Slovenská elektrizačná prenosová sústava, a. s.

TEN-YEAR NETWORK DEVELOPMENT PLAN FOR THE PERIOD 2018 – 2027

November 2017

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1. Introduction

Slovenská elektrizačná prenosová sústava, a. s., (hereinafter referred to as "SEPS"), as a transmission system operator (hereinafter referred to as "TSO") of the Slovak Republic (hereinafter referred to as "SR"), processes this document, the national Ten-Year Network Development Plan for the Period 2018 – 2027 (hereinafter referred to as "2027 NTYNDP"), under Art. 28, par. 3, subpar. b) of Act No. 251/2012 Coll. on Energy and on amendment of certain acts as amended. This paragraph prescribes that every year the transmission system operator shall be obliged to process the transmission system development plan including the development plan for the interconnectors for the period of the following ten years and to hand it over to the Ministry of Economy of SR (hereinafter referred to as "MoE") and to the Regulatory Office for Network Industries (hereinafter referred to as "NRA") always by 30th November of the respective calendar year including the report on fulfilment of the previous Ten-Year Network Development Plan.

Pursuant to Art. 29 of the Energy Act, TYNDP shall be based especially on the present and estimated future condition of the offer and demand for the system capacity, on the appropriate assumptions for electricity production, electricity supply, electricity consumption, and exchanges in electricity with other countries. In the field of cross-border exchanges electricity and development of the transmission system of SR towards abroad, 2027 NTYNDP takes into consideration the recently published ENTSO-E Ten-Year Network Development Plan (hereinafter referred to as "TYNDP") which represents the system development plan for the entire European Union. 2027 NTYNDP is also in compliance with the recent valid regional investment plan (hereinafter referred to as "RgIP") of the Continental Central East region (hereinafter referred to as "CCE").

2027 NTYNDP takes into account currently valid SEPS Development Programme, the respective approved SEPS investment plans and previous TYNDP.

Pursuant to Art. 29 of Act No. 251/2012 Coll., the Ten-Year Network Development Plan must contain effective measures to ensure the system appropriateness and safety of electricity supplies while providing especially:

a) the main parts of the transmission system which need to be built or upgraded in the following ten years including their assumed implementation dates,
b) all investments in the transmission system related to building new capacities or upgrade of the transmission system the implementation of which was already decided upon by the transmission system operator or which will have to be implemented in the following three years including implementation dates of such investments.

All these assumptions have been considered in this TYNDP 2027 appropriately in terms of the current knowledge and information available to SEPS at the time of processing of this document.

2. Description of the Current Condition of the Slovak Transmission System

The transmission system of SR is first of all a set of mutually galvanically connected 400 kV, 220 kV technological facilities and the selected 110 kV facilities through which the electricity transmission from its producers to individual consumers from the transmission system of SR (hereinafter referred to as "TS SR"), as well as cross-border electricity transmission is carried out. It is especially:

- national and cross-border 400 kV, 220 kV lines and the selected 110 kV lines,
- 400/220 kV, 220/110 kV, and 400/110 kV transformers,
- 400 kV, 220 kV switchyards and the selected 110 kV switchyards,
- compensation facilities.

TS SR includes also respective supportive, so called secondary facilities lacking which the electricity transmission and control of the electricity system of SR would be impossible. These are information control systems (hereinafter referred to as "ICS"), billing measurement systems, protections and automations and telecommunications transmission facilities, etc.. There are also users directly connected to TS SR through their electro-energetic facilities and these users currently include:

- three operators of regional distribution systems (hereinafter referred to as "DS"),
- five electricity consumers,
- four electricity producers.

Moreover, TS SR is synchronously interconnected also with the neighbouring transmission systems in the following extent:

- two simple 220 kV interconnections and three simple 400 kV interconnections in the direction to the Czech Republic (hereinafter referred to as “CZ”),
- one double circuit 400 kV line towards Poland (hereinafter referred to as “PL”),
- one single circuit 400 kV line towards the Ukraine (hereinafter referred to as “UA”),
- two single circuit 400 kV lines towards Hungary (hereinafter referred to as “HU”),

These interconnections allow for synchronous interconnections of the electricity system of SR (hereinafter referred to as “ES SR”) with other TS in Europe the operators of which are associated together with SEPS in the ENTSO-E association.

As at the processing date of this document, topology of TS SR, i.e. the scheme of mutual interconnection of the main technological facilities of TS SR serving for electricity transmission including interconnections in the direction to foreign transmission systems is illustrated in the following picture.

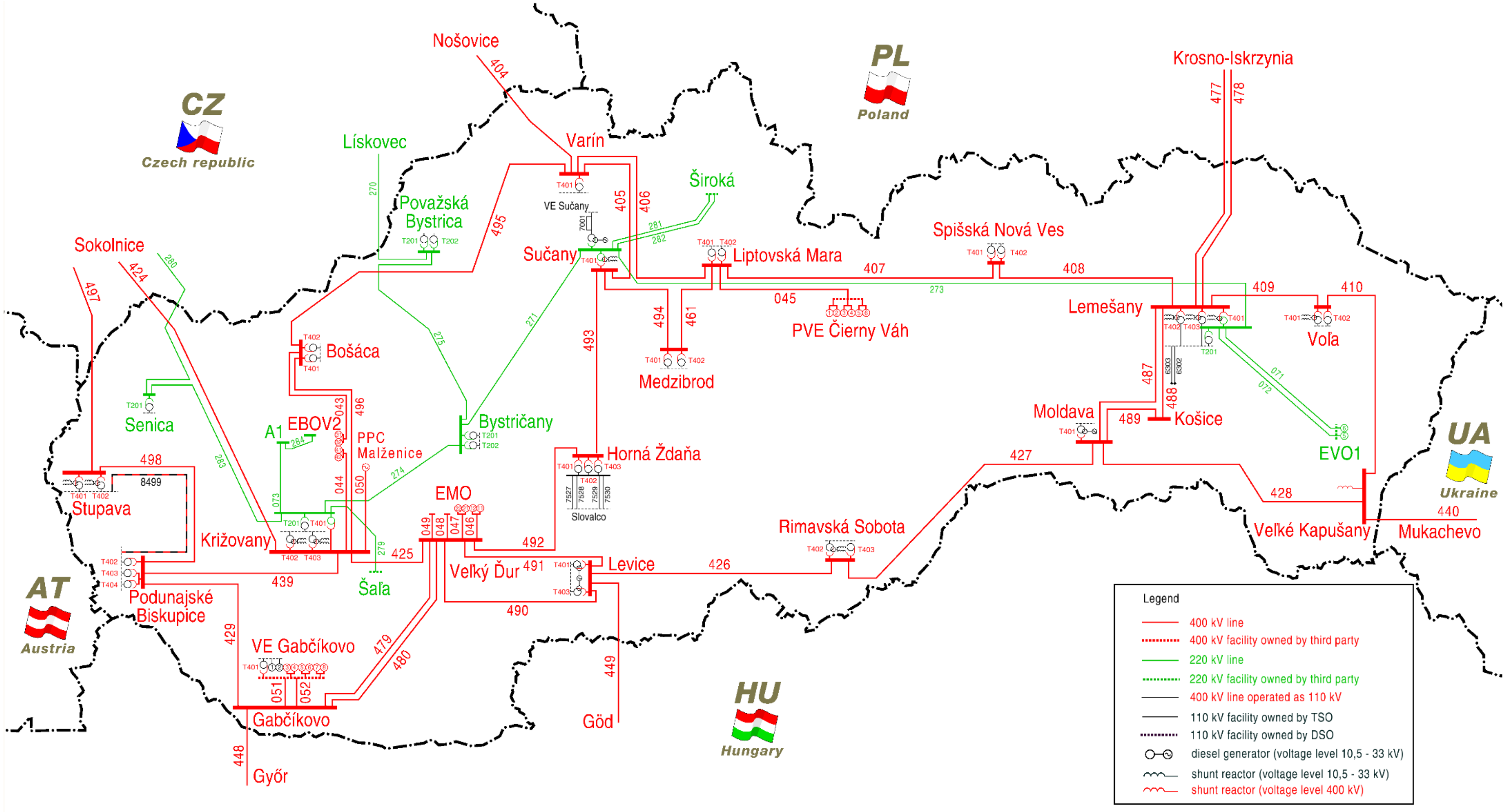


Fig. No. 1 Topology of TS SR

2.1 Current Condition of the Main Transmission Assets of the Slovak Transmission System

2.1.1 Substations

At present, TS SR operates twenty-two substations (hereinafter referred to as "ESt") of which:

- 3 substations with 400 kV and 220 kV switchyards including TS/TS and TS/DS transformations,
- 12 substations include built 400 kV switchyards including TS/DS transformations,
- 3 substations include built 220 kV switchyards including TS/DS transformations,
- 4 substations include built 400 kV switchyards without TS/DS transformation.

Within the renewal and upgrade, the TS SR substations are gradually transferred to the distance control mode what means that local operators need not be present at their operation and all actions concerning control and operation of the ESt electro-energetic facilities are being controlled remotely from the national dispatch centre. The following table provides the overview of substations in TS SR which are currently operated in the distance control mode, in the remote control mode and in local control mode (substation operation and control are performed with the personnel present). Currently, SEPS has fourteen remotely controlled substations.

Substation	Remote control mode (DR)	Distance control mode (DO)	Local control mode (MO)
Bošáca	✓	-	-
Bystričany	-	-	✓
Gabčíkovo	✓	-	-
Horná Ždaňa	-	✓	-
Košice	✓	-	-
Križovany	✓	-	-
Lemešany	✓	-	-
Levice	✓	-	-
Liptovská Mara	-	-	✓
Medzibrod	✓	-	-
Moldava	✓	-	-
Podunajské Biskupice	-	✓	-
Považská Bystrica	-	-	✓
Rimavská Sobota	✓	-	-
Senica	✓	-	-
Spišská Nová Ves	-	-	✓
Stupava	✓	-	-
Sučany	-	-	✓
Varín	-	-	✓
Veľké Kapušany	✓	-	-
Veľký Ďur	✓	-	-
Voľa	✓	-	-
Celkom	**14**	**2**	**6**

Table No. 1 List of SEPS Substations

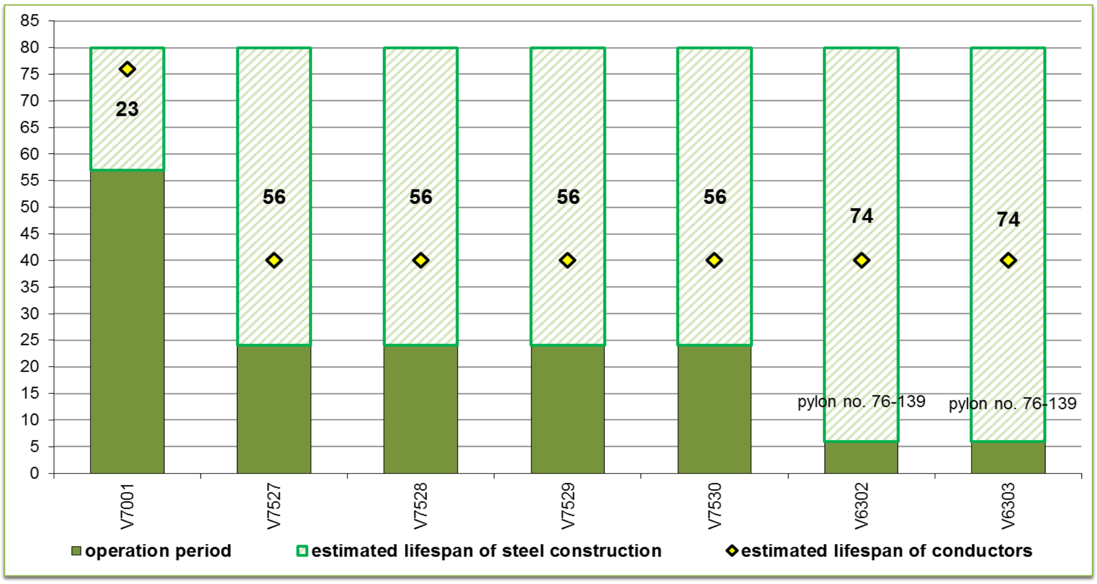
The SEPS website[1] includes development of the number of switchyards in the period 2007 – 2016.

[1] https://www.sepsas.sk/TechnickeUdaje.asp?kod=16

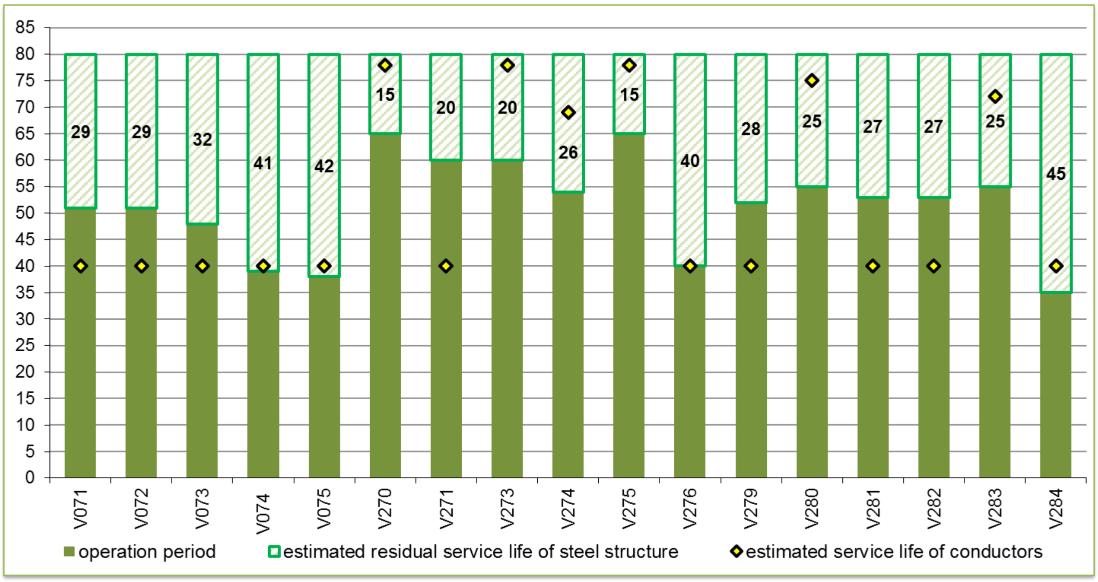
2.1.2 Transmission Lines

Individual substations in TS SR are mutually galvanically interconnected via forty-six 400 kV transmission lines with developed length of 2,138 km, seventeen 220 kV transmission lines with total length of 826 km and seven 110 kV transmission lines with total length of 80 km. Out of the total number of 400 kV and 220 kV transmission lines, TS SR disposes of eight 400 kV and two 220 kV cross-border electric lines jointly with the total length of approx. 444 km on the territory of the Slovak Republic which connect TS SR with the neighbouring transmission systems of CZ, HU, PL, and UA on the respective cross-border profiles. Further information – for example on the number of towers is published on the SEPS website[2].

The following three graphs show the operation time of individual 110 kV, 220 kV, and 400 kV lines, estimated lifetime of the wire lines (yellow label) and estimated residual lifetime of the tower steel structure. The estimated lifetime of the electric line in the SEPS conditions in fact equals the estimated lifetime of the tower steel structure. The provided information is important regarding the future SEPS technical-investment planning.

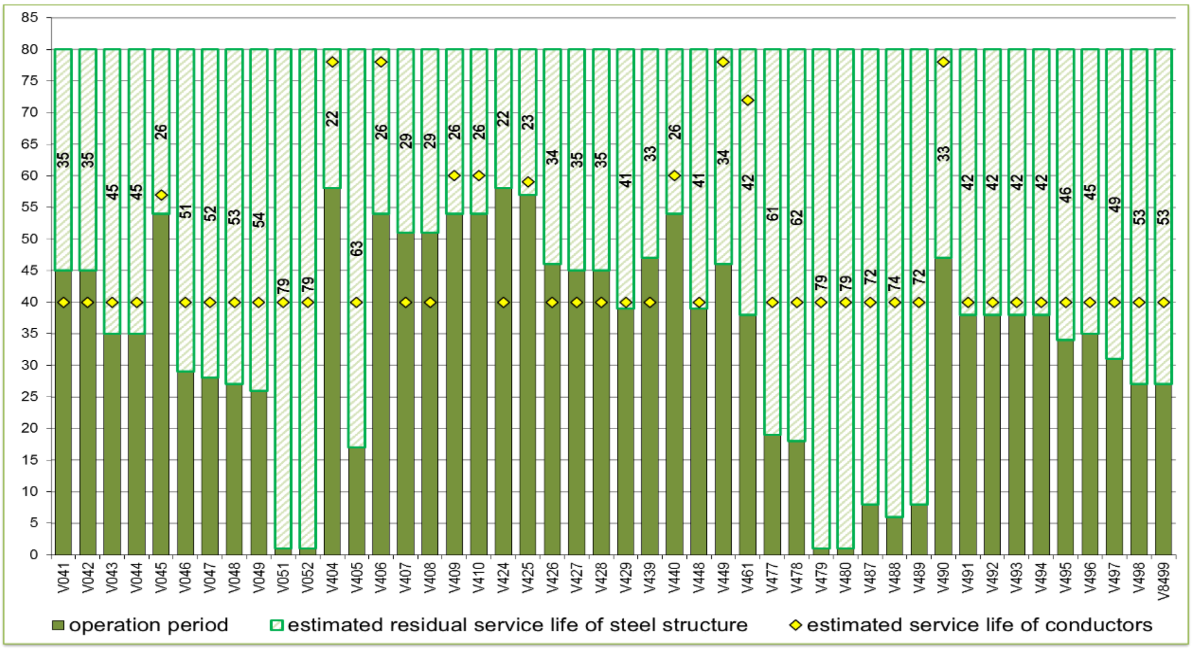


Graph No. 1 Overview of the Operation Period and Estimated Lifetime of 110 kV Lines of SEPS (in years)



Graph No. 2 Overview of the Operation Period and Estimated Lifetime of 220 kV Lines of SEPS (in years)

2 https://www.sepsas.sk/TechnickeUdaje.asp?kod=16



Graph No. 3 Overview of the Operation Period and Estimated Lifetime of 400 kV Lines of SEPS (in years)

The yellow label in all three above-mentioned graphs means that after reaching the line age of 40 (or 80) years, conductors' replacement including insulator suspensions on the respective line is being considered by SEPS. If required so by the condition of wires and insulators, their replacement shall be performed sooner or later, as necessary.

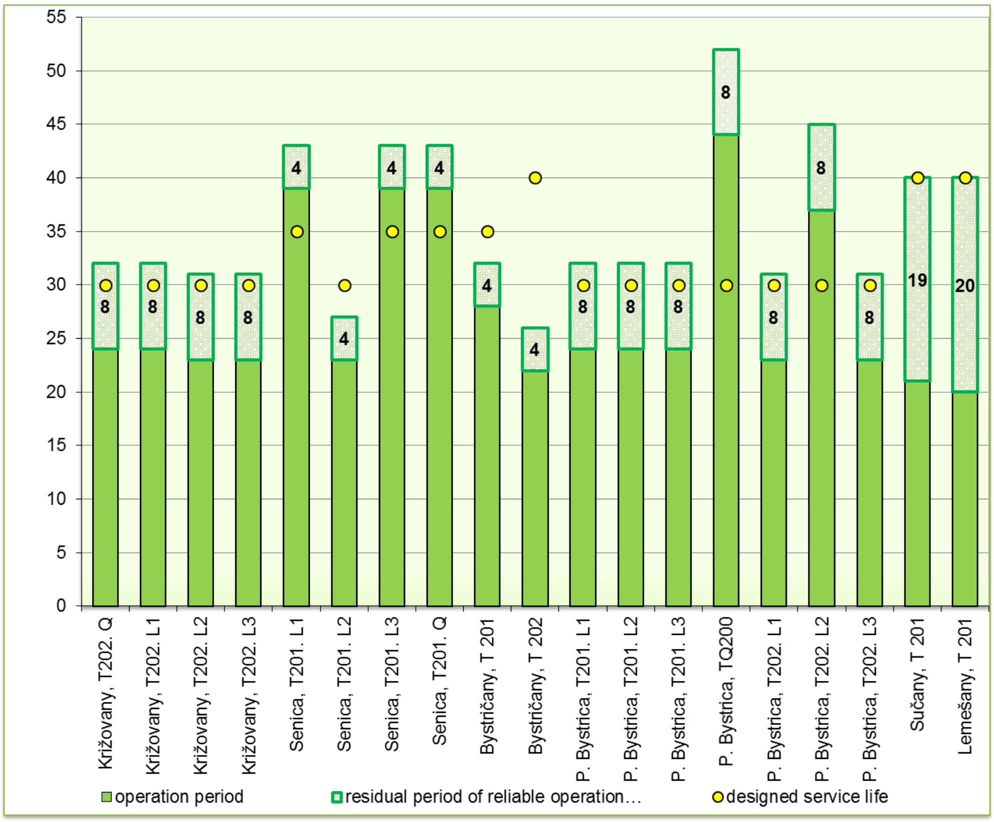
2.1.3 400/110 kV, 400/220 kV, and 220/110 kV Transformers

Power transformers which form the basis of the transmission system with transmission lines are installed almost in all substations except for Veľký Ďur, Veľké Kapušany, Gabčíkovo, and Košice switching stations owned by SEPS.

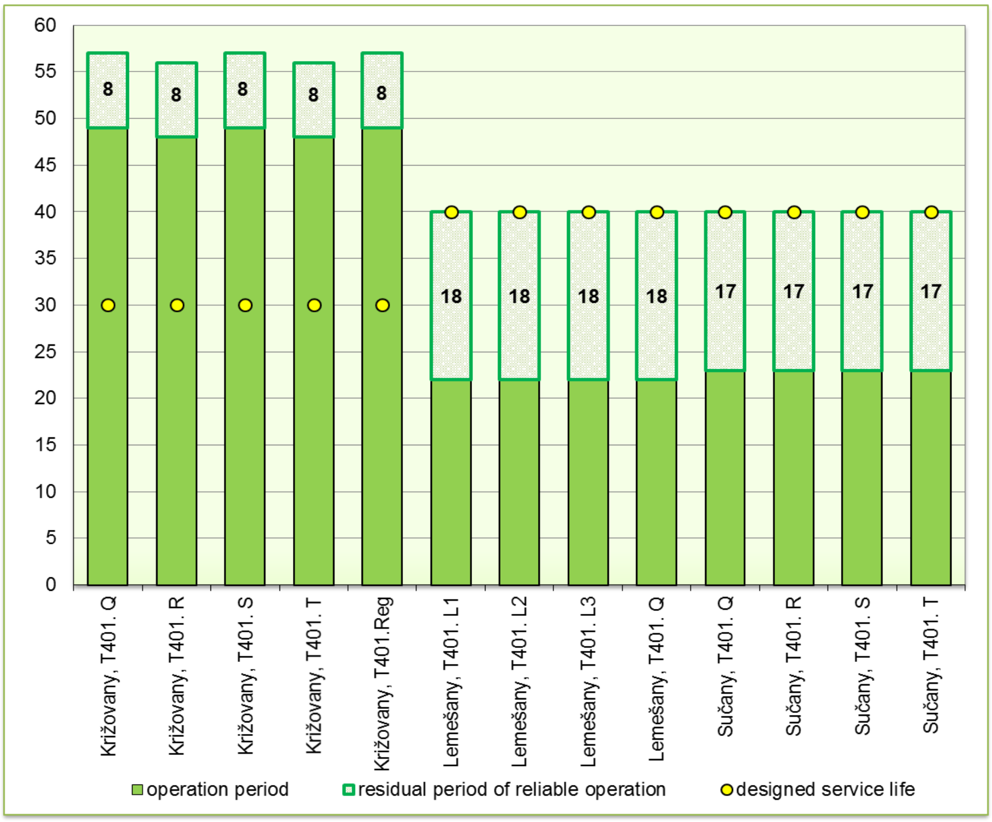
The graphs below show the operation period, residual period of reliable operation, and designed lifetime of individual transformers. The design lifetime is marked with a yellow label. The residual period of the reliable operation of SEPS transformers is verified based on the regular diagnostic inspections.

In case of transformers operated after reaching the design lifetime, the diagnostic measurements with a shorter repetition interval are performed. These measurements proved the possibility of safe operation of transformers even after reaching the design lifetime. Despite that SEPS prepares replacement of those transformers within the horizon of several years. The detail information on the planned transformer replacements are described in Chapter 4.4 Internal Investment Projects. More technical details are available on the SEPS website[3].

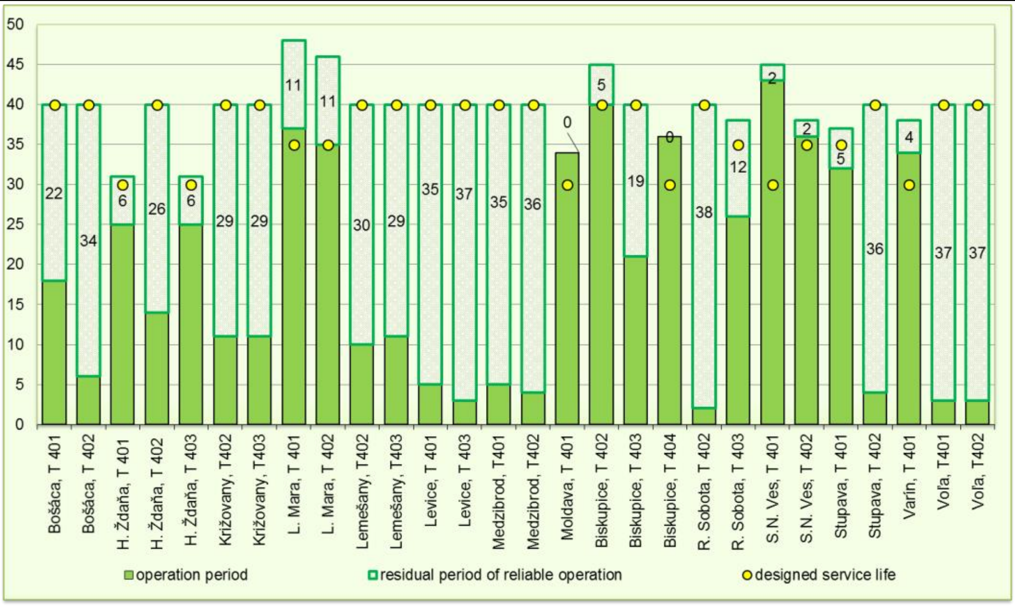
[3] https://www.sepsas.sk/TechnickeUdaje.asp?kod=16



Graph No. 4 Overview of Operation Period and Estimated Residual Period of Reliable Operation of SEPS 220/110 kV Transformers



Graph No. 5 Overview of Operation Period and Estimated Residual Period of Reliable Operation of SEPS 400/220 kV Transformers



Note: *replacement of Moldava T401 is carried out with the expected completion in 2017.*

Graph No. 6 Overview of Operation Period and Estimated Residual Period of Reliable Operation of SEPS 400/110 kV Transformers

2.1.4 Compensation Facilities

Within TS SR, SEPS uses only shunt reactors to compensate capacitive reactive power to help reduce voltage in the transmission system. Installation of power-factor capacitors to increase voltage in TS SR is not necessary at present.

Directly on the 400 kV level, the oil shunt reactor only in the Veľké Kapušany substation is connected in TS SR. The basic information on this reactor is in the following table.

Substation	Production year	Type	Operation period [years]	Q_n [MVAr]	Residual period of reliable operation [years]
Veľké Kapušany, TL1. L1	1972	Oil	45	50	1
Veľké Kapušany, TL1. L2	1991	Oil	26	50	1
Veľké Kapušany, TL1. L3	1972	Oil	45	50	1
Veľké Kapušany, TL1. Q	1971	Oil	46	50	1

Table No. 2 Overview of Operation Period and Estimated Residual Period of Reliable Operation of Reactors for 400 kV Nominal Voltage of the System

In all other cases, the shunt reactors in TS SR are connected in tertiary windings of TS/TS or TS/DS power transformers. Dry-type shunt reactors in power series, in particular 45 MVAr (3xy15 MVAr) are used but there are also power series 60 MVAr (3x20 MVAr) and 90 MVAr (3x30 MVAr) installed. The overview of this type of shunt reactors in TS SR is provided in the following table. The residual period of reliable operation in case of dry-type reactors is not specified since these are, in fact, maintenance-free devices and thus no diagnostics is carried out with them as it is with oil reactors or transformers.

Transformer	Production year	Type	Operation period [years]	Q_n [MVAr]
Nominal voltage of the system: 33 kV				
Križovany T402	2006	dry	11	2x45
Križovany T403	2006	dry	11	2x45
Lemešany T401	2003	dry	14	1x90
Lemešany T402	2007	dry	10	2x45
Lemešany T403	2007	dry	10	2x45
Stupava T402	2013	dry	4	2x45
Sučany T401	1994	dry	23	2x60
Rimavská Sobota T402	2015	dry	2	2x45
Voľa T401	2016	dry	1	2x45
Voľa T402	2006	dry	11	1x90
Nominal voltage of the system: 10 kV				
Stupava T401	2005	dry	12	2x45

Note: *1x90 MVAr reactor at T401 Lemešany was moved to T402 Voľa.*

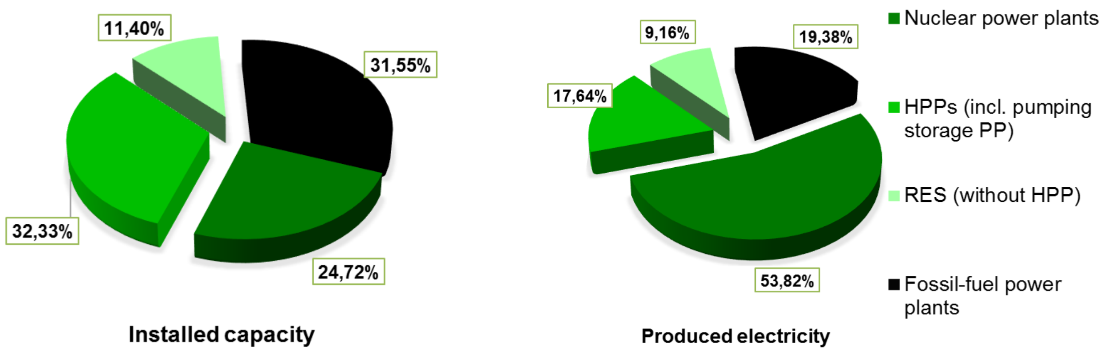
Table No. 3 Overview of Shunt Reactors Connected to Tertiary Windings of SEPS Power Transformers

2.2 Current Situation of Electricity Generators Installed Capacity and Electricity Production

In terms of potential ensuring of generator appropriateness, ES SR in the generator base has adequate installed capacity for electricity production. One third of the installed capacity consists of fossil-fuel power plants including thermal power plants and captive power station with prevalence of fossil fuels co-combustion. The remaining part consists of nuclear power plants, hydro-electric power plants, and renewable energy sources (hereinafter referred to as "RES"), the electricity generating facilities based on carbon-free technology. Their share in the total installed capacity of the generation mix of SR as at 31 December 2016 according to the primary energy source is shown in the following table and graph.

Electricity Generating Facilities	Installed Capacity [MW]	Production [GWh]
Nuclear power plants	1,940	14,774
Hydro-electric power plants (including PVE - pumping storage power plants)	2,537	4,844
RES (without HPP)	895	2,515
Fossil-fuel power plants	2,476	5,319
Total	**7,848**	**27,452**

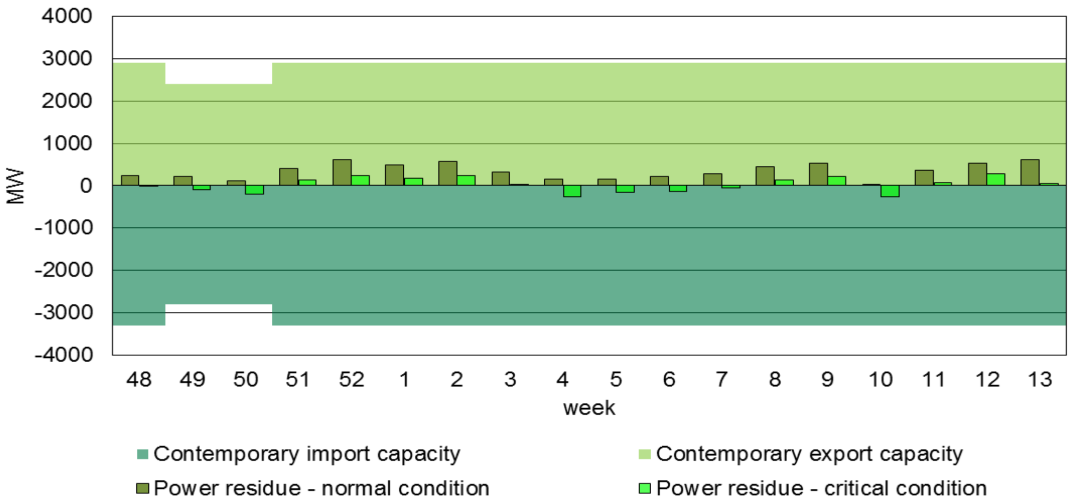
Table No. 4 Installed Capacity and Electricity Production of Electricity Generating Facilities of ES SR According to the Primary Energy Source (State as at 31.12.2016)



Graph No. 7 Percentage Share of the Installed Capacity and Produced Electricity of Electricity Generating Facilities of ES SR According to the Primary Source of Energy (State as at 31.12.2016)

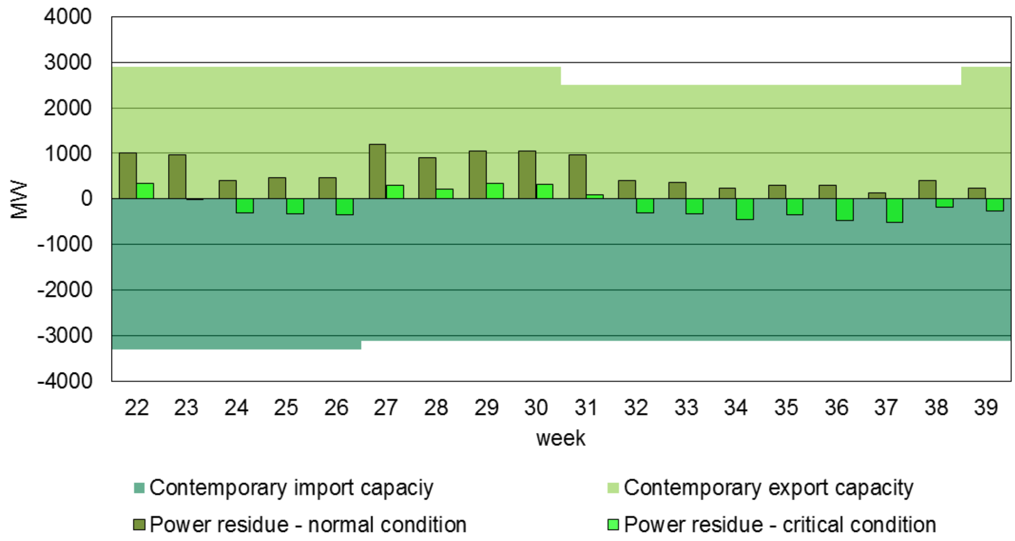
In the course of the period 2007 – 2016, ES SR had an import character. This is also demonstrated in Graph No. 10 below. After the economic crisis (2009) termination, the gradual increase of electricity production due to commissioning of new electricity generators, mainly CCGT and RES, occurred. The total electricity production in ES SR, however, failed to reach the level from the period before decommissioning of the nuclear power plant in Jaslovské Bohunice (2006 and 2008). The subsequent decrease of electricity production in the period 2013 - 2015 was caused especially by decommissioning or the failure to operate the CCGT Malženice and CCGT Bratislava electricity generating facilities due to economic reasons (fuel price, high production costs and electricity price) as well as gradual downturn of production up to decommissioning of Units 1 and 2 of the Vojany I. thermal power plant (03/2015). Due to emission limits, in 03/2016 Units 3 and 4 of the Nováky power plant were decommissioned. The mentioned Units of the Vojany I. power plant and Unit 4 of the Nováky power plant were deleted from the statistics of the total installed capacity of the electricity generating facilities in 2016.

Despite the aforementioned facts, there is adequate production capacity to cover load in SR under the standard climate conditions. In case of adverse climate conditions, the import capacity of TS SR is adequate to cover the peak loads in ES SR. However in terms of loads at the cross-border lines and due to unplanned transit flows, the situations threatening the safe system operation occurs (failure to meet the N-1 criterion) which are addressed by the operator of TS SR in cooperation with the neighbouring TS operators by means of remedial measures. Moreover, it is confirmed by the evaluation of the generator appropriateness according to the ENTSO-E methodology by means of so called Seasonal Outlooks published on the ENTSO-E website[4].



Graph No. 8 Evaluation of Generation Adequacy in ES SR in Winter Period 2016/2017

4 https://www.entsoe.eu/outlooks/seasonal/
Evaluation of adequacy of the production capacity to cover deterministically defined situations of the assumed weekly maximum/minimum loading of the system in winter and summer period in the normal and critical climate conditions.

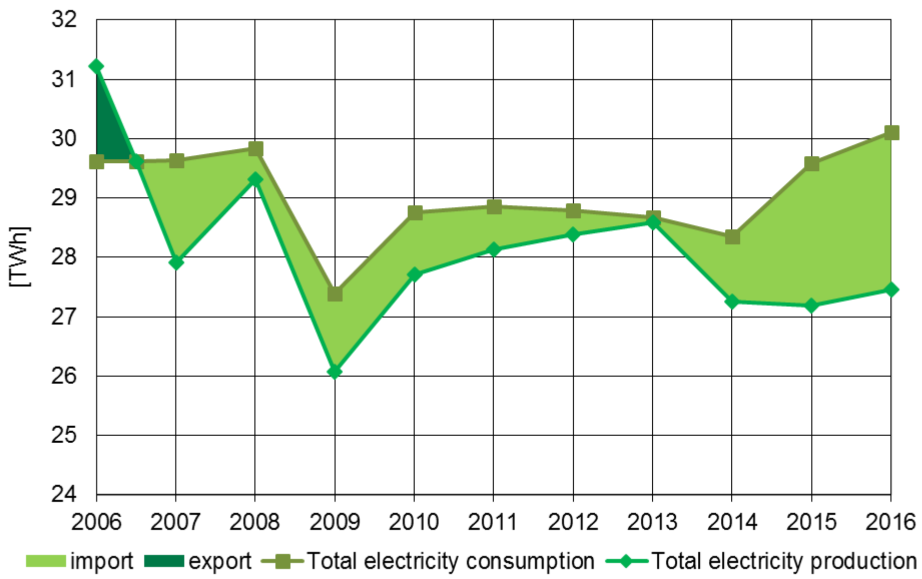


Graph No. 9 Evaluation of Generation Adequacy in ES SR in Summer Period 2017

2.3 Current Situation of Electricity Consumption and Electricity Load in the Slovak Electricity System

The total electricity consumption in the Slovak Republic on the level of 30,103 GWh in 2016 proves increase by 1.9 % against the previous year 2015. It is mainly due to increased economic growth of the Slovak Republic and EU. Despite little increase of the electricity production volume in ES SR, whether due to temporary and unexpected test operation of Unit 3 in the Nováky power plant or higher use of production in hydro-electric power plants and RES, the import balance of ES SR increased to 2,651 GWh in 2016 what forms 8.8 % of the total electricity consumption in the Slovak Republic. The deficit was covered by electricity imported from abroad within the cross-border trading in electricity.

Use of the installed capacity of electricity generating facilities in the Slovak Republic is adequate to cover electricity consumption, however, the operation of some types of technologies is unprofitable regarding the adverse development of proportion of their operating costs and market electricity prices. Electricity traders profit more from purchasing electricity from abroad and its import to the Slovak Republic than from electricity producers in the Slovak Republic.



Graph No. 10 Development of Total Electricity Production and Consumption in the Slovak Republic in the Period 2007 - 2016

2.4 Current Situation of Electricity Transmission on Cross-Border Lines of the Slovak Transmission System

SEPS has ten joint cross-border transmission lines with the neighbouring transmission system operators, but for Austria (hereinafter referred to as “AT”). The following picture shows cumulative annual commercial flows among the Slovak Republic and the neighbouring countries and actual cumulative physical cross-border electricity transmission flows. The dominating direction of power flows through ES SR is usually from north or north-west to south and south-east direction where the exporting countries are mostly the countries with the surplus production balance mostly in the north-west and north of the Slovak Republic. The importing countries are HU and UA or importing Baltic countries south of the Slovak Republic. The flows in the region are influenced by location of the pumped storage hydro-electric plants in Austria and Switzerland which allow storage of electricity overproduction in the north of Europe.

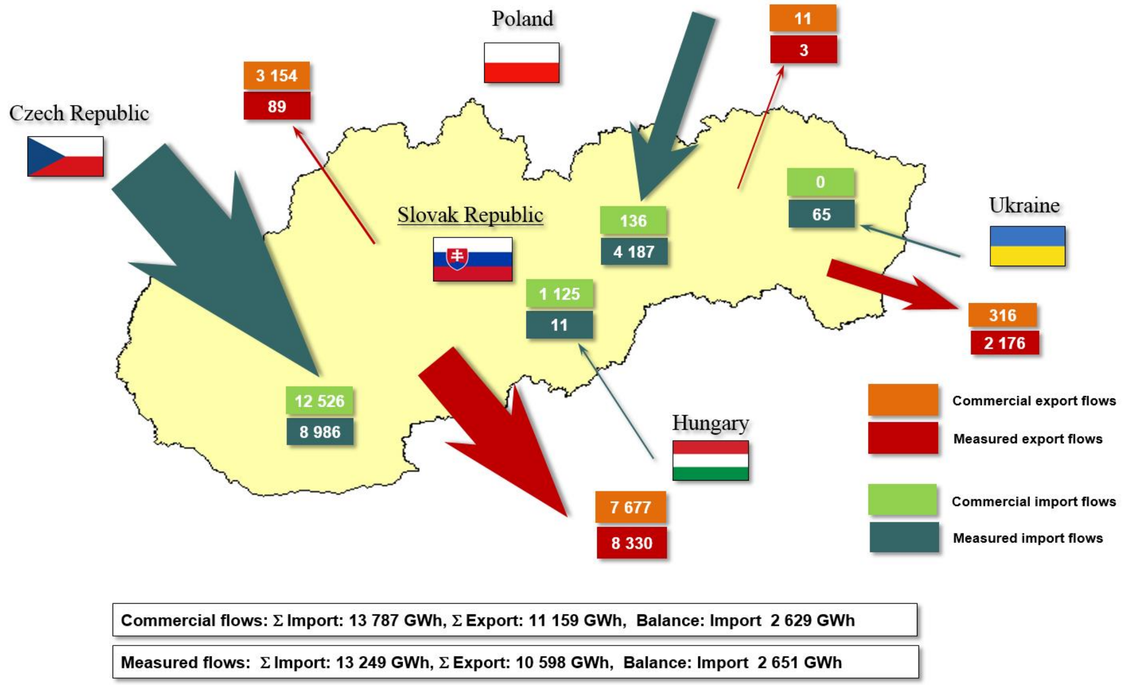


Figure No. 2 Commercial and Physical Cross-Border Electricity Transmission Flows of ES SR in 2016

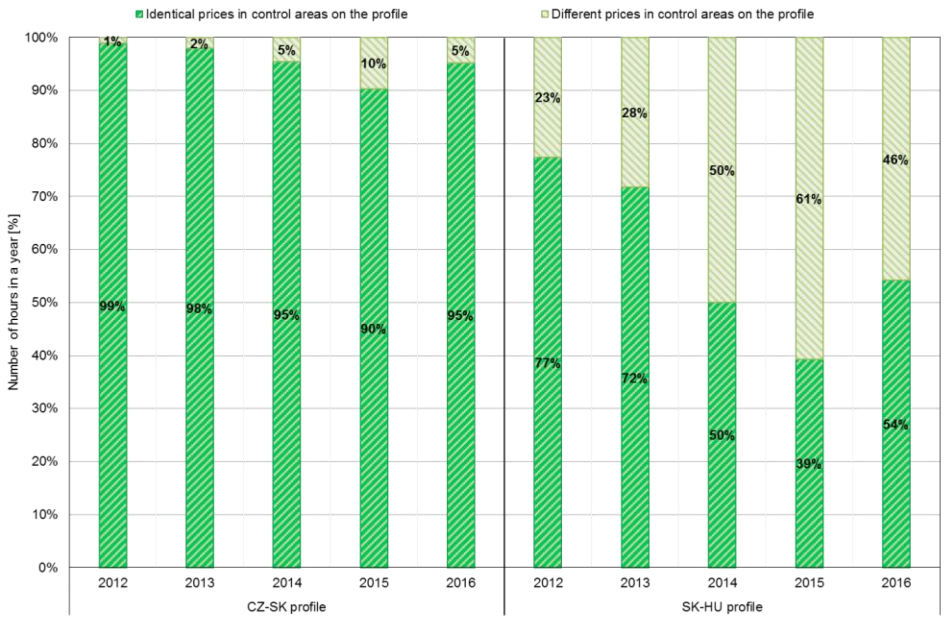
Market flows of electricity usually differ from physical transmission flows due to densely interconnected transmission systems in the CCE region and method of allocation of business capacities which does not respect impedances of internal transmission systems of individual control areas. Market flows are commercially agreed electricity transmission flows among individual market zones or countries within the interconnected ENTSO-E system. These commercially agreed electricity transmission flows shall be reflected in the real operation in the form of physical flows of electricity on individual cross-border transmission profiles. In some hours, physical flows exceed the planned market exchanges even by more than 100 % what results in the failure to meet the N-1 basic safety criterion.

As it was mentioned before, compared to the previous years, the import of electricity to the Slovak Republic increased. It is, however, still applicable, similarly as in the previous editions of TYNDP that this reality is related to economy of electricity generator operation in ES SR and European electricity systems, i.e. to the development of ratio of the electricity wholesale price and the price of primary generators for its production or amount of operating costs on the side of the generators for electricity production.

Graph No. 12 evaluates functioning of 4M MC among CZ-SK-HU-RO for the period 2012 - 2016 with focus on the SK-CZ and SK-HU cross-border profiles. The graph evaluates annual percentage share of business hours with the identical and different prices on those two mentioned profiles. Different prices between two control areas with the joint cross-border profile indicate insufficient business transmission capacity on the respective profile. The percentage share of business hours with different prices from the total amount of business hours in a year on both SK profiles which form a part of 4M

MC was growing annually in the period 2012 - 2015. In 2016, this share, however, was decreased and it returned approximately to the level of the year 2014. Development of adequacy or inadequacy of tradeable capacities on the Slovak cross-border profiled in 4M MC is directly related to the development of cross-border exchanges in electricity and development of transit flows through TS SR in the CCE region thus all possible reasons of such development are explained in Chapter 3.4. The absolute values of the percentage ratio of hours with the identical and different prices on the CZ-SK and SK-HU cross-border profiles prove exposure of especially the SK-HU cross-border profile where from 2012 to 2015 increase of different prices from 23 % to 61 % occurred but in 2016 the decrease to 46 % was recorded. This, however, still indicates high demand for tradeable capacity and narrow cross-border profile in the Central-East region of the EU. Also due to this reason SEPS plans strengthening of the SK-HU profile with new 400 kV cross-border lines.

Note: *in 2012, there are only 2,665 business hours considered as 100 % of the annual time fund because the Market Coupling with Hungary was commissioned on 12 September 2012. On the SK-CZ profile,a there are only 2,665 business hours in the year to maintain identical time windows and comparable values.*
In recent years, there are 8,760 business hours considered as 100 % of the annual time fund or total of 8,784 hours in the leap years 2012 and 2016.



Graph No. 11 Comparison of the Monitored Indicators of Functionality of the Interconnected Market in Electricity on SK Cross-Border Profiles which are a Part of 4M MC in the Period 2012 - 2016

The methodology of so called flow-based calculation of cross-border transmission capacities allocation is being developed in the “Core CCR Project” working group within ENTSO-E which associates 16 TSOs. Completion of its development is expected at the end of year 2018 and the process of its launch into real operation is expected approximately at the end of the year 2018 or in the course of the year 2019.

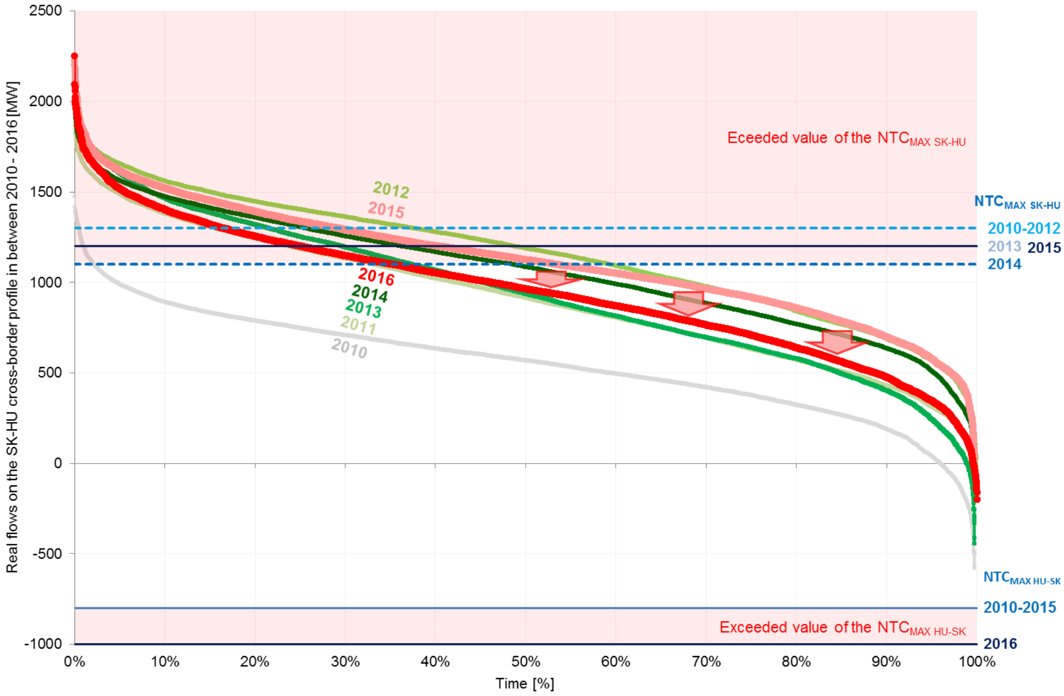
The basis of the idea for the flow-based allocation of capacities is an effort to include the actual topology of the transmission systems in the process of capacity allocation and consider actual division of physical flows of power on individual cross-border profiles what in other words means elimination of differences between the business and actual flows of power. The main consequence of those differences includes unplanned transit flows of electricity with the main reasons of their occurrence described in this chapter. These unplanned flows cause complications in the transmission system operation which in some cases threaten operational safety of the interconnected transmission systems including TS SR.

SEPS as TSO disposes of very limited options to resolve the situations with increased transit flows through TS SR. In order to provide for operational safety of ES SR even during such situations, SEPS must take complex operational measures. Currently, the only available short-term dispatcher measure for partial restriction of consequences of the unplanned transit flows, i.e. to eliminate overload of the TS SR components is TS SR reconfiguration. It is an operative change of topology of TS SR which results not only in reduction of load of the selected highly-loaded components of ES SR and reduction of transit flows through ES SR but also in reduction of the operational flexibility of the system, increase of losses in the system, risk of failure due to manipulations concerning the change of TS SR connection and some other operational restrictions. Thus from the point of view of SEPS it is an operative measure used only in the extraordinary (serious) operational situations.

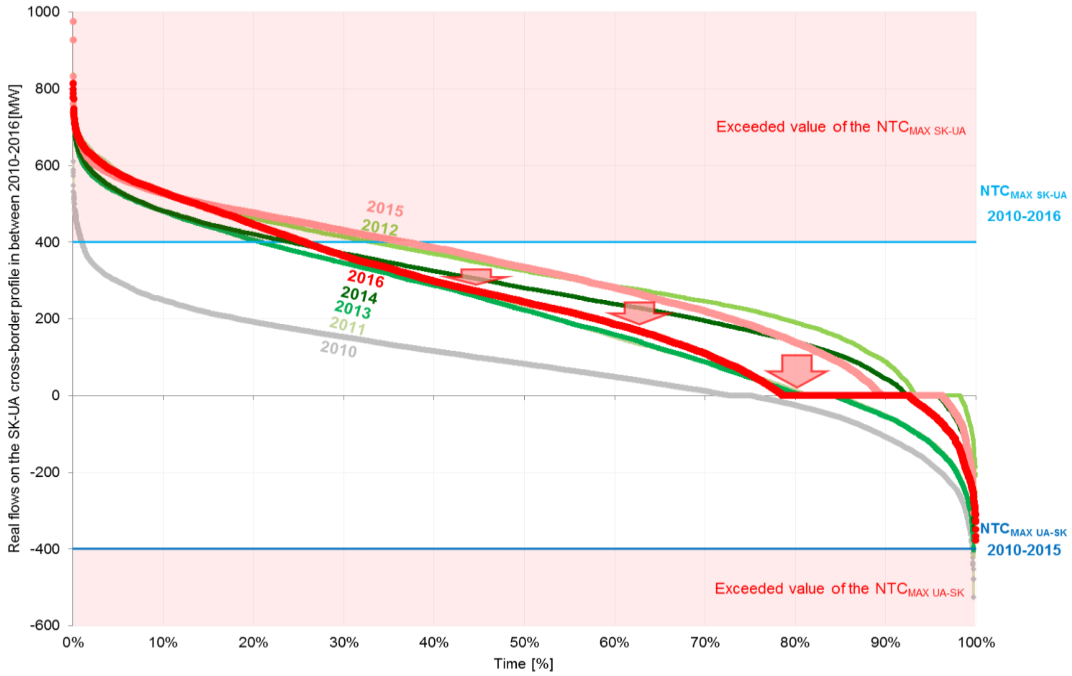
Most frequently such conditions in TS SR exist on the SK–HU and SK–UA cross-border profiles. Use of the SK-HU and SK-UA cross-border profiles in the period 2010 - 2016, i.e. comparison of physical power flows compared to maximum values of the tradeable capacities for particular years in the hourly resolution are shown in Graphs No. 12 and 13. Moreover, the graphs show overreaching the maximum value of the tradeable or net transmission capacity (hereinafter referred to as "NTC") (Net Transfer Capacity) of the profile in the year. The relationship between the total transmission capacity (hereinafter referred to as "TTC") (Total Transfer Capacity) of the profile and NTC of the profile is as follows:

$$\text{NTC} = \text{TTC} - \text{TRM} \quad [MW]$$

Blue lines in the Graph No. 12 indicate changes of maximum NTC (hereinafter referred to as "NTC_{MAX}") on the SK-HU profile due to inevitable change of the maximum safety margin (hereinafter referred to as "TRM", Transmission Reliability Margin). The result of the TRM increase in 2013 on the SK–HU profile was decrease of physical flows to the level of the 2011 values. In 2014, compared to the year 2013, even despite further increase of TRM (reduction of NTC_{MAX}), the volume of physical flows of electricity on the SK-HU profile increased, what is directly related to configuration of the market zones on the market in electricity and balances of control areas in the Central European Region. In 2015, the volume of physical flows on the SK-HU profile increased to the level of the 2012 values what could have been caused by reduction of the TRM value (increase of NTC_{MAX}) by SEPS in 2015. Then, in 2016, decrease of cross-border exchanges in electricity on the SK-HU profile occurred what was caused by reduction of volume of the transit flows through TS SR the reasons of which will be analysed further in this chapter.

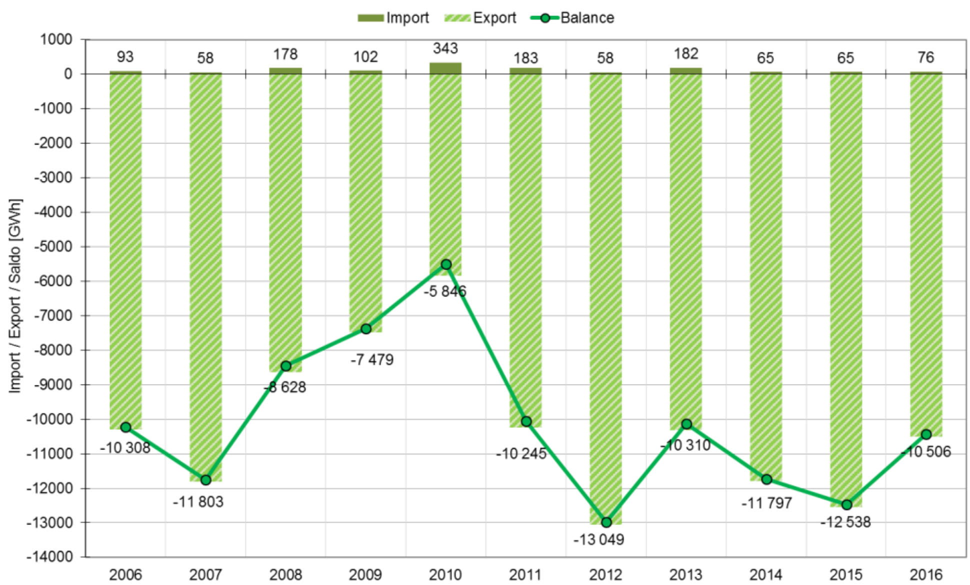


Graph No. 12 Aligned Hourly Physical Flows on the SK-HU Profile Compared to Maximum Commercial Values of NTC_{max} in the Period 2010 - 2016

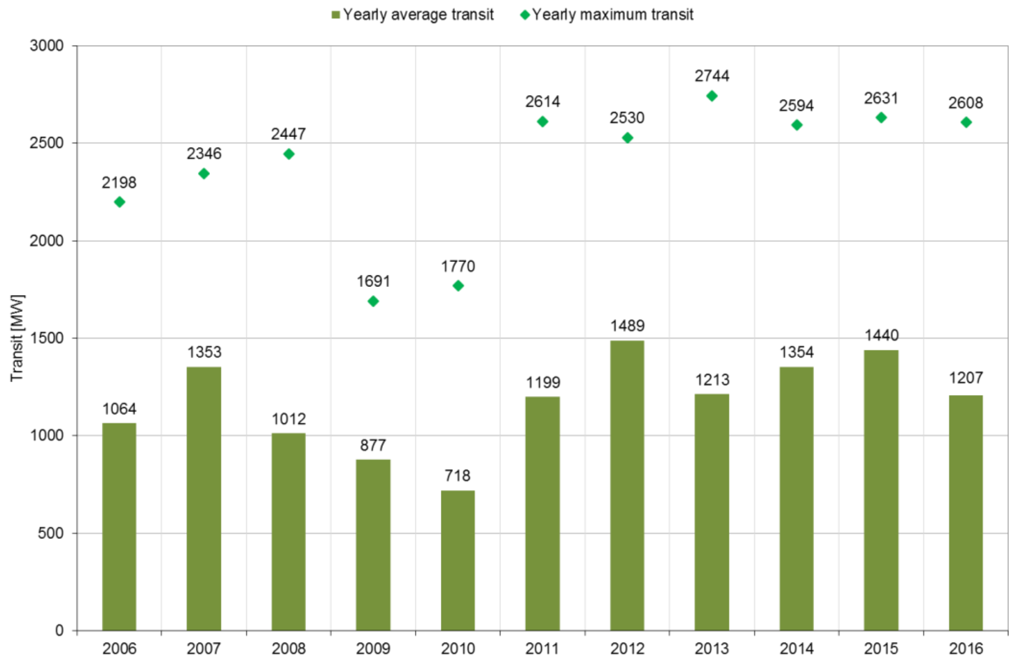


Graph No. 13 Aligned Hourly Physical Flows on the SK-UA Profile Compared to Maximum Commercial Values of NTC_{max} in the Period 2010 – 2016

Chart No. 13 shows evident decrease of physical flows on the SK-UA profile in the year 2013 to the 2011 values what resulted from the increase of TRM, and thus decrease of NTC_{MAX} on the SK-HU profile. This is a result of strong interrelation of the SK–HU and SK–UA profiles since the Ukrainian transmission system is strongly interconnected with the Hungarian transmission system. As in case of the SK-HU profile, similarly on the SK-UA profile in 2014, compared to the year 2013, the volume of physical flows of electricity increased due to the same reasons as with the SK-HU profile. In 2015, the volume of physical flows on the SK-UA profile increased to the level of the 2012 values what was caused by reduction of the TRM, and thus increase of the NTC_{MAX} value on the SK-HU profile in 2015. In 2016, decrease of cross-border exchanges on the SK-UA profile copied the development of the cross-border exchanges on the SK-HU profile. The SEPS development documents thus often evaluate both profiles together as SK-HU and UA (hereinafter referred to as “SK-(HU+UA)”), what is documented in Graph No. 14.



Graph No. 14 Total Annual Transmitted Electricity on the Joint SK–(HU+UA) Profile in the Period 2006 - 2016



Graph No. 15 Average and Maximum Annual Values of Electricity Transits through ES SR in the Period 2006 – 2016

Graph No. 15 shows the development of the maximum and average values of transit flows through TS SR evaluated in the period 2006 - 2016 in the SEPS conditions. Average values of transit flows through TS SR proved increasing trend in the period 2013 - 2015. In 2016, on the contrary, decrease was recorded what for TSO did not mean directly proportional reduction of the number of complex operating situations in the year which they must cope with in the real operation since the maximum values of transit flows have not changed significantly since 2011.

In 2016, TS SR was loaded by real transit flows of electricity, most of the time in a year in the direction north or north-west to south or south-east what is graphically documented by Fig. No. 3. The consequences of transit flows which SEPS must face include the increased demands to ensure safe and reliable operation of TS SR and increased losses on the transmission facilities in TS SR.

The reason for occurrence of transit flows through TS SR is:

- electricity production from RES with high total installed capacity in south-west Europe,
- import of electricity of the countries in the south-east part of Europe – electricity transmission for big distances,
- configuration of market zones on the market in electricity within Europe,
- high export of electricity from the countries neighbouring on the Slovak Republic,
- topology of individual transmission systems of Europe.

As already stated at the chapter beginning, the TS SR operator has limited options in terms of remedial measures to restrict transit flows. In order to provide for operational safety and reliability of ES SR at increased transit flows and their impacts on ES SR, reconfiguration of TS SR or reduction of the NTC value used especially at maintenance of cross-border lines, adjustment of TRM values in order to ensure return of the system to the safe and reliable operation is one of the extreme and very risky dispatcher measures. Advantages and disadvantages of these measures are described above. Disregarding the aforementioned facts, SEPS works on long-term conceptual solutions and measures via investment projects which consist in strengthening the internal and cross-border transmission infrastructure of the Slovak Republic.

In 2016, the amount of physical transit flows through TS SR achieved 10,598 GWh what means decrease compared to y. 2015 by 16 %. Compared to the maximum value of 13,080 GWh in 2012, it is the decrease of 19 %. The increasing trend of transit flows in some TS in the CCE region in the period 2012 - 2015 resulted in applications of the remedial measures with the TS operators facing the biggest problems concerning ensuring safe TS operation with constantly increasing transit flows.

The fall in 2016 could have been caused by:

- commissioning PST (phase shifting transformer) transformers on the Polish-German profile on the 2x400 kV Mikulowa – Hagenwerder line in December 2015
- switching off the cross-border 2x220 kV Krajnik – Vierraden line (from June 2016) due to upgrade of the 220 kV system in the given area to 400 kV to be able to commission PST transformers on the Polish-German profile on the 2x400 kV Krajnik – Vierraden line
- commissioning new transmission systems in TS of Germany, in particular the new 2x400 kV Altenfeld – Redwitz line – first circuit in December 2015 and second in the half of 2017

Since PST transformers on the Czech-German profile on one circuit of the 2x400 kV Hradec Východ – Röhsdorf line were commissioned in December 2016 or on the second circuit of this line the PST transformer was commissioned in the half of 2017, their impact on transit flows may be visible as early as in 2017. It must be emphasized that PST transformers will not be used for flat reduction of transit flows through some transmission systems in the CCE region but only in case of critical situations on the concerned cross-border profiles or components of the concerned internal TS.

Good conceptual development signal regarding the transit flow reduction is strengthening the internal German TS by construction of new 400 kV lines what should result in further elimination of loop transit flows which threaten the operation safety of the surrounding TS. Finally, the volumes and direction of physical flows of electricity (displayed in red colour in Fig. No. 3) should be significantly close to commercial flows of electricity (displayed in dark grey colour in Fig. No. 3).

It must be notified that summary volume of transit flows in 2016 fell but in some hours in the year there were still high values of transit flows (Fig. No. 4 and Graph No. 15) with which TSO SR had to apply reconfigurations to ensure safe and reliable operation of TS SR. In terms of numbers, instantaneous maximum flows in 2016 reached the maximum value of transit of 2,608 MW what means 116 % of the minimum load or 60 % of the maximum load of ES SR.

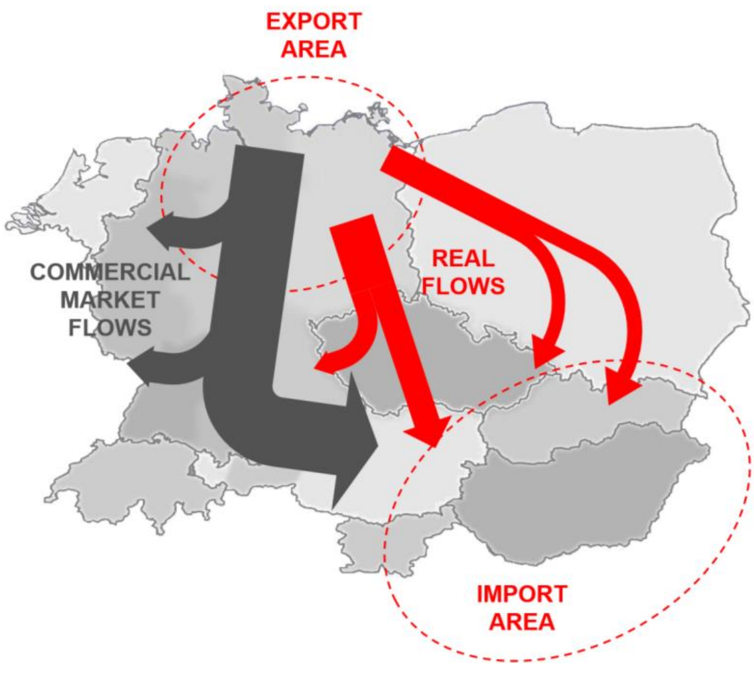


Fig. No. 3 Graphic Representation of Loop Transit Flows in the CCE Region

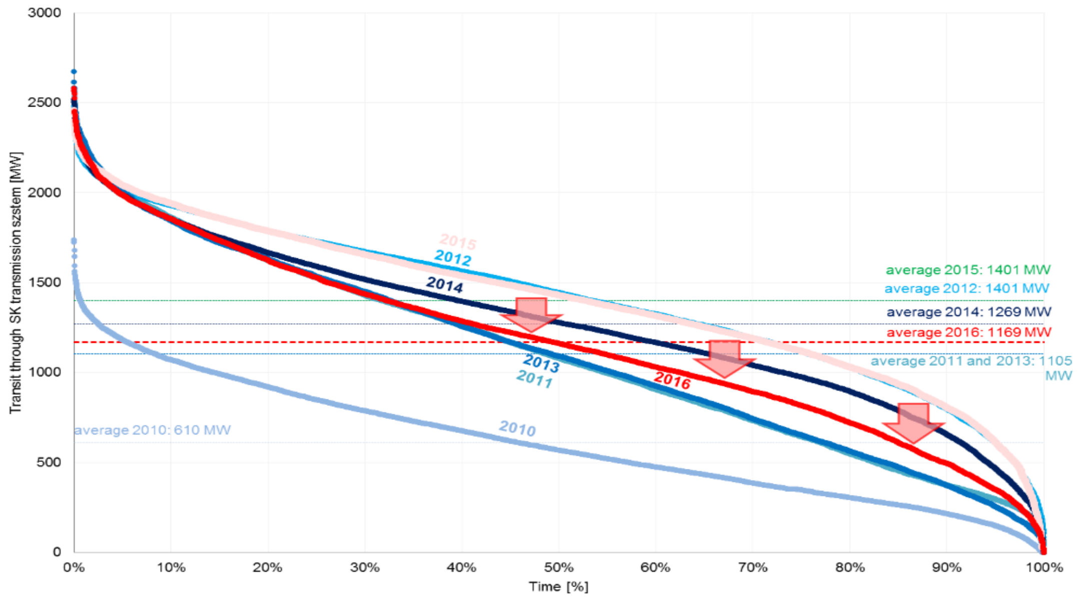


Figure No. 4 Curves of Electricity Transit Duration in TS SR in the Selected Years from 2010 to 2016

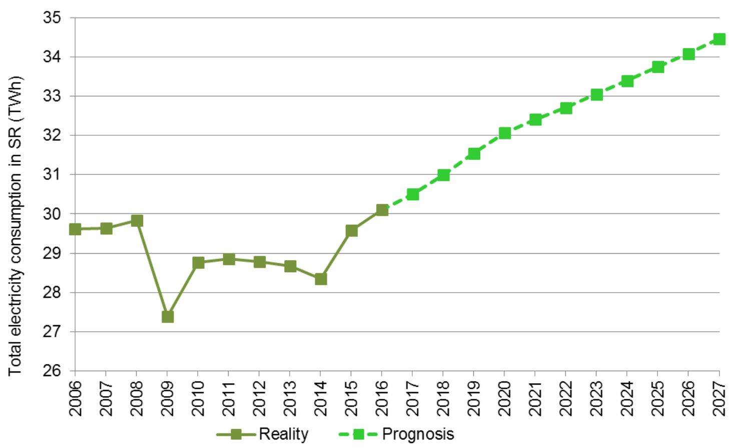
3. Assumed Future Situation of the Offer and Demand for the Transmission System Capacity

3.1 Assumptions for Electricity Consumption in ES SR

In 2016, the total electricity consumption in the Slovak Republic achieved the historic high. Regarding this fact as well as on the basis of the current increase of electricity consumption in 2017 and regarding the expected growth of investments in the industry in the Slovak Republic in the coming five years, the prognosis of electricity consumption in the Slovak Republic compared to the previous processing of TYNDP was updated.

In the period by 2027, an average inter-annual increase in the electricity consumption in the Slovak Republic on the level of 1.24 % is assumed.

Based on this assumption, the electricity consumption by 2027 would increase in the monitored period by 4.36 TWh what means 14.49 % growth compared to the year 2016. Based on the continuous monitored and evaluated statistical data by the date of processing of this TYNDP, in 2017 the increase of the total electricity consumption in the Slovak Republic by approximately 1.3 % compared to the previous year is assumed, i.e. the total electricity consumption in the Slovak Republic would reach the value of 30.5 TWh. In 2020, electricity consumption in the Slovak Republic is assumed on the level of 32.06 TWh and the assumption for the year 2025 is 33.75 TWh.

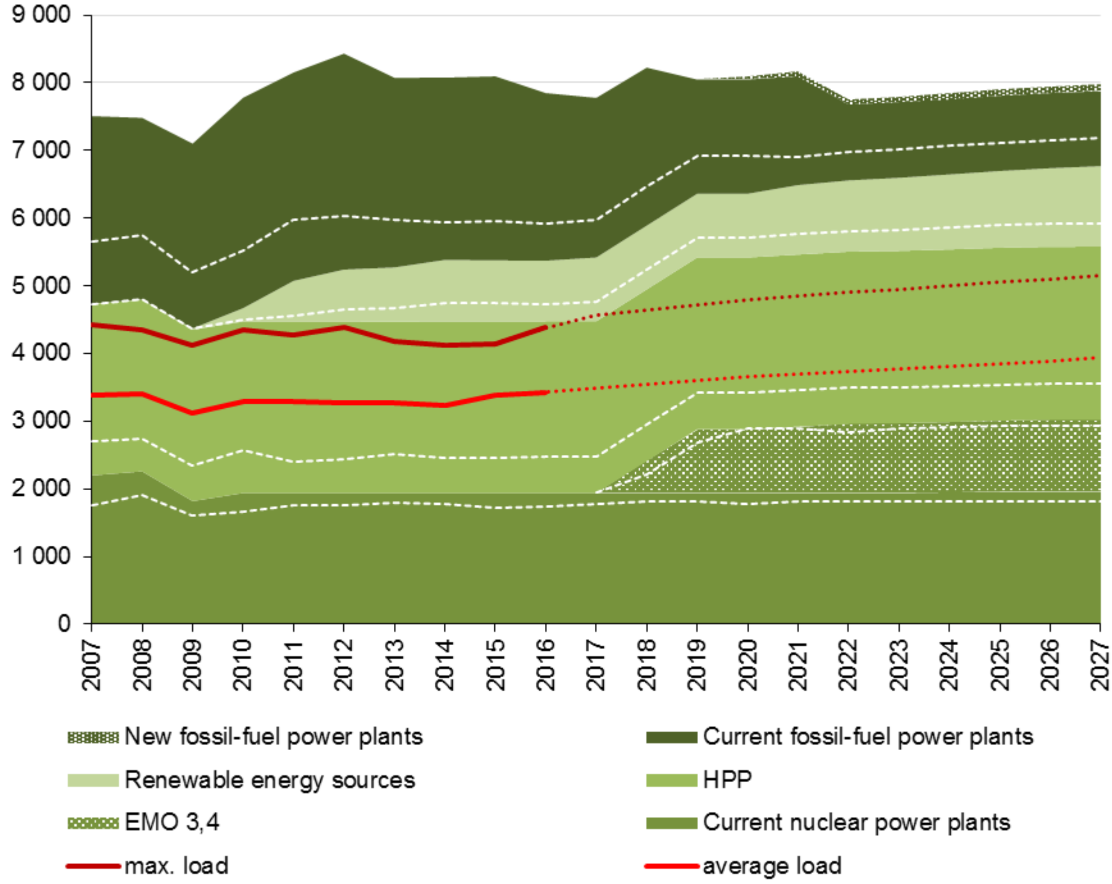


Graph No. 16 Prognosis of the Total Electricity Consumption in Slovakia

According to the draft Proposal of the Energy Policy of the Slovak Republic (2014) which assumed average inter-annual increase in the electricity consumption on the level of 1.2 %, the increase of electricity consumption in the Slovak Republic compared to the aforementioned current assumptions would be lower by 1.05 TWh in 2027.

3.2 Assumptions of Electricity Production in ES SR

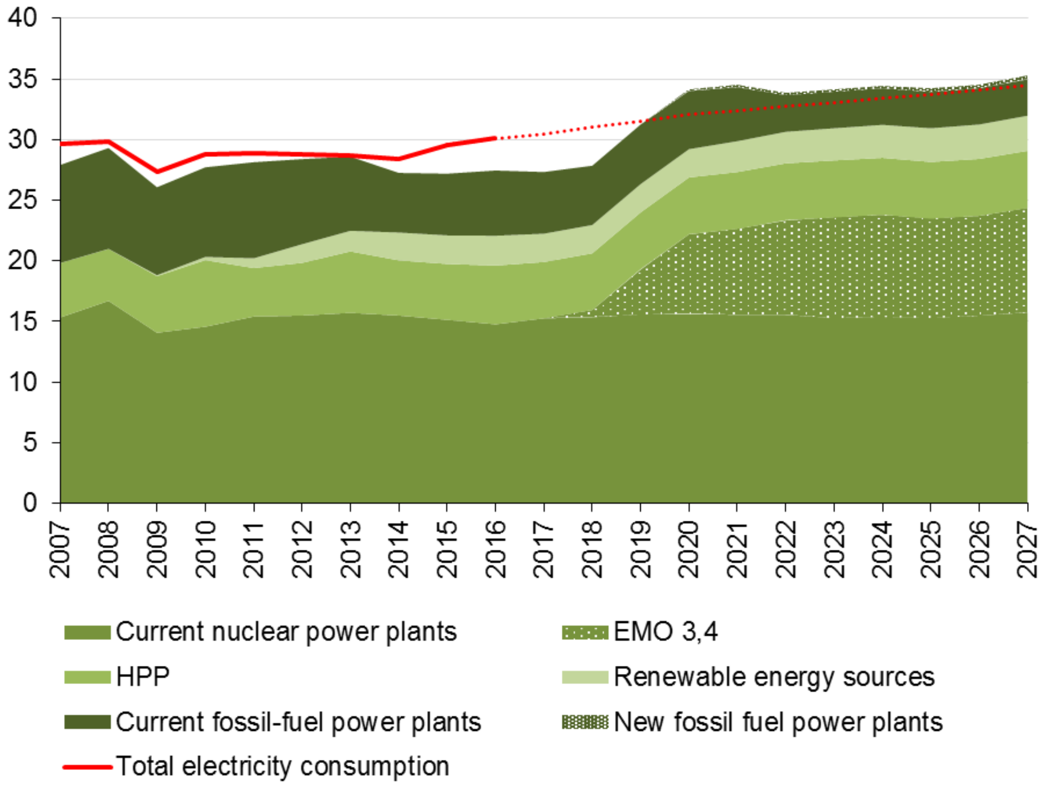
Within the monitored period of this TYNDP, even despite decommissioning of the existing production capacities due to emission limits, the increase of the installed capacity of electricity generating facilities in the Slovak Republic by more than 1,000 MW is expected, what in the electricity production will mean increase by approx. 10 TWh. It is especially the completion of Units 3 and 4 of EMO notified for long time with gradual increase of the installed capacity to 2x530 MW and assumed annual electricity production up to the level of 8.6 TWh. The remaining increase of the installed capacity and electricity production is assumed in RES and in new fossil-fuel power plants.



Graph No. 17 Assumed Development of Installed Capacity of Electricity Generating Facilities and Average and Maximum Load of the Slovak Republic by 2027 [MW]

The above-mentioned graph shows average annual use of the installed capacity of the electricity generating facilities according to the type of technology (dash-and-dot lines). While the NPP installed capacity usage achieves almost 90 %, the use of other types of technologies is relatively low. In case of HPP and RES, their use strongly depends on the current hydrological and climate conditions. The total average use of the installed capacity of electricity generating facilities in ES SR is adequate to cover average load which copies electricity consumption in the Slovak Republic shown in the following graph.

To ensure generation adequacy in ES SR the conditions have to be created to increase the share of flexible fossil-fuel generator in load coverage. Coverage of the maximum load and thus also balance in hours of the maximum load of ES SR will depend especially on use of flexible fossil-fuel generating facilities the operation of which strongly depends on economic indicators and emission limits. The operation of electricity generating facilities on the fossil generator basis is inevitable in certain volume to cover the required volumes of ancillary services via which TSO provides for system services for all ES SR users.



Graph No. 18 Assumed Electricity Production and Consumption in the Slovak Republic by 2027 [TWh]

The development of volume in electricity production from power plants in the Slovak Republic will be significantly influenced in the future by electricity generation price development on the markets in electricity, by regulatory framework and legislation of the Slovak Republic and EU which significantly influence operation economy of individual technologies for electricity production. Based on the found facts on the operation of the existing fossil fuel power plants, the lower volume of the total production is assumed in 2020 by 1.5 TWh and in 2025 by 0.9 TWh compared to the assumptions of electricity production development according to the approved Proposal of Energy Policy of the Slovak Republic and previous TYNDP.

Ensuring adequate power of the electricity generating facilities to cover electricity consumption in the Slovak Republic (generation adequacy) in individual scenarios and securing optimal generation mix in terms of ensuring reliable and safe operation of ES SR (system adequacy) is a complex task also with regard to great extent of uncertainty of invested cost return in the electricity generating facilities especially due to negative development of the ratio of market prices of primary fuels and electricity.

The following graph shows an analysis of the generation adequacy in the Slovak Republic according to the ENTSO-E [5]methodology for the assumed variants of winter and summer maximum load in the important years 2022 and 2027 for the scenarios mentioned in Chapter 4.2. After commissioning Units 3 and 4 of EMO, ES SR will include adequate power to ensure coverage of the assumed load of the Slovak Republic in each from the mentioned scenarios but for the crisis one. TS SR, however, has adequate transmission capacity to ensure electricity import/export to cover the expected load of the system (disregarding the influence of electricity transits through ES SR, loop flows etc.).

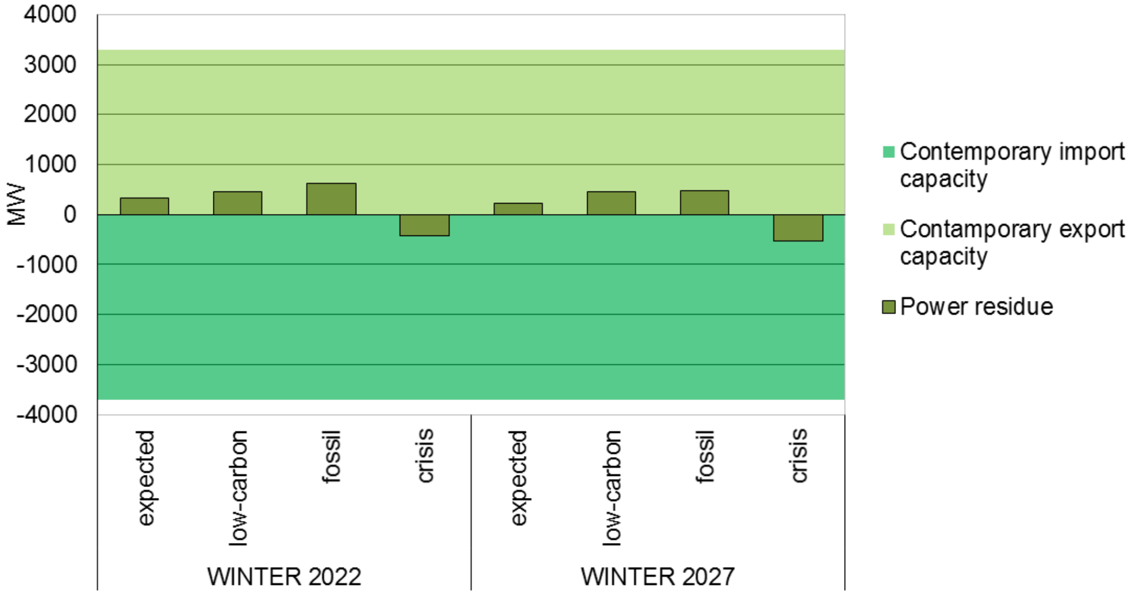
In terms of ensuring inevitable volume of the system services, in the worst[6] assumed deterministically defined operational situations in the control area of the Slovak Republic with the unchanged conditions, approx. 20 to 40 % of the required instantaneous power of regulation reserves (especially

[5] Target Methodology for adequacy assessment: https://www.entsoe.eu/Documents/SDC%20documents/SOAF/141014_Target_Methodology_for_Adequacy_Assessment_after_ Consultation.pdf

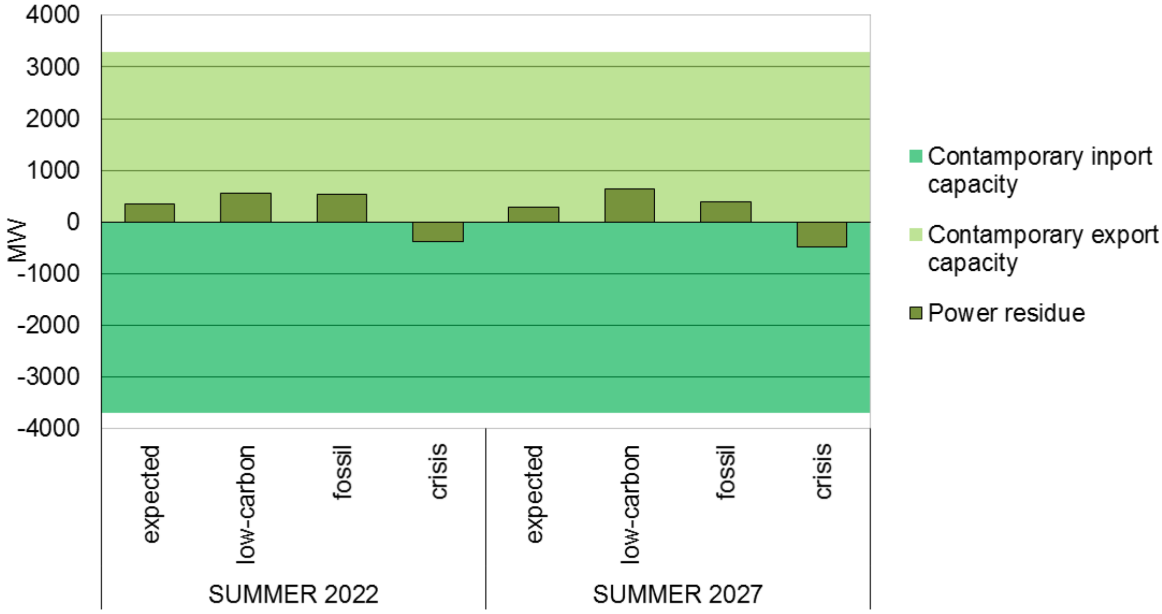
[6] In order to assess the system adequacy, the worst situations are assumed winter maximum and summer minimum of the ES SR load

SRV) can be missing in dependence on the considered generation mix in the respective scenario.

These are extreme situations of instantaneous inadequacy of the regulation power which occur at present. In the extraordinary operational situations in case of non-coverage of the requirements of individual PpS to 100 %, TSO dealt with such situation by purchase of the guaranteed or non-guaranteed regulation electricity from abroad to ensure safe operation of ES SR.



Graph No. 19 Evaluation of Generation Adequacy in ES SR in Time Horizons WINTER 2022 and 2027



Graph No. 20 Evaluation of Generation Adequacy in ES SR in Time Horizons SUMMER 2022 and 2027

Coverage of electricity consumption additions and replacement of the production capacities with the expired lifetime should be elaborated in the future in the strategic energy documents of the Slovak Republic in a way so as to achieve appropriate and balanced development of new capacities with nuclear, fossil-fuel and renewable sources for electricity production, especially with consideration of the requirements for safe and reliable operation and management of ES SR and requirements for safety of electricity supply on the territory of the Slovak Republic.

3.3 Assumptions for Electricity Exchanges with the Neighbouring Countries

Assumed cross-border electricity exchanges in the long-term horizon may be performed only under certain assumptions for electricity production and consumption development and available tradeable capacities what includes substantial uncertainty which shall be taken into consideration with such prognoses. In case of the following considerations, the allocated commercial transactions in 2016 and two possible scenarios of future development of the generation mix, electricity consumption and development of commercial capacities in interconnected TS within ENTSO-E which is documented in the ENTSO-E database for the purpose of processing the 2016 TYNDP served as a basis. In order to define assumptions of exchanges in electricity of the Slovak Republic with the surrounding countries, the “EU 2020” scenario from 2016 TYNDP was used for the year 2020 and “Vision 1” scenario from 2016 TYNDP was used for the year 2030.

The “EU 2020“ scenario stems from the national renewable energy action plans of individual EU member states or similar documents in case of the ENTSO-E members which are not EU members. The “Vision 1“ scenario is characteristic by reflecting the best possible estimate of individual TSOs associated in ENTSO-E as for development of the generation mix, transmission capacities, and estimated consumption for the year 2030.

The following picture shows the prognosis of the market cross-border exchanges in electricity among the Slovak Republic and neighbouring TS (but for AT) for the year 2027. The data were acquired by the linear interpolation of values for available real and modelled years 2020 and 2030. From the point of view of the Slovak Republic, compared to present, no substantial changes occurred in the estimated annual volumes of commercial flows for the year 2027. The increase of commercially agreed export of electricity in the direction towards UA, CZ and PL as well as decrease of commercially agreed import from CZ and PL is visible. These differences are caused by input data used in the ENTSO-E analysis for the years 2020 and 2030 which already includes development of the transmission infrastructure of the individual interconnected transmission systems, development/attenuation of the generation mix as well as various input assumptions in individual scenarios such as CO_2 emission price, price of primary fuels etc.

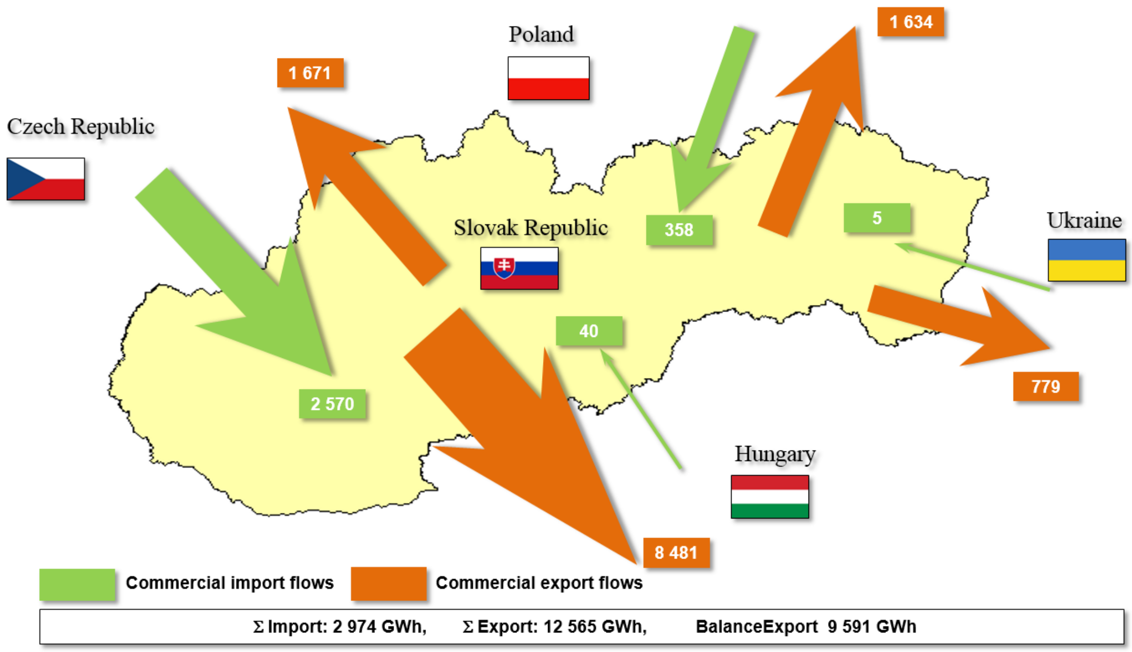


Fig. No. 5 Assumed Annual Volumes of Commercial Cross-Border Electricity Transmissions on SK Profiles for the 2027 Time Horizon from the Simulation Models of Generation Mix Operation of the ENTSO-E (Without Consideration of Transit and Loop Flows)

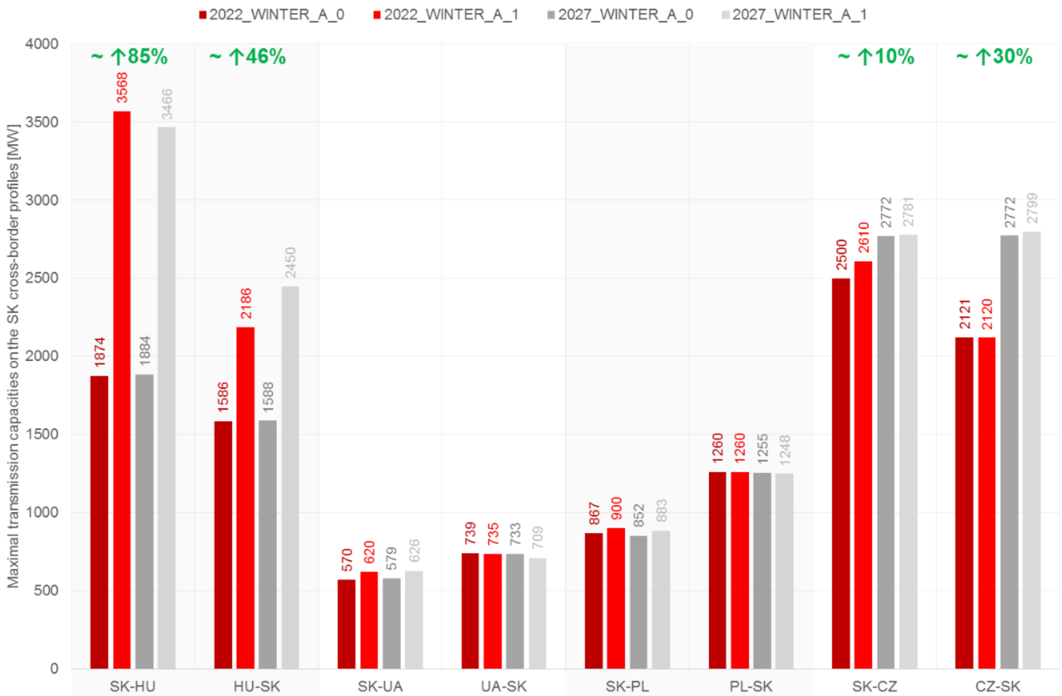
Regarding the current investment decisions by SEPS to strengthen the cross-border transmission capacities, the planned construction of new cross-border interconnections on the SK-HU profile still proves to be reasonable and already considered in the above-mentioned ENTSO-E scenarios. It can be expected that based on the above-mentioned considerations in the used scenarios and visions, the volume and direction of physical power flows on the SK-HU cross-border profile will be comparable while the change of ratio between electricity transit and export to HU can occur.

Transit flows of electricity through TS SR can be expected further mostly in the north-south direction in Europe in the approximately identical volume as at present according to the considered “EU 2020” and “2030 Vision 1” scenarios from 2016 TYNDP. In regard to production and consumption assumptions mentioned in Chapters 3.1 and 3.2, prevailingly export character of ES SR can be expected from the year 2018 with comparable volumes of electricity transits as in 2016.

It can be stated that the mentioned assumptions for volume and direction of electricity flows from ES SR confirm the proposed solutions for strengthening the TS SR transmission infrastructure towards abroad. Moreover, it is obvious that volume and direction of power flows depend on situation in development of the transmission infrastructure, generation mix as well as on political decisions not only in the Slovak Republic but also in the countries within the synchronously interconnected ENTSO-E system. The current and expected development of cross-border electricity flows is the main driver of the decisions on construction of a new cross-border transmission line what is considered also in Chapter 4.3.

3.4 Development of Cross-Border Transmission Capacities

The values of maximum transmission capacities on individual cross-border profiles of TS SR are calculated for the development time horizons 2022 and 2027 both for the import and export direction of power flows on cross-border profiles at consideration of restrictions only in TS SR, i.e. validity of the basic N-1 safety criterion is verified only on the TS SR components. These values of the maximum transmission capacities (TTS) of SK profiles depend especially on the system configuration, location of generators producing electricity, their committed capacity and permitted load of lines. On the other hand, the hourly values of the tradeable (net) transmission capacities (NTC) for the forthcoming year consider also inevitable safety reserves for the case of unexpected events and for occurrence of big differences between business and physical flows, so called loop flows. Along with consideration of the aforementioned conditions, the quantification of which is very difficult to estimate for future years, the calculated values of the tradeable transmission capacities NTC for the horizon 2022 and 2027 would be lower compared to the provided values of the maximum transmission capacities TTC.



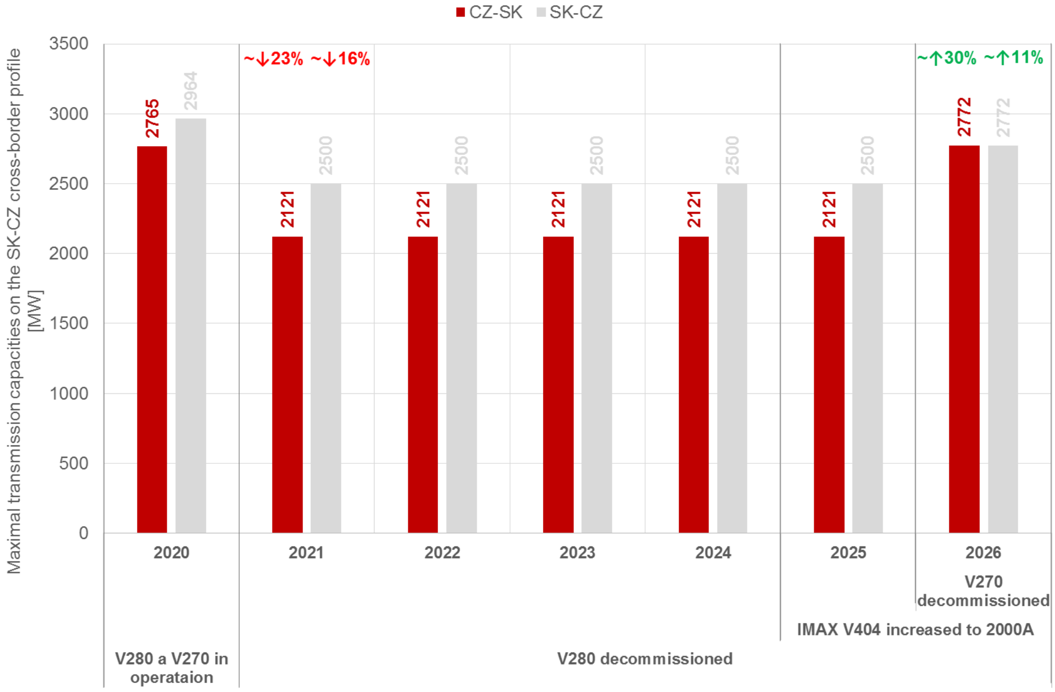
Graph No. 21 Development of Maximum Transmission Capacity on the SK Cross-Border Profiles in Time Horizons of 2022 and 2027

Based on the results of calculation of the transmission capacities of the SK cross-border profiles in the time horizons 2022 and 2027, it can be stated that construction of new cross-border lines 2x400 kV Gabčíkovo (SK) – Gönyű (HU) – Veľký Ďur (SK) and 400 kV R. Sobota (SK) – Sajóivánka (HU) will lead to significant increase of value of the maximum transmission capacity on the SK-HU cross-border profile by approx. 85 % in the export direction and by approx. 46 % in the import direction. The values of transmission capacities do not change substantially on other cross-border profiles.

Liquidation of the 220 kV system in the Central and West Slovakia regions, especially 220 kV cross-border lines on the SK-CZ profile and increase of maximum current carrying capacity of the V404 Varín – Nošovice line to 2,000 A, compared to the state with the decommissioned one 220 kV cross-border line on the SK-CZ profile V280 Senica – Sokolnice will cause increase of the maximum transmission capacity on the SK-CZ profile in the export direction by 10 % and by 30 % in the import direction. The cancellation of the 220 kV system has negligible impact on other evaluated cross-border profiles.

Within the time horizon of the year 2021, SEPS considers decommissioning of the cross-border 220 kV line V280 Senica – Sokolnice on the SK-CZ profile as a part of the process of the planned gradual liquidation of the 220 kV part of TS in the central and western Slovakia regions. Within the time horizon of the year 2027, SEPS considers decommissioning of the 220 kV cross-border line V270 Považská Bystrica - Lískovec. These topological changes may reduce maximum transmission capacity in both import and export direction on this profile approximately by 10 % from the current TTC value in both directions what was, moreover, confirmed by the results of calculations of the joint study by SEPS and ČEPS (TSO in the Czech Republic). One of the main general recommendations of this study for both companies is synchronization of the planned investment measures of both parties both in substance and timing to achieve the biggest reduction of the period with reduced value of TTC on the CZ-SK profile due to full decommissioning of the 220 kV cross-border lines. To eliminate reduction of the maximum transmission capacity on the CZ-SK profile, in 2025 the increase of the maximum permissible current carrying capacity of the V404 Nošovice – Varín line will be implemented from the current 1,740 A to approximately 2,000 A on the ČEPS side by complex reconstruction of the line in the course of the year 2018 and on the SEPS side in the period of the years 2024 and 2025 by building the new simple 400 kV line. Based on implementation of the above-mentioned planned investments on both sides, there will be not only compensation of the impact of decommissioning of the 220 kV cross-border lines but also a possibility of further increase of the TTC value on the CZ-SK profile. The objective of both SEPS and ČEPS for the future is still as great synchronization of the planned investment measures of both parties both in substance and timing as possible to achieve the biggest reduction of the period with the reduced value of TTC on the CZ-SK profile due to full decommissioning of the 220 kV cross-border lines.

Graph No. 22 shows the development of the transmitted capacities on the SK-CZ profile by individual years while considering gradual consecutive steps of decommissioning the cross-border 220 kV lines including the planned investment event concerning strengthening the V404 Varín – Nošovice line. Graph No. 22 clearly shows that in 2025 no increase of the transmission capacity on the SK-CZ profile will occur even after increase of the maximum current carrying capacity of the cross-border V404 line from the current 1,740 A to approximately 2,000 A. The reason is the fact that the 220 kV cross-border V270 Považská Bystrica - Lískovec line during failure of V404 is a limiting component at calculation of TTC in the direction from CZ to SK. Only at the moment of decommissioning of the V270 line, TTC will grow by approximately 30 % in the CZ-SK direction since the limiting component will not be V270 but the strengthened V404 line. In the SK-CZ direction, TTC will grow by approximately 11 %.



Graph No. 22 Development of Transmission Capacities on the SK-CZ Profile by Individual Years While Considering Gradual Consecutive Steps of Decommissioning the Cross-Border 220 kV Lines Including the Planned Investment Action Concerning Strengthening the Existing V404 Varín (SK) – Nošovice (CZ) Line

The described topological changes in 220 kV TS SR prove negligible influence on the values of maximum transmission capacities of other cross-border profiles and no significant change of values of maximum transmission capacities within the time horizon of the year 2027 is expected both in the export and in import direction on those cross-border SK profiles.

All considerations and assumptions on development of maximum transmission capacities of individual cross-border profiles of TS SR within the time horizons of the years 2022 and 2027 are based on the analyses and assumptions of SEPS and ENTSO-E. The provided values of maximum transmission capacities of the analysed development time horizons of the years 2022 and 2027 shall thus be understood as informative and non-binding annual values which are applicable exclusively to the analysed variants of the TS SR development. The values of net tradeable transmission capacities for the forthcoming period are or will be specified by the SEPS electric power dispatching.

3.5 Network Development Plan for the Entire EU and Regional Investment Plans

As already indicated in this document, TS SR is a part of the synchronously working European transmission system of ENTSO-E. Within ENTSO-E, a ten-year network development plan describing possibilities and possible direction of development of the entire transnational transmission system of ENTSO-E for the coming ten years is being elaborated every two years. In December 2016, third, most recent 2016 TYNDP was published. In general, TYNDP is a non-binding document focusing on ensuring bigger transparency regarding investments in the infrastructure in the entire European interconnected transmission system as well as support in the decision-making processes on the national, regional, and European level.

According to the Regulation of the European Parliament and of the Council No. 347/2013 on Guidelines for the Trans-European Energy Infrastructure, TYNDP performs a double role. In addition to the aforementioned, it is a fact that a list of the transmission infrastructure investment projects within ENTSO-E having a character of projects of European interest attributed to them within TYNDP shall form the basis for selection of the priority European projects referred to as “Projects of Common Interest” (hereinafter referred to as “PCI”).

A list of the SEPS investment projects of the pan-European significance in the TYNDP 2016 document is as follows:

- 2x400 kV Gabčíkovo (SK) – Gönyű (HU) – Veľký Ďur (SK) line,
- 2x400 kV Rimavská Sobota (SK) – Sajóivánka (HU) line,
- 2x400 kV Veľké Kapušany (SK) – area of Kisvárda (HU) line.

Based on the aforementioned, the Union-wide lists of PCI projects are being adopted by the delegated EC regulations. The Union-wide list of PCI projects always stems from the last valid TYNDP in the year following the year in which the list of projects of pan-European interest in the TYNDP document was published. The current 2nd Union-Wide List of PCI Projects from y. 2015 is based on 2014 TYNDP and it includes the PCI projects included in it with SEPS as their promoter or co-promoter.

- 2x400 kV Gabčíkovo (SK) – Gönyű (HU) line,
- 2x400 kV Rimavská Sobota (SK) – Sajóivánka (HU) line,
- 2x400 kV Veľké Kapušany (SK) – area of Kisvárda (HU) line[7].

The assumed approval date of 3rd List of PCI Projects stemming from the recent valid 2016 TYNDP is till the end of the year 2017.

The PCI status is to help the concerned projects and their promoters especially in acquiring the required permissions for the project implementation and to ensure that the national regulator weighs these projects adequately upon forming a regulatory framework regarding the all-European character of the PCI projects. The PCI status can also be used to acquire financial support dedicated to the area of energy infrastructure for the trans-European energy projects for the period 2014 – 2020 from so called Connecting Europe Facility framework established by the Regulation of the European Parliament and of the Council (EU) No. 1316/2013. It is, however, necessary to meet the strict criteria for this purpose, while the financial support amount need not be motivating for the system operators and project promoters.

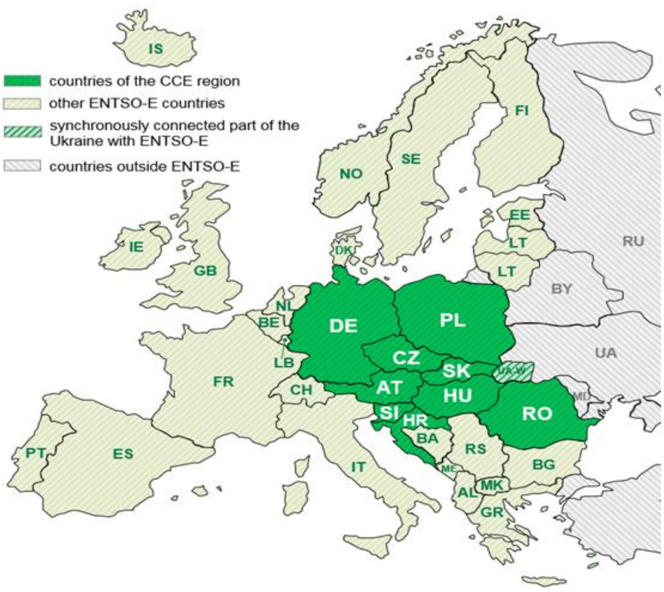


Fig. No. 6 Map of the CCE Region and Other European ENTSO-E Countries

As already mentioned in this TYNDP, there is also RgIP[8] being elaborated within the CCE region together with the TYNDP report. It identifies the Projects of Regional and National Significance which are not or will not be a part of the TYNDP document since they fail to meet the status of projects of the European interest and finally they do not correspond to the PCI interest, however, they still play an important role at planning transmission infrastructure development in the region in order to ensure safe operation of the connected transmission systems. In RgIP CCE 2015, SEPS has the following investment projects:

- Set of constructions Voľa[9],
- Reconstruction of ESt Bystričany to 400 kV,
- 2x400 kV Križovany – Horná Ždaňa line (including looping of one circuit to new R400 kV Bystričany),
- Doubling of the 400 kV Lemešany – Veľké Kapušany line including extension of the 400 kV Lemešany and Veľké Kapušany[10] switchyards,
- 2x400 kV Gabčíkovo – Veľký Ďur line incl. extension of the 400 kV Veľký Ďur switchyard.

[7] This document does not include any other information about the project, as it is planned after it has been published.

[8] Regional Investment Plan 2015-RG CCE-Final.pdf

[9] The construction was implemented and commissioned

[10] The construction was implemented and commissioned

4. National Ten-Year Network Development Plan for the Period 2018 – 2027

Many from the investment projects of the SEPS ten-year investment plan by the year 2027 are verified by the SEPS network calculations for the considered scenarios and variants of the electricity system development for the time horizon of the year 2027. Verification is carried out by means of mathematical models of ES SR or ENTSO-E, in relation to various options of generation mix development while considering the same assumed development of electricity consumption in the Slovak Republic in all considered scenarios. The remaining investment projects are included in the ten-year investment plan due to expiry of the projected lifetime of facilities, unfavourable results of diagnostic tests, changes of the respective legislation, and technical standards due to fast technological progress etc..

4.1 Transmission System Development and Requirements of the Slovak Transmission System Users

The TS SR development and the related need of planning individual investment measures reflect the requirements of both existing and potential new TS SR users. The requirements of new Users of the distribution system operator type, direct electricity consumer type from the transmission system or electricity producer type connected to the transmission system leading to the need of the TS SR topology strengthening are usually submitted to SEPS “directly” via an application for connection to the transmission system or via the request for the SEPS opinion on issuance of the certificate for construction of energy facility pursuant to Act No. 251/2012 Coll. (hereinafter referred to as “Requests for TSO Opinion”). These requirements are assessed comprehensively in the next elaborated SEPS Development Programme and they are always verified by an independent study of influence.

The need to extend TS SR, however, may also stem from the conclusions of the SEPS Development Programme since pursuant to Act No. 251/2012 Coll. and the Technical Condition for Access and Connection, Transmission System Operation Rules (Document N, Chapter N1) all TS SR users shall be obliged to submit inputs to process the SEPS Development Programme. Moreover, the SEPS Development Programme considers the development of the neighbouring transmission system operators and it is in compliance with the ENTSO-E ten-year development plan.

As for the requirements of the existing distribution system operators, these have an option to ask SEPS to strengthen the transmission system in compliance with the Operation Rules of the Transmission System Operator Slovenská elektrizačná prenosová sústava, a. s. Electricity consumers and producers connected to TS SR intending to change the technical parameters of their facilities connected to TS SR due to which the adjustment of facilities in TS SR may be required will proceed according to these Operation Rules.

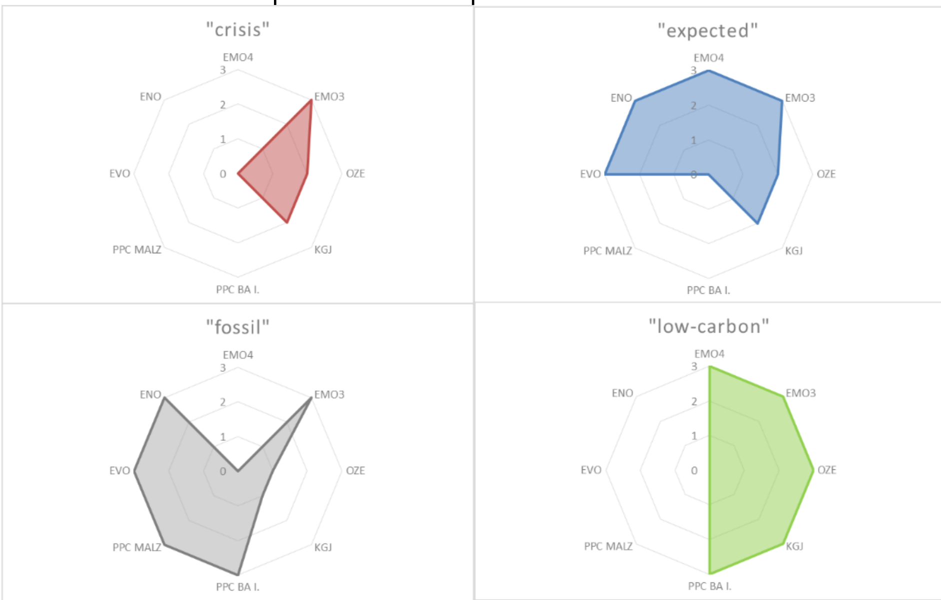
4.2 Scenarios and Variants for Investigation of the Future Development of the Slovak Transmission System

SEPS as a TSO pursuant to Art. 28, par. 2, subpar. d) of Act No. 251/2012 Coll. shall be obliged to provide for the system coordination and development. For the purpose of the TS SR development planning, all entities directly connected to TS SR are obliged to provide SEPS with inputs within the range defined by the Technical Condition for Access and Connection, Transmission System Operation Rules publicly available on the SEPS website[11]. Based on those inputs and experience in the ES SR operation and its development and based on analyses of future facts which may occur in ES SR, the probability model of ES SR operation and of the neighbouring countries simulating deployment of the considered generating facilities in the system to cover the assumed load of ES SR in an hourly resolution for the monitored period in the defined scenarios was created for the needs of recent processing of the internal document - SEPS Development Programme. Moreover, detail network models of ES SR for the time horizons of the years 2022 and 2027 and for individual variants of the possible development of ES SR are created.

Scenarios are elaborated based on the information on uncertainty of the operation, state, and lifetime of the existing electricity generating facilities and significant electricity consumers as well as assumed commissioning of new notified equipment and RES development in the interaction for regulation, legislative, and market conditions and their assumed development. They consider possible “marginal”

[11] https://www.sepsas.sk/TechPod.asp?kod=281

development of the generation mix in the Slovak Republic and impact on ensuring safe and reliable operation of ES SR in the monitored period. Altogether, there were four scenarios of the possible development of the generation mix in ES SR elaborated while the development in the area of electricity consumption is identical for all scenarios. Graph No. 23 shows varying of generators in dependence on the scenario. The corners of the polygon of diagrams representing individual scenarios mean considered assumptions and their quantification.



Graph No. 23 Graphic Representation of Scenarios and Quantification of Considered Assumptions for ES SR Development in the Years 2022 and 2027

Expected scenario considers preservation of operation of the existing Nováky and Vojany power plants with completion and commissioning of both Units 3 and 4 of the Mochovce power plant according to the current time schedule. On the contrary, no operation of CCGT Malženice which has been decommissioned for long time is considered and no operation of CCGT Bratislava I which is currently operated only for ancillary service provision is considered. Mild increase of decentralized production on the basis of gas is considered and after the year 2021 increase of RES on the level of fulfilment of the EU objectives by the year 2030 is assumed. The expected scenario considers the most probable development in the field of the generation mix from the point of TSO in the Slovak Republic.

Crisis scenario should point out the possibilities of coverage the assumed load of ES SR as well as to verify the adequacy of regulation reserves in ES SR while not considering the operation of CCGT Malženice, CCGT Bratislava I, EVO, ENO and EMO 4.

Low-carbon scenario considers increase in RES and CGU of the estimated TSO as a substitution for the current fossil fuels. The scenarios should verify adequacy of regulation reserves in the system due to RES (FVE and VTE).

Fossil scenario stems especially from the central production of electricity from fossil fuels (thermal power plants, CCGT, thermal power plants). There is a slow trend of RES development considered, thus the EU objectives in the field of climate and power engineering will not be fulfilled.

The state of TS SR and of its individual components in the assumed winter and summer maximum load of ES SR (assumed worst situations in the system) are further analysed in detail using network calculations for the expected scenario and proposed variants. Variants mean the change of connection or change of state of the selected components against the basic assumption in the scenario for the purpose of more detail quantification of impact of this change on TS SR and proposal of the operating or investment measure to prevent such conditions adverse for the system. It is especially the impact of commissioning new SK-HU lines, impact of asynchronous maximum load of TS/DS transformations (transformation adequacy) as well as impact of increased unplanned transit flows of electricity through TS SR.

Main objectives, input assumptions, and the preparation process of individual time horizons, scenarios, and variants which were subject to network analyses and analyses of generation mix operation and calculations in a two-year process of the 2016 TYNDP preparation within ENTSO-E are mentioned in the final report "2016 TYNDP Scenario Development Report"[12].

4.3 Investment Needs for the Development of the Slovak Transmission System

In case of reconstructions of the existing ones and building new substations within TS SR, the SEPS long-term objective is to use the most up-to-date devices and equipment which comply with strict requirements for safe and reliable operation of TS SR as well as requirements for sufficiently long trouble-free operation of this equipment with minimum demands for performance of revision and maintenance activities. The same applies also to construction or reconstruction of electric lines and to all secondary pieces of equipment required for TS SR operation, management, and control.

The substantial decision of TSO in terms of future development of TS SR is continuous controlled attenuation of 220 kV TS SR and building the new facilities of TS SR only on the 400 kV voltage level. Controlled attenuation of such large infrastructure is a complex, long-term, and ambitious strategic objective. The following time schedule of the 220 kV transmission system decommissioning shown in the following tables provides a basic overview of the currently operated 220 kV lines and 220 kV switchyards in individual SEPS substations.

Line designation	Assumed Year of Decommissioning
V073 and V284*	2018
V274	2021
V071, V072, V280	2022
V283	2023
V273	2024
V270, V271, V275	2025[13]

Note: ** Assumed beginning of disassembly is 4Q of the year 2018 (obtaining permission for removal of the construction in 3Q/2018)*

Table No. 5 Overview of Decommissioning of 220 kV Lines

Name of substation with respective R220 kV	Assumed Year of Decommissioning
Bystričany, Senica	2022
Križovany	2023
Lemešany	2024
Považská Bystrica[14]	2025[15]

Table No. 6 Overview of Decommissioning of 220 kV Substations

Termination of the TS 220 kV operation in a particular place will not mean that automatic direct replacement of the decommissioned 220 kV facility by the similar 400 kV facility occurs. In cases when importance of such replacement is not proved and SEPS should perform definite liquidation of such facility, the use of some 220 kV facilities on the distribution system (DS) level may be considered. This covers especially 220 kV electric lines. The controlled attenuation of 220 kV TS SR is carried out in close coordination with all concerned TS SR users and SEPS arranges regular discussions concerning this topic with the concerned entities in the joint bilateral and multilateral meetings.

SEPS assumes that immediately after the year 2025, only the V281/282 lines, R220 kV Sučany and transformers T401, 400/220 kV and T201, 220/110 kV Sučany (supplying OFZ, a. s. and SSE-D) will be in operation in ES SR on the 220 kV voltage level as the last ones. All other 220 kV lines

[12] TYNDP 2106 Scenario Development Report.pdf
[13] The exact date will depend on the final technical solution of the 400/110 kV Ladce transformation.
[14] Particular investment measure shall be added in the SEPS investment plan only after evaluation of the Study results (Chapter 4.4).
[15] The exact date will depend on the final technical solution of the 400/110 kV Ladce transformation.

including cross-border V270 and V280 lines will be decommissioned. The future of connection of direct consumers DUSLO, a. s., and OFZ, a. s. to the transmission system after decommissioning of 220 kV TS SR is subject to independent negotiations. In both cases, mutually satisfying solution for maintaining supply for these consumers from the transmission system level is subject to joint search.

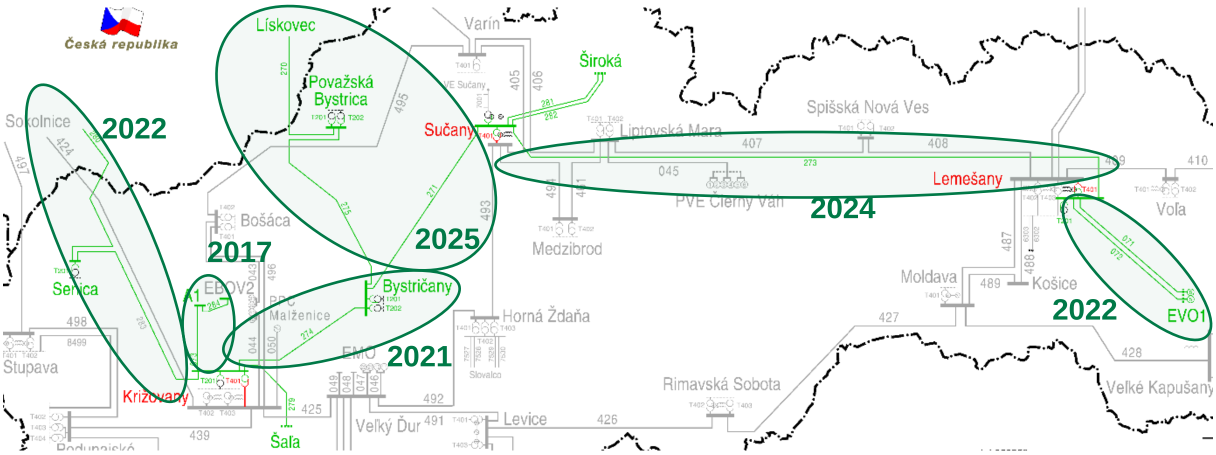


Fig. No. 7 Graphic Representation of Gradual Decommissioning of the 220 kV TS SR

SEPS will continue in reconstruction of its substations concerning distance control with operator-free operation. Transition of substations to distance control means these substations are being significantly upgraded and assimilated to new operational, safety and reliability requirements along with the requirements for high energy efficiency of the transmission. Currently, there are 14 substations under the distance control mode out of 22 substations owned by SEPS. By 2027, SEPS considers introduction of the distance control mode in the Podunajské Biskupice substation, Spišská Nová Ves substation, Sučany substation and Varín substation. In case of a substation on the 220 kV voltage level with 220/110 kV transformation – with regard to the aforementioned – no distance control mode is considered in these substations.

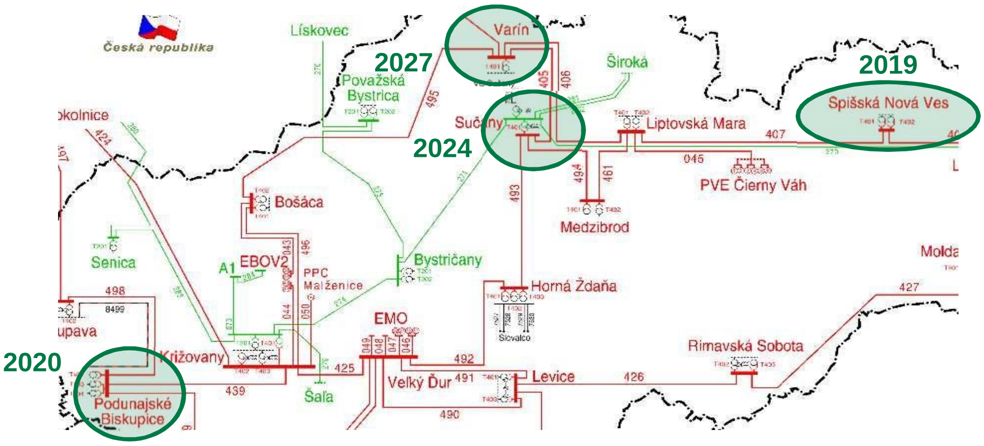


Fig. No. 8 Graphic Representation of Substations in which Distance Control Mode is planned

The controlled attenuation of 220 kV TS SR is deemed by SEPS a measure related to ensuring management of the transmission system energy efficiency. In this way, SEPS decommissions old and energy-demanding 220 kV transmission system facilities and replaces them by the up-to-date 400 kV transmission system facilities, if necessary. Moreover, further such investments also include replacement of TS/DS transformers since current modern transformers comply with much stricter criteria as for amount of losses at electricity transformation. Using a new type of ropes with higher transmission ability on the newly-built substations will increase energy efficiency of electricity transmission, however, use of the existing towers of TS lines must be verified by the static-dynamic assessment of steel structure of a particular transmission line. These conceptual measures are cost-demanding but from the long-term perspective they are beneficial for improvement of energy efficiency and reaching energy savings of electricity infrastructure of SEPS.

4.4 Internal Investment Projects

Within gradual controlled attenuation of the 220 kV TS SR, the Bystričany and Senica substations will be subject to significant changes by 2022. Regarding the physical age and the current technical condition of the 220 kV facilities, SEPS considers transition from the 220/110 kV transformation to the 400/110 kV transformation in their case, thus causing natural cancellation of the 220 kV substations. Moreover, distance control mode will be implemented in these substations. In the Považská Bystrica substation, transition from the 220/110 kV transformation to the 400/110 kV transformation is planned, currently there are study works carried out on the “Feasibility Study of the 400/110 kV Transformation in the Považská Bystrica and Ladce Substations” (hereinafter referred to as “Study”) which is aimed at proposal of the technical and layout solution of the Považská Bystrica substation transition to the 400/110 kV transformation and alternatively also in the location of the city of Ladce close to crossing with the V495 and V275 lines. This project is prepared in close coordination with SSE-D.

Implementation of the running project “Transformation of 400/110 kV Bystričany” will result in the significant shift in the area of gradual substitution of the 220 kV system in TS SR. This set of investment items is co-financed from the BIDSF supporting fund administered by the European Bank for Reconstruction and Development which is intended for elimination of consequences of V1 nuclear power plant in Jaslovské Bohunice premature decommissioning. This set of investment items includes the following structures:

1. 400 kV Bystričany switchyard,
2. 2x400 kV Horná Ždaňa – Oslany area,
3. 400 kV Horná Ždaňa switchyard – extension,
4. 2x400 kV Bystričany - Križovany line,
5. 400 kV Križovany switchyard – extension,
6. 400/110 kV Bystričany transformation – T401 and T402 transformers.

One circuit of the prepared 2x400 kV line Bystričany – Križovany shall be temporarily operated as the 220 kV line Bystričany – Križovany while for this new line the corridor of the original 220 kV line V274 Križovany – Bystričany will be used. The second circuit will be operated as the 400 kV Bystričany - Križovany line and in the Oslany location it will be interrupted with outlet into 400 kV switchyard Horná Ždaňa. It is a temporary condition prior the final termination of the transformation 220/110 kV operation in Bystričany with regard to time-limited drawdown of finances from the BIDSF fund for this set of investment items. Completion of the entire set of investment events is expected in 2021. At present, the project is in the implementation phase or in the phase of the contractor selection (for 2x400 kV line Križovany - Bystričany) and it is carried out in close coordination with SSE-D.

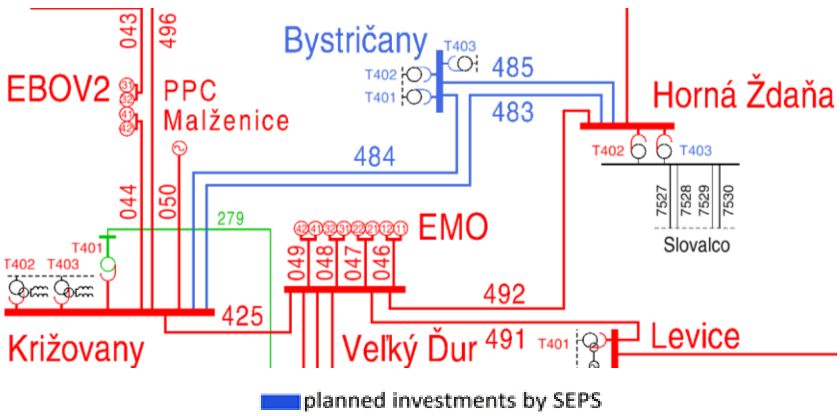


Fig. No. 9 Graphic Representation of the Planned Investments in the Bystričany Substation.

In the western part of TS SR, SEPS plans further two important investment projects. The first one is the aforementioned transition of the Senica substation from the 220 kV voltage level to 400 kV. The name of this project is “Set of Investment Events - Transformation of 400/110 kV Senica” and it consists of the following investment events:

1. construction - Transformer station 400/110 kV Senica,
2. construction - Looping of 400 kV line V424 to the Senica transformer station

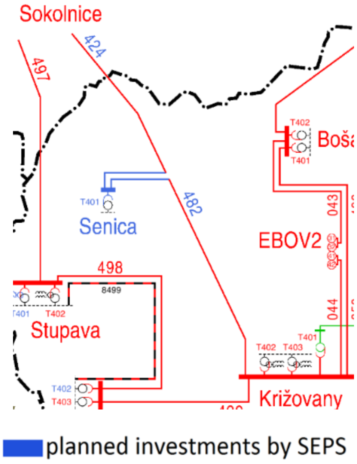


Fig. No. 10 Graphic Representation of the Planned Investments in the Senica Substation

Implementation of the aforementioned investment project focuses especially on securing long-term connection of the Senica node area after gradual attenuation of the transmission system on the 220 kV voltage level. Transition to the 400 kV level in this substation shall be ensured by building the new 400 kV switchyard within the scope of five fields, by looping the existing 400 kV line of V424 (Križovany - Sokolnice (the Czech Republic)) to the new 400 kV switchyard and by building the 400/110 kV, 350 MVA transformer. At the same time, building R400 kV Senica will lead to definite decommissioning of the existing R220 kV Senica. The project is in the preparatory phase on the project documentation level acquisition. It is being developed in close coordination between SEPS and ZSD and the assumed time frame for its implementation is 2021-2023.

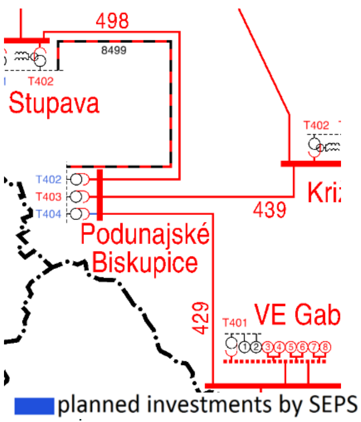


Fig. No. 11 Graphic Representation of the Planned Investments in the Podunajské Biskupice Substation

Further one is the currently carried out investment project “Distance control and replacement of the T404 transformer in the Podunajské Biskupice substation, transition of the 400 kV Podunajské Biskupice switchyard to the switchyard of a new type”. Within the mentioned investment project, the transition of the 400 kV Podunajské Biskupice substation from the remote control mode to the operator-free operation mode with the distance control is implemented, moreover, the transition of the existing R400 kV Podunajské Biskupice substation to the new type of the switchyard with tube bus bars and width of fields of 18 m is carried out. Moreover, the replacement of the existing T404, 400/110 kV, 250 MVA transformer by the new T404, 400/110 kV, 350 MVA one is carried out. Replacement of the T404 transformer was caused by the ZSD requirement for increase of the transformation power in the Podunajské Biskupice meter point. The implementation should be completed in 2020. The project is carried out in close coordination with ZSD.

“Replacement of the T401 transformer, installation of shunt reactors in the Varín substation” is a significant investment project in the middle part of TS SR. It shall include replacement of the existing T401 transformer by a new one with nominal output of 350 MVA. Moreover, tertiary 33 kV switchyard for connection of shunt reactors 2x45 MVAr and the transformer of self-consumption to tertiary winding of the new T401 transformer shall be built. The project is in the phase of the feasibility study with the assumed beginning of the engineering and project activity contractor selection in 2018. The assumed horizon of its implementation is currently estimated for the period 2020-2022. By 2027, in the Varín substation, the implementation of the investment project “Distance control in the Varín substation” is considered with which the entire substation will be transferred into distance control. The implementation is currently estimated for the period 2025-2027. By 2030, the replacement of the T401 and T402 transformers in the Liptovská Mara substation and transition of this station to the distance control by 2032 is planned in the middle part of TS SR. At present, this project is in the project plan phase. In regard to Liptovská Mara, it is in the phase of the feasibility study processing for installation of 2x45 MVAr shunt reactors to the T401 and T402 tertiary windings. This is a project aimed at installation of shunt reactors in this part of TS SR within the time horizon by the year 2020 to be able to reduce high voltage on TS SR lines with overlap to abroad (the Czech Republic) effectively.

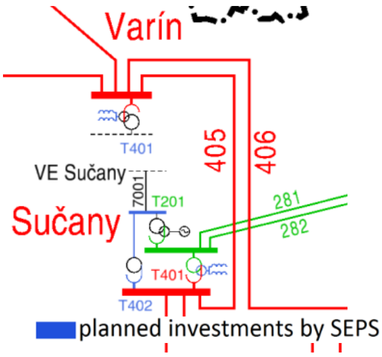


Fig. No. 12 Graphic Representation of the Planned Investments in the Varín Substation

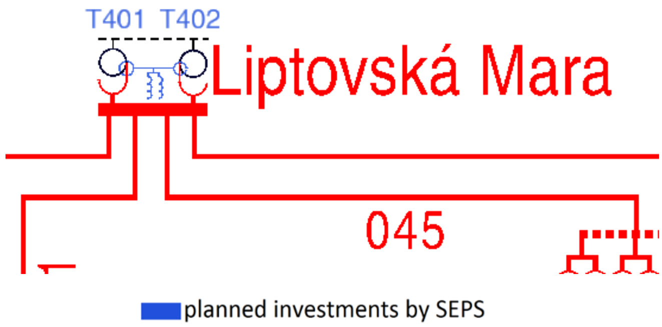


Fig. No. 13 Graphic Representation of the Planned Investments in Liptovská Mara Substation

An important plan in terms of supply safety of electricity wholesale consumer, OFZ, a.s., which is a direct consumer of electricity from the transmission system and SSE-D, is the planned implementation of the T402, 400/110 kV, 350 MVA transformation in the Sučany substation and transition of the substation to the distance control. This project will enable SEPS to gradually decommission the 220 kV line V273 (including the related equipment in the Lemešany substation) while observing quality and safety of electricity supply for OFZ, a. s. and SSE-D. The project is in the feasibility study preparation phase. The project implementation in the Sučany substation for increase of the compensation output from 120 MVAr to 180 MVAr was commenced. Applying two steps, two groups of 33 kV, 3x30 MVAr shunt reactors (moved from the Voľa substation and Lemešany substation) will be connected to the tertiary winding of the T401 transformer. Original shunt reactors from T401 (2x3x20 MVAr) will be shifted and used in other substations.

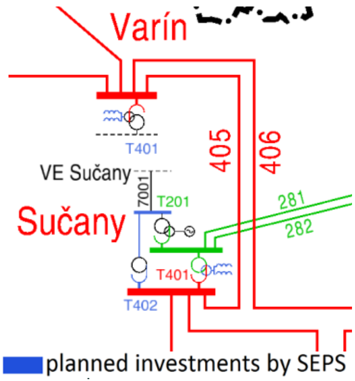


Fig. No. 14 Graphic Representation of the Planned Investments in the Sučany Substation

In the east part of TS SR, the implementation of the investment project "Replacement of the T401, T402 transformers and distance control mode in the Spišská Nová Ves substation" commenced within which transition of the substation to distance control mode will be performed along with replacement of the T401 and T402 transformers reaching the end of their lifetime by new ones with nominal output of 250 MVA. This project is implemented in close cooperation with VSD and its assumed completion should be by 2019.

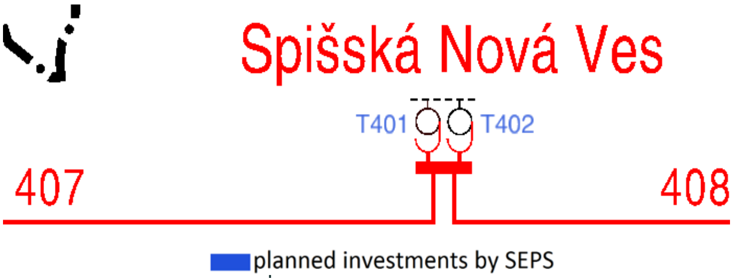


Fig. No. 15 Graphic Representation of the Planned Investments in the Spišská Nová Ves Substation

By 2027, in the field of the TS/DS transformation, supplementation or replacement of physically obsolete transformers with which it is assumed their technical condition after their lifetime expiry does not allow their further safe and reliable operation is expected. Apart from the aforementioned replacements of transformers within other sets of investment events, the following projects are involved:

1. replacement of T401 in the Moldava substation,
2. replacement of T401 in the Stupava substation,
3. replacement of T402 in the Podunajské Biskupice substation,
4. replacement of T401 and T403 in the Horná Ždaňa substation.

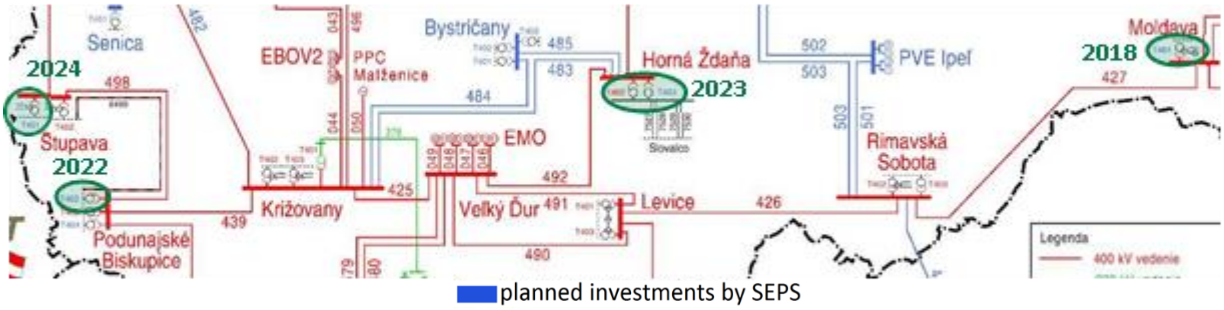


Fig. No. 16 Graphic Representation of the Planned Replacements of the TS/DS Transformers by 2027

4.5 Cross-Border Investment Projects

The most expected cross-border projects to be implemented by SEPS by 2027 are projects concerning building transmission lines to Hungary. It is the 400 kV line Gabčíkovo (SK) - Gönyű (HU) -

Veľký Ďur (SK) and 400 kV line Rimavská Sobota (SK) – Sajóivánka (HU). In March 2017, the Contract on building these lines between SEPS and MAVIR was signed with the assumed commissioning date in December 2020.

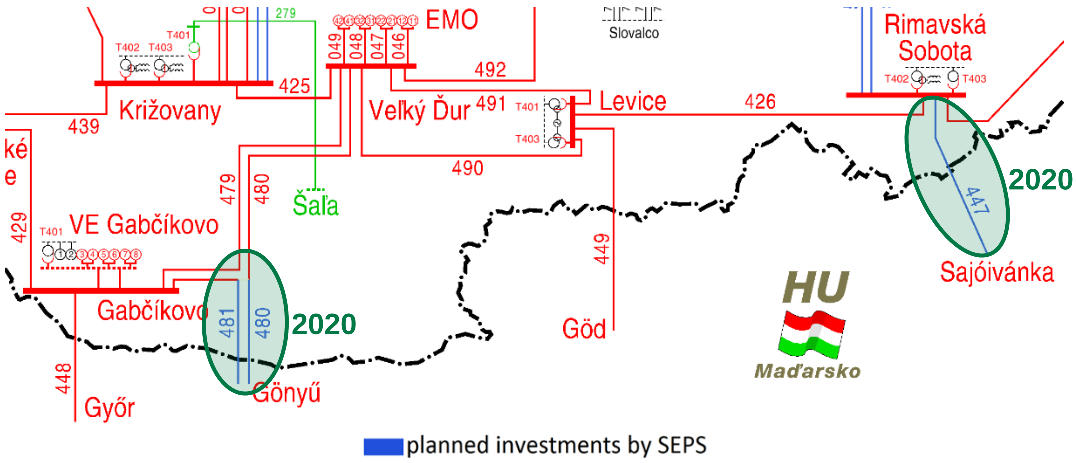


Fig. č. 17 Schematic view of the planned investment project for the construction of new cross-border lines on the SK-HU profile

On the side of SEPS, there are designing and engineering works on both lines carried out with the financial contribution from the “Connection Europe Facility” instrument. Since these are projects having a status of the Project of Common (European-wide) Interest, the European Commission pays increasingly more intense attention to them.

By 2027, SEPS does not plan to strengthen other cross-border profiles with new lines, however, in the years 2024 and 2025 a reconstruction of the cross-border line V404 Varín (SK) – Nošovice (the Czech Republic) is scheduled. There will also be maintenance works and investments in reconstruction of the existing lines (replacement of insulators and conductors, repair of foundations etc.) carried out.

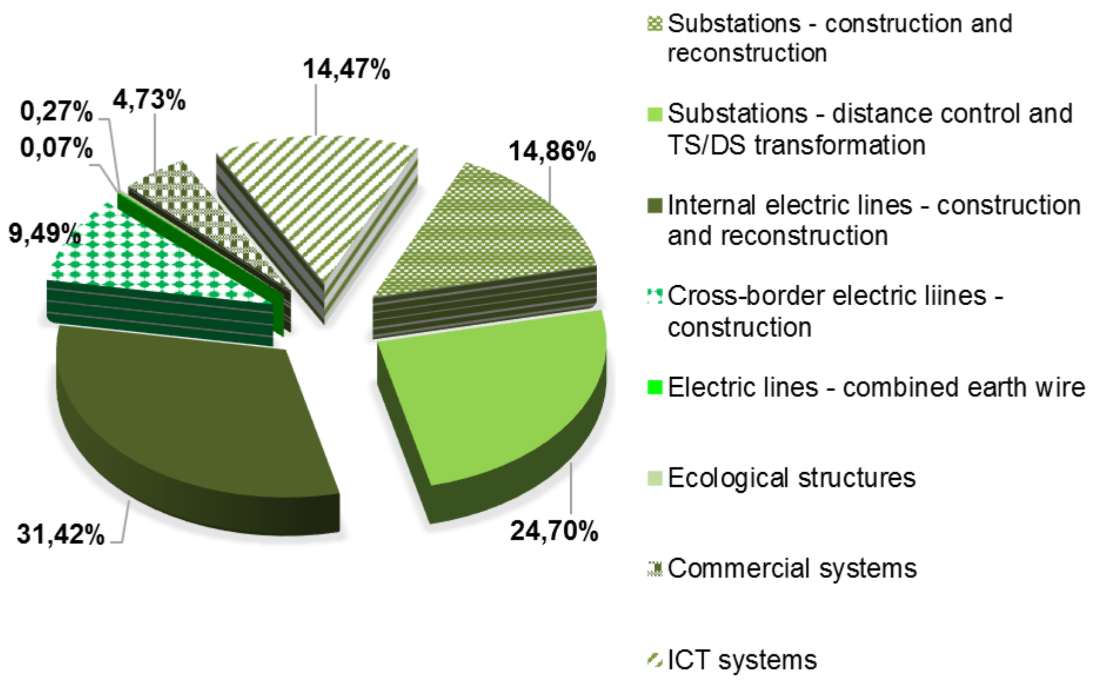
In case of development of inter-state connections of the Slovak Republic, it is necessary to consider it is related mainly to the situation and development of electricity consumption in ES SR and installed capacity of generators or their production in ES SR. Moreover, this takes into account the situation and development of the power system in the neighbouring countries, interests and approaches of their operators and support of inter-state exchanges in electricity development or trading in electricity within EU and adjacent economies from electricity point of view. In this sense, thus SEPS further maintains and develops coordination activities with transmission system operators of Hungary, Poland, the Czech Republic, and the Ukraine both on the ENTSO-E level and bilateral level. Negotiations with the Austrian transmission system operator concerning building new cross-border line are currently not carried out, since even in the long-term horizon no mutual interconnection of TS SR and Austria is envisaged. It is, however, necessary to state that after a longer pause, the communication with the transmission system operator in the Ukraine, NPC “Ukrenergo” was successfully established. The

Slovak - Ukrainian cross-border profile often means a bottleneck (together with the Hungarian profile) in case of cross-border electricity transmissions and it causes operational problems and control problems also to the Slovak electric power dispatching. In June 2017, SEPS and NPC “Ukrenergo” signed the Memorandum of Understanding concerning the increase of the transmission capacity between the Slovak and the Ukrainian transmission systems. There is a real assumption that cooperation will be specified in the form of the cooperation agreement in the course of the following months.

Moreover, it must be notified the development and construction of new inter-state interconnections must be in compliance with the development and possibilities of internal interconnections while new international interconnections can be built only to such extent so as not to threaten safety and reliability of TS SR or ES SR.

4.6 Investment Plan for the Period 2018 - 2027

SEPS intends to invest approximately EUR 731.6 mil. via investment projects mentioned in the Ten-Year Investment Plan what means annual average investment demand amounting approx. to EUR 73.2 mil. to ensure inevitable increase of the existing capacities and inevitable upgrade of the main parts of the transmission system. The distribution of the SEPS investments into individual categories within the Ten-Year Investment Plan is shown in the following graph.



Graph No. 24 Relative frequency distribution of the SEPS Investment Needs By 2027

The particular investment projects are documented in the table below and the principal national and cross-border investment projects are illustrated in the following picture.

Table No. 7 Overview of implementation of Investments in the Transmission System for 2018 - 2027

Order No.	Investment projects	Identifica-tion No.	Beginning and end of investment projects		Assumed costs [EUR mil.]	Incurred costs by 31.12.2016 [EUR mil.]	State of project
	Substations - erection and reconstruction						
1	Adjustments in the related facilities in the Gabčíkovo switching station and Veľký Ďur substation [code RGI: 214] [code TYNDP: 48.214] [code PCI: 3.16]	2015-1	2018	2020	0.129		
2	400 kV Bystričany switchyard – const. of new R400 kV sy [code RGI: 297]	2013-5	2014	2019	10.430	0.730	
3	400 kV Horná Ždaňa switchyard – extension [code RGI: 845]	2013-6	2014	2019	4.485	0.570	
4	400 kV Križovany switchyard – extension [code RGI: 845]	2013-7	2015	2020	4.898	0.209	
5	400 kV Rimavská Sobota switchyard - extension [code RGI: 695] [code TYNDP: 48.695] [code PCI:3.17]	2013-9	2017	2020	4.060		
6	Automatic decay in Veľký Ďur substation	2013-14	2016	2019	0.421	0.029	
7	Replacement of bus bar wires in Veľký Ďur substation	2015-3	2017	2019	2.850		
8	Replacement of bus bar wires in Levice substation	2015-5	2017	2019	1.463		
9	Replacement of disconnectors in 400 kV switchyard in Sučany substation	2015-6	2013	2021	1.900	0.112	
10	Reconstruction of 220kV switchyard in Sučany	2015-8	2018	2020	4.447		
11	Innovation of ICS facilities for control of R 220 kV switchyard in Lemešany	2013-16	2019	2019	0.500		
12	Innovation of ICS facilities for control of R110 kV switchyard in Horná Ždaňa subst.	2013-18	2017	2019	1.500		
13	Refurbishment of secondary technology in R400 kV Lemešany - Replacement of protections and CIS innovation	2015-24	2017	2018	1.443		
14	Refurbishment of secondary technology in R400 kV Bošáca - replacement of protections and CIS innovation	2014-1	2017	2020	4.180		
15	New station and 33 kV field for 90 MVAr reactors in the Sučany substation	2016-3	2017	2019	0.580		
16	Innovation of ICS - central office in Košice switching station	2015-11	2019	2019	0.410		
17	Innovation of ICS - central office in Veľké Kapušany substation	2015-12	2019	2019	0.480		
18	Refurbishment of secondary technology in Sučany substation	2015-23	2018	2019	1.080		
19	Refurbishment of secondary technology in Križovany 400 kV substation	2015-26	2019	2021	2.450		
20	Shunt reactors in Liptovská Mara substation	2017-1	2019	2021	2.000		
21	400/110 kV Senica transformation	2014-3	2018	2023	25.200		
22	Innovation of ICS - central office in Horná Ždaňa 400 kV substation	2015-13	2020	2020	0.480		
23	Refurbishment of secondary technology in Horná Ždaňa subst. 110 kV and 400 kV	2015-27	2019	2020	0.750		
24	Innovation of TIS in SEPS substation	2015-29	2020	2020	0.193		
25	Refurbishment of secondary technology in Liptovská Mara substation	2015-30	2020	2020	0.140		
26	Innovation of ICS in Križovany 400 KV substation	2015-14	2020	2021	2.550		
27	Innovation of ICS - central office in Veľký Ďur substation	2015-15	2021	2021	0.550		
28	Innovation of ICS - central office in substation Levice	2015-16	2021	2021	0.480		
29	Refurbishment of secondary technology in Stupava substation	2015-32	2021	2021	0.360		
30	Innovation of ICS - central office in Medzibrod substation	2015-17	2022	2022	0.410		
31	Innovation of ICS - central office in ST Voľa	2015-18	2022	2022	0.480		
32	Innovation of ICS - central office in Stupava substation	2016-4	2022	2022	0.480		
33	400 kV Ladce switchyard	2016-1	2022	2026	19.200		
34	Innovation of ICS - central office in Rimavská Sobota substation	2016-5	2023	2023	0.480		
35	Innovation of ICS in Lemešany 400 kV substation	2015-20	2023	2024	1.750		
36	Innovation of ICS in Veľké Kapušany substation	2015-19	2024	2024	1.180		
37	Refurbishment of secondary technology in Horná Ždaňa 110 kV substation	2015-33	2024	2024	1.350		
38	Refurbishment of secondary technology in Lemešany 400 kV substation	2015-34	2024	2024	1.080		
39	Refurbishment of secondary technology in Veľké Kapušany substation	2015-36	2024	2024	1.350		
40	Refurbishment of secondary technology in Moldava substation	2015-37	2024	2025	0.820		
41	Innovation of ICS in Moldava substation	2015-21	2024	2025	1.180		
42	Refurbishment of secondary technology in Rimavská Sobota substation	2015-38	2025	2025	0.140		

Order No.	Investment projects	Identification No.	Beginning and end of investment projects		Assumed costs [EUR mil.]	Incurred costs by 31.12.2016 [EUR mil.]	State of project
43	Refurbishment of secondary technology in Spišská Nová Ves substation	2015-39	2025	2025	0.140		
44	Refurbishment of secondary technology in Levice substation	2015-40	2025	2025	0.150		
45	Innovation of ICS in Horná Ždaňa 400 kV substation	2015-22	2025	2026	1.180		
46	Innovation of ICS in Košice switching station	2016-6	2026	2026	0.920		
47	Refurbishment of secondary technology in Horná Ždaňa 400 kV substation	2016-7	2026	2026	0.700		
48	Innovation of TIS in SEPS substation	2016-8	2026	2026	0.215		
49	Refurbishment of secondary technology in Košice switching station	2016-9	2026	2026	0.880		
50	Refurbishment of secondary technology in Bošáca substation	2017-3	2027	2027	0.300		
Substations - remote control and TS/DS transformation							
51	Shift of the T11 transformer from Moldava substation to Lemešany substation	2017-4	2018	2018	0.100		
52	Distance control mode and replacement of the T404 in Podunajské Biskupice s., transition of the 400 kV Podunajské Biskupice switchyard to the new type	2013-20	2004	2020	39.628	1.583	
53	Distance control mode and replacement of T401 and T402 in Spišská Nová Ves	2013-24	2006	2020	26.840	1.037	
54	Distance control mode of Sučany substation	2013-25	2006	2025	27.990	0.153	
55	Distance control mode and replacement of T401 and new shunt reactors in Varín substation	2013-27	2012	2028	35.000	0.069	
56	Replacement of transformer T401 and new self-consumption transformer in Moldava substation	2013-28	2014	2018	8.143	0.384	
57	Transformer 400/110 kV Bystričany – T401	2013-31	2016	2020	10.920	0.622	
58	Transformer 400/110 kV Bystričany – T402	2014-4	2016	2021	7.203	0.353	
59	Transformer T402 400/110 kV in substation Sučany	2015-46	2020	2023	10.010		
60	Replacement of the T402 transformer in Podunajské Biskupice substation	2013-29	2020	2023	6.200		
61	Replacement of the T401 transformer in Stupava substation	2013-32	2021	2025	6.200		
62	Replacement of T401 and T403 and self-consump. transf. in Horná Ždaňa s.	2013-30	2022	2026	10.622		
63	Voltage transformer 400/110 kV Ladce	2016-13	2022	2026	12.200		
64	Distance control mode and replacement of T401 and T402 in Liptovská Mara s.	2013-26	2025	2032	36.500		
65	Replacement of the T403 transformer in the Rimavská Sobota substation	2016-10	2025	2029	6.200		
Internal electric lines - erection and reconstruction							
66	2x400 kV Bystričany - Križovany line **[code RGI: 845]**	2013-35	2012	2020	69.980	3.861	
67	2x400 kV Horná Ždaňa - Oslany line **[code RGI: 845]**	2013-36	2012	2020	34.298	1.148	
68	Conn. of the V484 line (circuit 220 kV) to R400 kV Križovany and Bystričany **[code RGI: 845]**	2016-11	2021	2021	0.270		
69	V427 insulator replacement	2015-48	2017	2020	5.000		
70	Replacement of suspension insulators and conductors on the V425 Križovany - Veľký Ďur line, section tower No. 1 - 6z	2013-43	2018	2019	7.600		
71	Looping of the 400 kV line V424 to Senica substation	2014-7	2018	2022	7.800		
72	V072 insulator replacement	2017-5	2019	2019	1.000		
73	Replacement of conductors and insulation replacement of the 400 kV line V424 Križovany - Sokolnice line, in section of tower No. 256 - tower No. 171(CR bord.)	2013-44	2019	2020	3.400		
74	V428 insulator and conductor replacement	2015-49	2020	2022	5.000		
75	Replacement of conductors and of insulation of the 400 kV line V482 Križovany - Senica line, in section of the Križovany substation - tower No. 256	2017-2	2021	2023	6.800		
76	V448 insulator and conductor replacement	2013-47	2021	2023	1.700		
77	V044 insulator replacement	2013-48	2023	2024	1.000		
78	V043 insulator replacement	2013-49	2022	2023	3.000		
79	V496 insulator replacement	2013-50	2022	2024	3.200		
80	V041 insulator and conductor replacement	2015-50	2021	2021	0.700		
81	V429 insulator and conductor replacement	2013-46	2021	2023	6.000		
82	V408 line innovation	2013-52	2022	2025	36.000		
83	Insulator replacement of the V071 line (only if Units 5 and 6 of EVO are operated after 2021)	2017-6	2023	2023	1.800		

Order No.	Investment projects	Identification No.	Beginning and end of investment projects		Assumed costs [EUR mil.]	Incurred costs by 31.12.2016 [EUR mil.]	State of project
84	V407 line innovation	2013-51	2023	2026	32.000		
85	Looping of V495 in Ladce substation	2016-17	2024	2026	1.600		
86	V045 line innovation	2016-12	2025	2027	10.000		
87	Reconstruction of the V406 line in the Ružomberok – Liptovská Mara section	2017-7	2027	2029	12.000		
Cross-border lines – construction							
88	2x400 kV Gabčíkovo - Gönyű (HU) - Veľký Ďur line (part Veľký Meder – state border with HU) **[code RGI: 214]** **[code TYNDP: 48.214]** **[code PCI: 3.16]**	2013-53	2015	2021	21.582	0.126	
89	2x400 kV Rimavská Sobota – Sajóivánka (HU) line (the part up to the state border with HU) **[code RGI: 495]** **[code TYNDP: 48.495]** **[code PCI: 3.17]**	2013-54	2012	2021	25.697	0.155	
90	V404 line innovation	2016-14	2018	2025	23.760		
Electric lines – combined earth wires							
91	Second optical interconnection of AB Bratislava - substation Podunajské Biskupice	2016-16	2017	2018	0.500		
Environmental investments							
92	Bošáca Substation - waste water treatment plant	2015-55	2018	2018	0.310		
93	Lemešany Substation - waste water treatment plant	2015-57	2018	2018	0.400		
94	Liptovská Mara Substation - waste water treatment plant	2015-58	2021	2021	0.420		
95	Križovany Substation - waste water treatment plant	2015-59	2021	2021	0.420		
96	Moldava Substation - waste water treatment plant	2015-60	2022	2022	0.420		
Commercial systems							
97	Upgrade of the DaE system	2013-63	2013	2020	4.933	2.149	
98	Innovation of the information billing system	2013-66	2019	2021	1.500		
99	Innovation of the quality measurement system	2013-60	2018	2020	2.600		
100	Innovation of measurement sets	2013-64	2017	2020	2.000		
101	Modifications of ADC System according to the requirements of legislation and users	2013-58	2022	2023	2.850		
102	HW infrastructure	2017-8	2018	2018	0.500		
103	Use of WAMS in the SEPS environment	2017-9	2018	2019	0.650		
104	Business system innovation	2015-61	2022	2024	8.000		
105	Innovation of the ADC System	2015-63	2021	2023	6.000		
106	Innovation of the information billing system	2015-64	2023	2024	1.500		
107	Upgrade of the business system	2015-62	2025	2033	0.900		
108	Modifications of ADC System according to the requirements of legislation and users	2013-65	2026	2027	4.000		
109	Innovation of the ADC System	2017-10	2027	2029	6.000		
ICT systems							
110	Upgrade of ICS SED	2013-67	2012	2019	17.707	1.098	
111	Upgrade of load-bearing telecommunication network of SDH	2013-68	2017	2018	4.180		
112	Data backup centre in Podunajské Biskupice	2016-15	2018	2018	3.000		
113	Upgrade of F-MUX facilities	2013-71	2018	2018	1.800		
114	Implementation of the security system	2013-72	2017	2018	1.034		
115	Innovation of remote SCADA clients of CIS ESt for operating administrations	2017-11	2017	2018	0.992		
116	Optimization, increase of safety and availability of TIS protections	2017-12	2017	2020	2.940		
117	Innovation of DMZ switches	2017-13	2018	2018	0.160		
118	Innovation of IIS servers	2017-14	2018	2019	0.450		
119	Simulators of self-consumption for TS Západ (West) including the programme of MEGA DATABASES	2017-15	2018	2018	0.325		
120	Implementation of safety systems resulting from legislation requirements - GDPR	2017-16	2018	2018	1.000		

Order No.	Investment projects	Identification No.	Beginning and end of investment projects		Assumed costs [EUR mil.]	Incurred costs by 31.12.2016 [EUR mil.]	State of project
121	Implementation of safety systems resulting from legislation requirements - Act on Cyber Security	2017-17	2018	2020	4.500		
122	Extension of SBI by the systems installed in AB BA	2017-18	2018	2018	0.300		
123	Extension of SBI by the systems installed in SED ZA	2017-19	2018	2018	0.300		
124	Implementation of Cisco - ISE	2017-20	2018	2018	0.260		
125	Optimization of authentication of domain users	2017-21	2018	2018	0.400		
126	Monitoring system of ICT assets	2017-22	2018	2018	0.130		
127	Complex ensuring of logical perimeter of network infrastructure	2017-23	2018	2018	0.600		
128	Optimization of detection of CI component disturbance	2017-24	2018	2020	10.000		
129	Reconstruction of mechanical guards on CI components	2017-25	2018	2022	4.000		
130	Implementation of security systems	2017-26	2019	2033	27.700		
131	Upgrade of security systems	2017-27	2019	2033	12.400		
132	Development of supporting systems	2017-28	2019	2020	2.000		
133	Technologies for a new PBIS data centre	2017-29	2019	2020	1.000		
134	Software for use of data exchange on the system deviation of SEPS, a. s. and ČEPS, a. s.	2013-75	2019	2021	0.524		
135	Upgrade for the system for coordinate security analyses - AMICA	2017-30	2021	2021	0.300		
136	Innovation of CORE switches	2017-31	2022	2022	1.500		
137	Replacement of LAN infrastructure	2017-32	2022	2022	1.400		
138	Innovation of IIS applications	2017-33	2022	2026	0.500		
139	Innovation of transmission devices for protection signals	2017-34	2023	2023	0.300		
140	Upgrade of ICS SED	2015-65	2023	2025	20.000		
141	Innovation of IIS servers	2017-35	2024	2024	0.400		
142	Innovation of transmission devices for protection signals	2017-36	2025	2025	0.300		
143	Upgrade of load-bearing DWDM telecommunication network	2017-37	2026	2026	4.000		
144	Upgrade of access telecommunication network	2017-38	2027	2027	2.000		
	TOTAL Investment Projects				**852.042**	**14.388**	

Investments”

investments to be implemented in the following three years

investments already decided upon by the transmission system operator

other investments related to the transmission system upgrade

Project situation – this indicator is applicable to the investment categories and

implementation works are carried out

there are project and engineering activities carried out

the works on the project have not started yet

[code PCI: x.xx] - PCI projects [code RGI: xxx] - RGI projects [code TYNDP: xx.xxx] - TYNDP projects

Notes:

1. The mentioned investment costs are set up by the qualified estimate of the SEPS employees while considering the price level at the time of incorporation of investments in the investment plan, free of inflation impact and eventual change of the technical solution at the time of the investment implementation. In case of further TYNDP processing, the investment costs shall be updated.
2. A list of investments in the transmission system for the period 2018 - 2027 does not consider all SEPS investment needs in the next ten-year horizon, but only the investment projects related to ensuring inevitable increase of the existing capacities and necessary upgrade of the main parts of the transmission system.

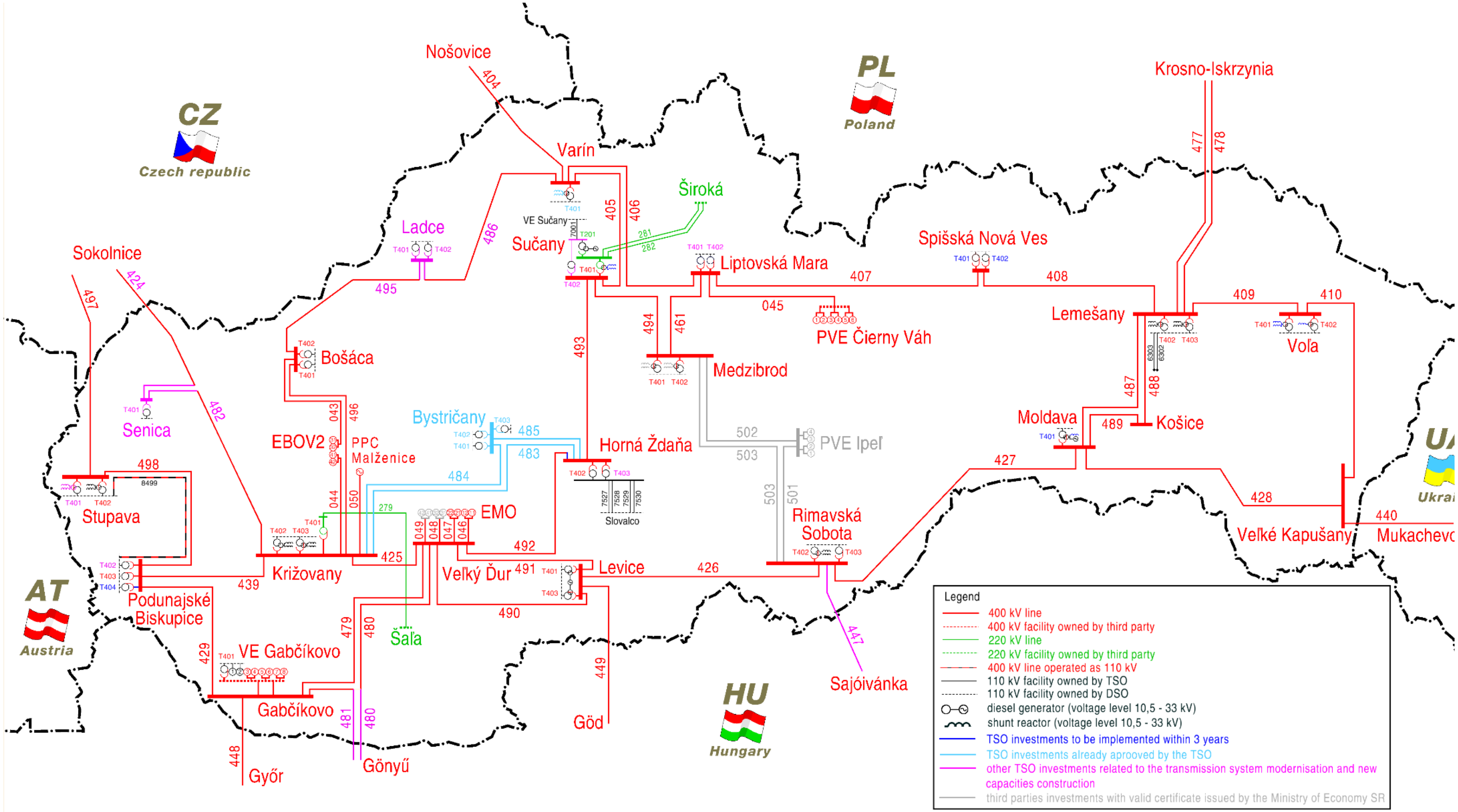


Figure No. 18 Assumed Situation of the Transmission System in 2027

5 Conclusion

At preparation of this 2027 NTYNDP, SEPS stemmed from the current and expected future condition of offer and demand for the system capacity, from the assumptions of future electricity production, electricity consumption, and exchanges in electricity with other countries while taking the system development plan for the entire European Union and regional investment plans processed by the ENTSO-E association into consideration (in particular the TYNDP document including the regional investment plan for the CCE region). This document, however, reflects the SEPS Development Programme, respective approved SEPS investment plans and the recent valid 2026 TYNDP approved by NRA. The document was subject to the comment procedure by all TS SR users, NRA and MoE of SR. All these assumptions and starting points are described and considered in 2027 NTYNDP based on the current knowledge and information available to SEPS as to TS SR operator, as at the time of the 2027 NTYNDP submission to NRA for approval.

SEPS must be able to react adequately to the international and internal development so as to ensure safe and reliable electricity supply to TS users in every moment. This strategic task can be fulfilled in the long-term horizon only by correct decisions aimed at TS development. This TYNDP is to show which direction should be followed in order to meet this strategic objective.

The substantial and long-term decisions of SEPS in the field of further development and use of TS SR includes building new facilities only on the 400 kV voltage level. It is still applicable that TS SR on the 220 kV voltage level due to gradual decommissioning of electricity generators connected to it and with regard to its age and worsening technical condition gradually becomes meaningless. Due to gradual decommissioning and liquidation of the parts of the 220 kV transmission system, these parts will not be replaced by similar facilities of the same voltage level but SEPS will build only the 400 kV facilities but only if based on thorough consideration it is required in terms of TS SR safety and reliability as well as in terms of electricity supply safety and reliability. In case of transition from 220 kV to 400 kV, concurrently, significant upgrade of SEPS substations occurs with regard to the current criteria and requirements for efficient electricity transmission. All such reconstructed substations are built as operator-free substations with distance control mode. Reaching this operational and control mode in all substations is a long-term strategic objective of SEPS.

Regarding foreign countries, SEPS long-term priority is building new 400 kV interconnections towards Hungary which were included in the list of the PCI projects. This confirms their significance and importance not only for TS SR and Hungary but for the wider CCE region. On the SEPS side, their preparation is in the phase of design and engineering works which shall be completed by obtaining a building permit in 2018. Zoning permits for both constructions came into force already in September 2017.

The SEPS priorities in the next ten years shall thus include - based on the aforementioned - investment projects which shall serve to ensure:

- replacement of gradually decommissioned parts of the 220 kV transmission system,
- transition of the remaining substations from local and remote control mode to distance control mode,
- increase of transmission capacity of the existing SK-HU transmission profile.

The main SEPS investment projects provided in this 2027 NTYNDP are not only in compliance with the aforementioned priorities but they also correspond to the 2016 TYNDP document which is the recent valid plan of the system development for the entire European Union. Moreover, a list of investment projects was within confirmation of the main SEPS investment decisions verified by the network calculations within processing of the SEPS Development Programme for the years 2019 – 2028 with the use of inputs from all concerned entities in the Slovak Republic.

6 List of used abbreviations

AT	-	Austria (ISO code)
BIDSF	-	Bohunice International Decommissioning Support Fund
CCE	-	Continental Central East
CGU	-	cogeneration unit
CIS	-	control and information system
CZ	-	the Czech Republic (ISO code)
DaE	-	Damas Energy (complex information system for commercial management of the transmission system)
DE	-	Germany (ISO code)
DS	-	distribution system
EBO	-	Jaslovské Bohunice Nuclear Power Plant
EMO	-	Mochovce Nuclear Power Plant
ENTSO-E	-	European Network of Transmission System Operators for Electricity
ES SR	-	electricity system of SR
ESt	-	substation
EU	-	European Union
GDP	-	gross domestic product
HPP	-	hydroelectric power plant
HU	-	Hungary (ISO code)
MAVIR	-	Hungarian transmission system operator
MoE SR	-	Ministry of Economy of SR
N	-	Number of the system components in basic load
NRA	-	Regulatory Office for Network Industries
NTC	-	Net Transfer Capacity
PCI	-	Projects of Common Interest
PL	-	Poland (ISO code)
PQM	-	Power Quality Meter
PVE	-	pumped storage hydro-electric power plant
R	-	switchyard
RES	-	Renewable energy sources
RgIP	-	Regional Investment Plan
RO	-	Romania (ISO code)
SDC	-	System Development Committee
SE	-	Slovenské elektrárne, a.s.
SED	-	Slovak Electric Power Dispatching
SEPS	-	Slovenská elektrizačná prenosová sústava, a.s.
SK	-	the Slovak Republic (ISO code)
SR	-	the Slovak Republic
SSE-D	-	Stredoslovenská energetika – Distribúcia, a. s. (regional DSO)
SSt	-	switching station
T	-	transformer
TL	-	reactor
TR	-	transformer station
TRM	-	Transmission Reference Margin

TS SR	-	transmission system of SR
TSO	-	Transmission System Operator
TTC	-	Total Transfer Capacity; total transmission capacity of the profile consisting of NTC and safety margin (TTC = NTC + safety margin)
TYNDP	-	Ten-Year Network Development Plan
TYNDP	-	ten-year network development plan
UA	-	the Ukraine (ISO code)
V	-	line
VSD	-	Východoslovenská distribučná, a.s.(regional DSO)
ZSD	-	Západoslovenská distribučná, a.s. (regional DSO)