and Sports Vehicles (Official Gazette of RS, no. 54/2017) entered into force, which prescribes technical norms for safe installation, as well as fire and explosion safety for the construction of new facilities, and the upgrading, adaptation, reconstruction and rehabilitation of existing facilities of fuel stations for transport vehicles in road traffic, less h vessels, small business and sport aircraft, as well as handling and technical standards for equipment, installation and equipment for safe storing and transferring fuel to these stations.

Based on data from the Ministry in charge of energy, at the end of 2018, the total number of active stations for the fuel supply (petrol stations PS) in Serbia was 1.481 of which 323 NIS a.d. Novi Sad (22%), Lukoil 115 (8%), Knez Petrol 83 (5%) and OMV 61 and EKO 54 (4%)

The largest number of petrol stations 416 (57%) is located in the city, then in the village 140 (19%), on the main road 112 (16%), while on the highway there is only 54 (8%).

The six companies with the largest number of petrol stations: NIS JSC, Lukoil Serbia, Knez Petrol, OMV Serbia, EKO Serbia and Mol at the end of 2018 had 673 petrol stations [56].

Other petrol stations which represent almost 50% are owned or leased by a large number of licensed entities that have from one to several stations and are not included in the analysis.

5.5. Program of Modernization and Investment of Refineries

The program of modernization of Pančevo Oil Refinery envisaged the total price of the project in the amount of 547 million euros, of which 396 million goes to construction of hydrocracking complex, the rest of 151 million euros is foreseen for the projects of ecological significance - the construction of plants for the production of hydrogen in Pančevo Oil Refinery, as well as the modernization and construction of industrial infrastructure of Refinery [44][40].

The project was initiated by signing a contract with engineering company CBI&Lummus, in September 2009. The start of construction is planned for the June 2010 and ending in late 2012.

The investment program, which included the modernization of production capacities and technological reconstruction of the processing complex, in order to increase product quality up to the standard Euro - 5 as well as the environmental protection was implemented to the fullest extent. Until now it has been invested into environmental projects for over 60 millions €, in parallel with the development of modernization of production. Thanks to the modernization, NIS JSC will fully satisfy needs of the domestic market for fuels with 10 ppm S and unleaded petrol.

The realization of the complex for mild hydrocracking and hydro (complex MHC/DHT) in Refinery Pančevo, enabled the NIS JSC to completely switch to the production of ecologically clean fuel - unleaded petrol and euro diesel with a sulfur content not exceeding 10 ppm.

In 2016, the realization of Deep Processing project ("Coking") continued which is the second phase of modernization of the refining complex, with the aim of completing the desulphurisation process in refinery capacities.

Also, the capital overhaul at the Pančevo Oil Refinery was successfully carried out. During the capital overhaul, a hydrocracking catalyst was replaced in order to increase the yield of medium distillates.

The contract for the implementation of the final phase of project „Deep Processing” was signed, a new heat exchanger Packinox was put into operation, a gas line installation project was completed. New types of oil "Kirkuk" and "Forcados" have been started.

The deconservation and start of the plant "Small" atmospheric distillation and Merox kerosine were performed in order to increase the volume of processing and production efficiency.

In accordance with the draft of Program [3] for the forthcoming period, projects are envisaged as part of the project "Deep Processing".

The project also includes the implementation of delayed coking technology as the second phase of modernization of processing capacities of the oil refinery in Pančevo.

This project will allow the increasing of depth of processing (to 92%) and increasing of production of white derivatives (to 85.8%), while simultaneously it will improve and increase the efficiency of the processing process, the availability of the plant and the maximization of level of optimization of energy costs.

The realization of the project, along with other measures that will also be implemented in the Pančevo Oil Refinery, the Energy Intensity Index (IEI, determined based on the Solomon methodology) will be almost equated with world refineries whose IEI is positioned as a benchmark index [3].

In 2018, the production of petroleum products increased by 6% compared to the same period in the previous year as a result of market demands (diesel, jet fuel, virgin naphtha, bitumens).

In 2018 a ten year high volume of oil refining and finishing was achieved, of 3.8 million tonnes.

During 2018 the implementation of the Bottom of the Barrel project dynamics has been accelerating, especially with regards to construction, concrete and mechanical works, and the number of employees at the site is increased.

The detailed project of the project Bottom-of-the- Barrel was completed, with the exception of works in connection to changes induring in the construction process.

The foundations were laid and the basic steel constructions of the project installed, while the general construction works have been completed.

All oversize and critical equipment was delivered and installed. Installation of heat exchanger and vessels, including the coke oven, has been performed.

A fully equipped transmission substation and a distribution substation for the distribution of electricity, as well as a control block for instrumentation, were constructed. 95% of the equipment and material for the project was delivered. Works on the installation of pipelines, electrical and technical equipment and instrumentation in the field were conducted.

The renovation was completed on the plant for bitumen production, as well as at the Klaus, Visbreaking and Diesel deparaffinization plants. Within the works on the Bottom-of-the-Barrel project, the Merox plant was handed over for reconstruction.

A new compressor for ejector gas at the vacuum distillation plant was put into operation, which significantly reduced the sulphur oxide emissions into the atmosphere. The APC (Advanced Process Control) system was implemented on the hydrocracking unit.

Technological conditions for connecting CCPP Pančevo to the existing lines within POR were established.

The procedure for extending the scope of certification for the new type of bitumen for the roads ‘EV 35/50’, which NIS wishes to launch on the European market has been completed.

In 2018, we were working actively on the projects within digital transformation, which will be continued in 2019, with the focus on the project €kon$, where the commissioning of the first phase of the project at the Primary Refining Plants (Atmospheric and Vacuum Distillation) is expected already in early 2019.

In January, the bitumen production unit was overhauled and the bitumen loading system was reconstructed without the need to shutdown this production unit.

In mid-February 2018, a planned overhaul was conducted by applying modern methods for equipment cleaning, in order to increase the total efficiency of refining and improving the operation during the summer period. During this scheduled shutdown, the technological line of the hydrogen unit was completely replaced, which will result in the higher operational reliability of this and other refining units, 14 heat exchangers and more than 20 air cooler sections were cleaned. The revision and overhaul of four columns were carried out while several technical and technological modifications were made on processing units.

The catalysts were replaced on the pyrolysis gasoline hydrodesulphurisation unit.

Scheduled overhaul activities on the small atmospheric distillation plant were carried out.

The overhaul of the plants Klaus (C-2450), and Visbreaking (C-200) was carried out together with the current overhaul of the plant for Diesel deparaffinization (C-2400).

The overhaul of the boiler BF-9602/1 was carried out, the repair of the furnace 2401, as well as the repair of the GB 2501 compressor on FCC (C-2300) plant.

Throughout 2018, preparatory activities were carried out for the execution of POR capital overhaul in February-March 2019, which were planned to be completed in 38 days (from the start of the suspension until the establishment of the normal technological regime).

During 2018, the LOTO system (isolation and locking equipment) was implemented in order to increase occupational safety.

The following investment projects have been put into operation: Contractor accommodation location, Installation of on-line analyzers for linear API separation and POR line analysis, Modernization of the installation for loading / unloading of bitumen on RS/ACS at Pančevo Refinery, Application of antireflection furnace coating on Catalytic Reforming Plant (S-300), Installing an on-line simulator distillation analyzer and a blinking point on the MHC/DHT diesel line, Reconstruction of the tank FB- 0805. Expansion of the APC controller from S-300 to S-500, Extension of the railway scale (legal obligation) and Modernization of the radio system in POR.

The implementation of the Digital Transformation was initiated in the Refining Block with the projects for training operators on plant simulators (OTS), the project for the anticipation of failures (Machine Learning) and the operator support project (€kon$) have been started

A feasibility study for Automatic fire extinguishing systems for the extinguishing and cooling of old POR plants and protection of the furnace in the event of gas leakage on POR plants has been developed.

The NIS Executive Board approved the realization phase of the following projects: Reconstruction of the system for prevention of corrosion at the Atmospheric distillation plant (S-2100) of POR, Reconstruction of the fire protection system in POR (Module 1), Reconstruction of the laboratory building in POR, Upgrade of DCS system in block 5,6, FCC and Bitumen.

The reconstruction of the POR dispatcher building was finished. Implementation of the complex project System of integral and technical protection of POR is currently in progress.

5.6. Overview of the Technological Security of Oil System, Quality and Maintenance of Oil and Petroleum Products

According to the Article 324 of the Energy Law [1], energy entities who realizes the energy activities of oil transport through oil pipelines, the transport of petroleum products, storage of oil, petroleum products and biofuels, the wholesale of fuels for the supply of vessels, the retail sale of fuels for the supply of vessels and biofuel production, are obliged to use and to maintain energy plants in accordance to the technical regulations and standards relating to the activity they perform, as well as the protection from fire and explosion, environmental protection determined by law and other regulations.

The conditions prescribed by this regulation are: pressure regulation and safety measures against exceeding the allowed working pressure, marking the route of the pipeline and product pipeline, the protective zone of oil and product pipelines, inhabited buildings, spaces and infrastructural objects in the protected zone of oil and product pipelines and work area, dangerous zones and corrosion protection of oil and product pipelines, conditions and mode of remote monitoring and management, conditions of design, installation and maintenance of electrical equipment and installations in dangerous areas, the requirements and testing of pipelines and product pipelines during the construction and before they are put into operation, the conditions and modes of use and handling of oil and product pipelines and their maintenance during operation, repairing and extraordinary events, conditions and modes of corrosion protection and of leaking of oil and product pipelines; examination and maintenance of security devices, conditions and method for protecting the oil and product pipelines, and protecting of their related overground devices, plants and spaces from unauthorized use or damage.

The pipeline PE Transnafta from the Croatian border to Pančevo has an installed SCADA system for remote control of vents on the block stations along the route of 154.3 km. It is also established a system for the detection of leaks Motorola MOSCAD by which the slightest leak is detected for a short period of time. A wireless remote control system is installed in case of a broken fiber cable that is the basic means for transmitting communication.

In the main dispatching center in Terminal Novi Sad, a video surveillance with motion detection and alarm is installed in each block station.

Every five years the recording of status of pipeline performs by passing the intelligent inspection device (pig) on the basis of which it receives a report of the status of pipeline located on damaged places, the degree of damage and the remaining service life of pipelines, all in accordance with European standards relating to the integrity of the pipeline.

During 2018, PE Transnafta performed in line inspection of the section from the Terminal Novi Sad to Oil Rafinery Pancevo, and in 2019, the reconstruction of critical sites was executed according to the obtained test report.

There have been carried out periodically inspection of riverbed of rivers Danube and Tisa in place where pipeline crosses through watercourses to ensure preventive response and to prevent accidents.

The Article 327 of the Energy Law [1] defines that the energy entity carrying out the transport through oil pipeline or transport of petroleum products through product pipelines establishes the Rules of Procedure of the system for transport through oil pipelines and the Rules of Procedure of the system for transport of petroleum products through pipelines, which include, in particular: technical conditions for the safe operation of system, procedures in case of disaster and critical situations, or interruption of transport, the rules on access to the system for transport of oil and petroleum products, requirements regarding the quality of oil and petroleum products which are given for transport, rules on measurement with defined necessary measuring devices and other transport conditions.

PE Transnafta applies valid document Rules of the transport system [57] which defines all activities in order to provide safe and secure transport and storage of crude oil.

On the route of the pipeline from the dispatching station in Elemir to Novi Sad Oil Refinery, the system of leak detection Krohne is implemented, and also the installation for system's measuring at the entrance to the refinery system by which all parameters of flow are received in a real time.

In 2018, in the final phase, the relocation of a part of the pipeline route in the highway zone and the industrial zone of Novi Sad. After connecting the new part of the route to the existing system, the shooting will be carried out by intelligent oil pipelines coming to the Transnaft Terminal.

PE Transnafta is successively cleared the technological and storage tanks at the Terminal Novi Sad, recovering them and bringing in excellent working order.

The cleaning is performed every 10 years and in that period testing of tanks and reparation of any damage are done as well as the laser measuring with drafting of volume tables is conducted every 5 years, all in accordance with the Rulebook on Types of Criteria that is Required Verification and Intervals of their Periodic Verification (Official Gazette of the RS, no. 49/2010 and 110/2013) [58].

PE Transnafta in 2017 finished reconstruction of the manipulative pipelines was carried out at the Terminal Novi Sad.

The activity of the transport of products through product pipelines is not done because there are no functional product pipelines built on the territory of the Republic of Serbia.

PE Transnafta initiated the drafting of technical documentation in order to implement the project System of product pipeline through Republic of Serbia, which would include the construction of a pipeline from Sombor, through Novi Sad, Pančevo, Smederevo and Jagodina to Niš with a branch from Pančevo to Belgrade. Also, the project envisages the construction of the terminal at specified locations. This would achieve a safer and more secure transport with minimal impact on the environment. The total length of oil product amounted to 402 km with a capacity of 4.3 MTA.

By the end of 2016, the geodetic and hydrological psychiatric substrates have been completed, while in 2017 the Project for the execution of the section Pančevo – Smederevo was under construction. The preliminary design includes sophisticated equipment for remote control and monitoring and leak detection.

At terminals and warehouses of NIS JSC and other licensed entities for petroleum products storage and wholesale the substitution of pouring of the charging system performed to avoid evaporative losses and to reduce environmental pollution. Also, the systems for the filling of petrol will be installed for condensate recovery units (VRU units) [44][40].

The port activity is defined by the Law on Amendments to the Law on Navigation and Ports on Inland Waters (Official Gazette of the RS, no. 73/10, 121/12, 18/15, 96/15 – other Law, 92/16, 104/16 - other Law, 113/17 - other Law and 41/18) [59]. In the Republic of Serbia there are 1.364 km of navigable rivers and channels. Transport of derivatives by waterways is done mainly on rivers Danube and Sava and the reception and dispatch of products is done at locations Bezdan, Novi Sad, Sremski Karlovci, Pančevo, Smederevo and Prahovo where a modern ports are built respecting all regulations and safety measures in terms of environmental protection (protective dams, skimmers).

River fleet engaged in transport must realize the requirements in terms of security in accordance with the Regulations on the manner of transport of dangerous goods in water transport and obligations of the participants in the transport of dangerous goods by extraordinary events (Official Gazette of the RS, no. 125/2014). Water traffic in the transport of dangerous goods is done by boat which is celebrated in accordance with the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways ADN (European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways). (Official Gazette of the RS - International Treaties, No. 8 / 2017-1 of 04 September 2017).

5.7. Capacities for Import and Export of Crude Oil and Petroleum products

According to the data from the Energy Balance for 2018 [60], the transport of petroleum products in the Republic of Serbia is carried out by rail, shipping and road transport. From Refinery to terminal plants it is mainly performed by railway and ship transport, and to final customers by road transport. Currently available capacities of specified types of transport satisfy all needs for transport of products. The only provider of pipeline transport of crude oil in the Republic of Serbia is PE Transnafta. The activity of this company is oil pipeline transport through the Republic of Serbia.

5.7.1. Capacities for Import and Export of Crude Oil

The available capacities for import of crude oil are not fully used and the capacity of the oil pipeline, which manages PE Transnafta and which amounts 9 MTA is currently using less than 30%. Considering that the Novi Sad Oil Refinery is currently not operating and for which the capacity of 3 MTG has been reserved, the capacity of the direction to Pančevo from 6 MTGs is slightly above 50%. There is no possibility to export and reversible transport through existing pipelines and there are not built other pipelines that could carry out the export of manufactured domestic oil via oil pipeline transport. In 2018,was imported 2,693,926 tonnes of crude oil [16].

An alternative to pipeline importing of significant quantities of crude oil represents the import by barges on the Danube from Konstanca, but there are several factors for the inefficiency of this mode of transport. The main reason is the restriction of mobility of Danube in Djerdap hydroelectric power plants and the absence of river fleet capacity which could deliver at the optimal time the necessary amount of crude oil according to the planning needs of the processing [44][40].

The condition and capacity of railway tracks in Serbia represents a limiting factor for significant applications in imports of crude oil [44][40].

Domestic crude oil is transported by pipeline from the dispatching stations to Novi Sad Oil Refinery and shipping continues to the Pančevo Oil Refinery. Oil - type Velebit due to its bad rheological transport properties must be mixed with imported or domestic crude oil, and only by bringing to the conditions prescribed by the rules of the transmission system of PE Transnafta can be transported to the Pančevo Oil Refinery.

When it comes to the waterways transport of domestic crude oil there is a possibility for transport of domestic crude oil by pipelines from the dispatching station to the refinery. The biggest dispatching stations of NIS JSC Nadrljan and Elemir have the possibility of shipping of crude oil through barges but that mode of transport in the regular work of the pipeline is not implemented [44][40].

The transport of crude oil by tanks is only carried out from domestic oil fields (Turija fields of South Banat and Stig) from collecting stations that are not connected by pipelines with delivery stations previously mentioned. These are amounts that do not exceed 10% of total production. When the Novi Sad Oil Refinery stopped working, the crude oil from the oil field Turija is shipped to the Pančevo Oil Refinery by tank trucks, as due to its unfavorable rheological properties can not be transported by pipeline [44][40].

5.7.2. Capacities for the Import and Export of Petroleum Products

On the market a significant number of licensed entities who import derivatives by rail, car tanks, river vessels (river tankers, barges and self - propelled tanks) in its property or leasing.

The import of petroleum products by rail mostly is carried out by rail tankers in property of NIS JSC or Standard Logistic while the import by vessels, except NIS JSC (for which transportation is performed by "Jugoslovensko rečno brodarstvo a.d. Beograd") is performed by several companies with their own fleet (Speed Ltd, Naftachem Ltd, Kazuk Ltd, Ladjar Kupra, Rubikon Shipping, Dunav Oil Trans, Judra Ltd, Ladjar Transport Ltd, Euro Gas Subotica, MB Gas Oil, Mario MilTrans Ltd [44][40].

With the modernization of Pančevo Oil Refinery and achieving of products quality on European level, NIS JSC has reduced the import while Intermol and Lukoil stayed the leaders of import.

NIS JSC mainly does the export of petroleum products by rail transport using rail tankers, by waterways using barges and by road transport using truck tanks.

5.8. Overview - Geographical Origin of Imported Fuels

Based on the available data of Ministry in charge of energy which is composed from database that is filled by entrepreneurs [61] as the data that the ministry receives from the Customs Administration, and in accordance with the classification of Section 4 of Anex B of Regulation (EC) No. 1099/2008 an overview of geographic origin and percentage of imported fuels is made.

From the table below (Table 32) it is seen that oil and lubricants and LPG is a fuel which is imported from a lot of different countries and a consequence is in a large number of licensed entrepreneurs as well as the minimum of necessary technical capacities for its storage, which is not the limiting factor in the market and do not prevent competition.

In 2018, the crude oil is from Russia (Novy Port, REB), Iraq (Kirkuk) and Iran (Iranian Heavy), while the refinery gas is from Russia. In 2018 compared to 2017, oil from Iran (0.75%) is imported and Novy Port's share increases from 11.10% to 32.41%, until doesn’t import Kazakhstan's oil (CPC Blend).

The primary petrol is from Croatia, while the motor gasolines are mostly imported from Hungary, Austria and Romania and because of that we have many big international companies such as OMV, Mol, Lukoil. Hungary is also the country from which most of the energy products are imported and whose percentage 38.52% is almost identical to 2017 [26].

Diesel fuels are imported from different areas opposed to gasolines: Austria, Hungary, Romania, Bulgaria and Russia. The paraffins, bitumens, petroleum coke and lubricants include different spectrum of products [26].

Most of the market participants is provided by euro diesel from the domestic resources, opposed to previous year when the only supply was from the import [26].

Compared to 2016 and 2017 in 2018, the number of countries from which significant quantities of derivatives are imported are reduced. Hungary, Romania, Bulgaria and Russia are the countries from which more than 70% of the derivatives are imported.

Table 32: Table of geographic origin of imported fuels [26]

		%Crude oil	% Petroleum products	Refinery gas (not liquefied)	LPG	Naphtha	Motor gasoline	Kerosene type jet fuel	Gas/diesel oil (distillate fuel oil)	White spirit and SBP	Lubricants	Bitumen	Paraffin waxes	Petroleum coke	Other products
AL	Albania		1,81									●		●	
AT	Austria		2,35				●		●			●			●
BA	Bosnia and Hercegovina		2,28								●	●	●		
BE	Belgium		0,53							●	●				
BG	Bulgaria		5,98						●						
BY	Belarus		0,20		●										
CN	China		0,01												●
CZ	Czech Republik		0,60		●										
DE	Germany		0,56		●					●	●				
ES	Spain		0,46										●		
FR	France		0,08												●
GB	Great Britain		0,27												●
GR	Greece		0,76					●			●				
HR	Croatia		1,41			●					●				●
HU	Hungary		38,52		●		●		●	●	●	●	●	●	
IN	India		0,04								●				
IT	Italy		1,48								●				
KZ	Kazakhstan		0,95		●										
LT	Lithuania		0,24								●				
MD	Moldavia		0,53												●
MK	North Macedonia		0,06								●				
NL	Netherlands		0,05												●
PL	Poland		1,54		●										●
RO	Romania		16,93		●		●		●		●			●	
RU	Russian Federation	49,74	9,94	●	●				●		●		●		
SE	Sweden		0,08												
SI	Slovenia		0,50							●	●				
SK	Slovakia		1,18		●		●								
UA	Ukraine		1,07						●						
US	SAD		7,01											●	
IQ	Iraq	49,51													
IR	Iran	0,75													
	Other		2,57												●

6. CONCLUSION

On the basis of the available data from the realization of the balance in the field of electricity, we should emphasize the increase of production in the field of renewable energy sources, first of all from wind power plants and small hydro power plants. In addition to the positive energy effects, these results significantly contribute to the fulfillment of international commitments undertaken by the Republic of Serbia in the field of ecology and the share of renewable energy sources in total production and consumption (more detail in chapters 3.8 and 3.10). At the same time PE EPS continues to have problems in production. If we compare the years 2011 and 2018, it can be seen first that total production has fallen by approximately 5%. In doing so, PE EPS is constantly highlighting the new megawatts it has gained from existing power plants thanks to its revitalization. This was suppose to increase production rather than reduce it. On the other hand, only operating revenues from the sale of products and services (predominantly from the sale of electricity) of PE EPS are steadily increasing, reaching a significant 1.94 billion € in the previous year (consolidated financial report on the site of PE EPS). This is an increase of approximately 3.75% only in relation to 2017. It is clear that the constant increase in operating income in previous years is due to the significant increase in electricity prices when it comes to commercial supply, which was achieved thanks to the opening of the market.

The main problem in our most important company in the field of electricity is still the decline of production in thermal power plants, which is described in more detail in the chapter 3.8. This time, additional concern is the physical decline in coal production, especially in TPP Kostolac. This has also led to a decline in electricity production in this branch. The second coal mine, MB Kolubara, has been failing to supply TENT power plants for several years. The existing problems of low energy value of coal (lower thermal power is significantly lower than guaranteed, with increased ash and moisture content, as well as the content of the admixture - clay and sand, very uneven quality even on a daily basis, failure to complete the balance of the coal, are compounded by the problem of a physical smaller volume of delivery, and a decrease in supplies at all landfills. This inevitably leads to a constant decline in production in the TENT and as shown in the chapter 3.8, it is down about 3.6 billion kWh in the last year compared to the first year of this decade. The hopes that it will be better soon are first of all laid down in the completion of the “green project” in MB Kolubara. which is discussed in more detail in the report.. Opening replacement capacities is the biggest problem. It is noticeable that in the last few years the relevant text in the plans of PE EPS relating to this issue has not changed much, which means that the problems identified have been very slowly resolved. The natural gas sector is characterized by a declining trend of indigenous production since most of the gas fields are in the final stage of exploitation. In recent years, there haven’t been significant discoveries of new gas deposits. This will result in a steady increase in natural gas imports in the future.

Analysis of the energy balance of the country indicates a steady increase in the consumption of this energy source. The main risk in natural gas supply is related to the fact that it is provided from one, predominant source of supply and by the only one supply route. In the previous period, occurred situations, of a significant reduction in the delivered daily quantities of imported natural gas into the system, due to the problems not caused by Serbia. Short-term measures for overcoming such situations are the withdrawal of stored quantities from the underground storage Banatski Dvor and the interventional gas supply from countries in the region, as well as the substitution of this energy source by other energy sources (to the maximum extent possible).

Medium-term measures include the expanding of the Banatski Dvor storage capacity and the construction of new natural gas interconnector through the Republic of Serbia and which will be connected to the Bulgarian and Hungarian national transmission systems, as well as interconnections with countries in the region (Bulgaria, Romania, Croatia).

Long-term measures include cooperation in international projects for ensuring new directions of supply, as well as securing new contracts for the supply of natural gas from new sources. In this way, the security of the supply of the domestic natural gas market would be significantly improved, the reliability of the system would be ensured, and the possibility of purchasing natural gas under more competitive conditions would be established.

All these measures open the possibility for reducing the transit costs, as well as the possibility of supplying natural gas from Russia and other directions of supply. The possible new supply routes and gas sources are as follows: South Corridor (Azerbaijan, liquid natural gas from the terminal in Greece, etc.), from the Republic of Romania, North African gas from the via of Italy (via Croatia), or liquid natural gas via the foreseen terminal in the Republic of Croatia.

Establishing a system of mandatory reserves of the Republic of Serbia and implementing the dynamics of filling the warehouses in accordance with the adopted Action Plan will increase the security of supply when it comes to crude oil and oil derivatives.

At the same time, it is actively working on the reconstruction of existing and construction of new storage capacities at existing terminals, as well as considering the possibility of other modes of financing the construction of new storage terminals.

From year to year, the Energy Reserve Directorate provides new quantities of petroleum products, as well as tickets, in accordance with the Law on Commodity Reserves and Directive 2009/119/ EC. It is necessary to achieve the planned dynamics of emergency stocks forming in order to provide quantities for 90 days of net imports or 61 days of inland consumption, by January 1, 2023.

Compared to the previous period, capacities in public ownership for storage of mandatory reserves of the Republic of Serbia have been increased and the first quantities of crude oil and oil products have been stored.

On the other hand, the constant trend of crude oil production decline in the country requires an increase in imports and a greater dependence of the Republic of Serbia on import volumes. The negative trend in crude oil production in the country can be partially stopped by investing more significant assets in the exploration and exploitation of new oil fields, both the geographical locations and deeper layers of current landfills. In addition, in the process of production, secondary and tertiary methods can be introduced in line with the most up-to-date global trends in this field.

The constant trend of crude oil production decreasing requires import increase and a greater dependence of the Republic of Serbia on import volumes. The problem of just one direction of crude oil supplying still remains. It is a part of the pipeline infrastructure of the former Yugoslav oil pipeline operated by PE Transnafta. In the reporting period, however, there was no threat to crude oil supply of the Pančevo Oil Refinery.

Providing a new direction for crude oil import by pipeline in the coming period is essential. By establishing new interconnections, the Republic of Serbia would have significant flexibility in this regard.

Construction and implementation of Oil product pipeline network through Serbia, and connection with the neighbouring countries, will allow secure and safe transport and presence of sufficient quantity of oil products at any time. In addition to the proven cheapest, safest and fastest way of transportation, introducing this type of transport the Republic of Serbia would also unload the river transport. According to the undertaken obligations and the signing of the ADN Agreement, which regulates the transport of motor fuels by barges with double bottoms on inland waterways, the Republic of Serbia has committed to provide this type of transport for the petrol fractions by December 31, 2018. This obligation, in view of the lack of an adequate river fleet, greatly increases costs and complicates the transport of oil products from the refinery to the consumers. By introducing the pipeline transportation system, the existing oil products transport by Danube on the Pančevo - Novi Sad and Pančevo - Smederevo routes, would be reduced to a minimum.

Solving the existing problems of the railway infrastructure through the construction of new or reconstruction of existing railway tracks and increasing the axle load-carrying capacity, would enable the possibility of transporting larger oil products quantities by railway, both for import and export, which would significantly improve the security of supply of the Serbian market with these energy products.

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