Slovenská elektrizačná prenosová sústava, a. s.

TEN-YEAR NETWORK DEVELOPMENT PLAN FOR THE PERIOD 2020 – 2029

April 2019

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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 Ten-Year Network Development Plan for the Period 2020 – 2029 (hereinafter referred to as "2029 TYNDP"), under Art. 28, par. 3, subpar. b) of Act No. 251/2012 Coll. on Energy and on amendment and supplementation of certain acts as amended. This paragraph prescribes that once in two years the transmission system operator is 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 SR") and the Regulatory Office for Network Industries (hereinafter referred to as "RONI") always by 30 April of the second calendar year in which the relevant ten-year network development plan is fulfilled including the report on fulfilment of the Ten-Year Network Development Plan.

Pursuant to Art. 29 of the Energy Act, national TYNDP should be based especially on the present and estimated future situation 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 electricity exchanges and the Slovak transmission system development towards neighbouring countries, 2029 TYNDP takes into consideration the recently published ENTSO-E[1] Ten-Year Network Development Plan (hereinafter referred to as "TYNDP") which represents the system development plan for the entire European Union and other ENTSO-E member countries. 2029 TYNDP is also in compliance with the recent valid regional investment plan[2] (hereinafter referred to as "RgIP") of the Continental Central East region (hereinafter referred to as "CEE") under ENTSO-E's System Development Committee.

Moreover, 2029 TYNDP takes into account the currently applicable 2020 - 2029 SEPS Development Plan, the respective approved SEPS investment plans and the previous national TYNDP for the period 2018 - 2027.

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 are to be built or upgraded in the following ten years including their assumed implementation dates,

b) all investments in the transmission system related to build new capacities or upgrade of the transmission system the implementation of which was already decided upon by the TSO 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 2029 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 selected 110 kV facilities via 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 selected 110 kV lines,
- 400/220 kV, 220/110 kV and 400/110 kV transformers,
- 400 kV, 220 kV switchyards and selected 110 kV switchyards,
- reactive power compensation facilities.

The transmission system of SR includes also relevant supportive, so called secondary facilities lacking which electricity transmission and control of the electricity system of SR would be impossible. These are control information systems (hereinafter referred to as "CIS"), billing measurement systems, protections and automations and telecommunication transmission facilities, etc.

[1] https://tyndp.entsoe.eu/tyndp2018/

[2] https://tyndp.entsoe.eu/tyndp2018/power-system-2040/

There are also users directly connected to TS SR, which are currently:

- 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:

- 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 neighbouring transmission systems is shown in the following picture.

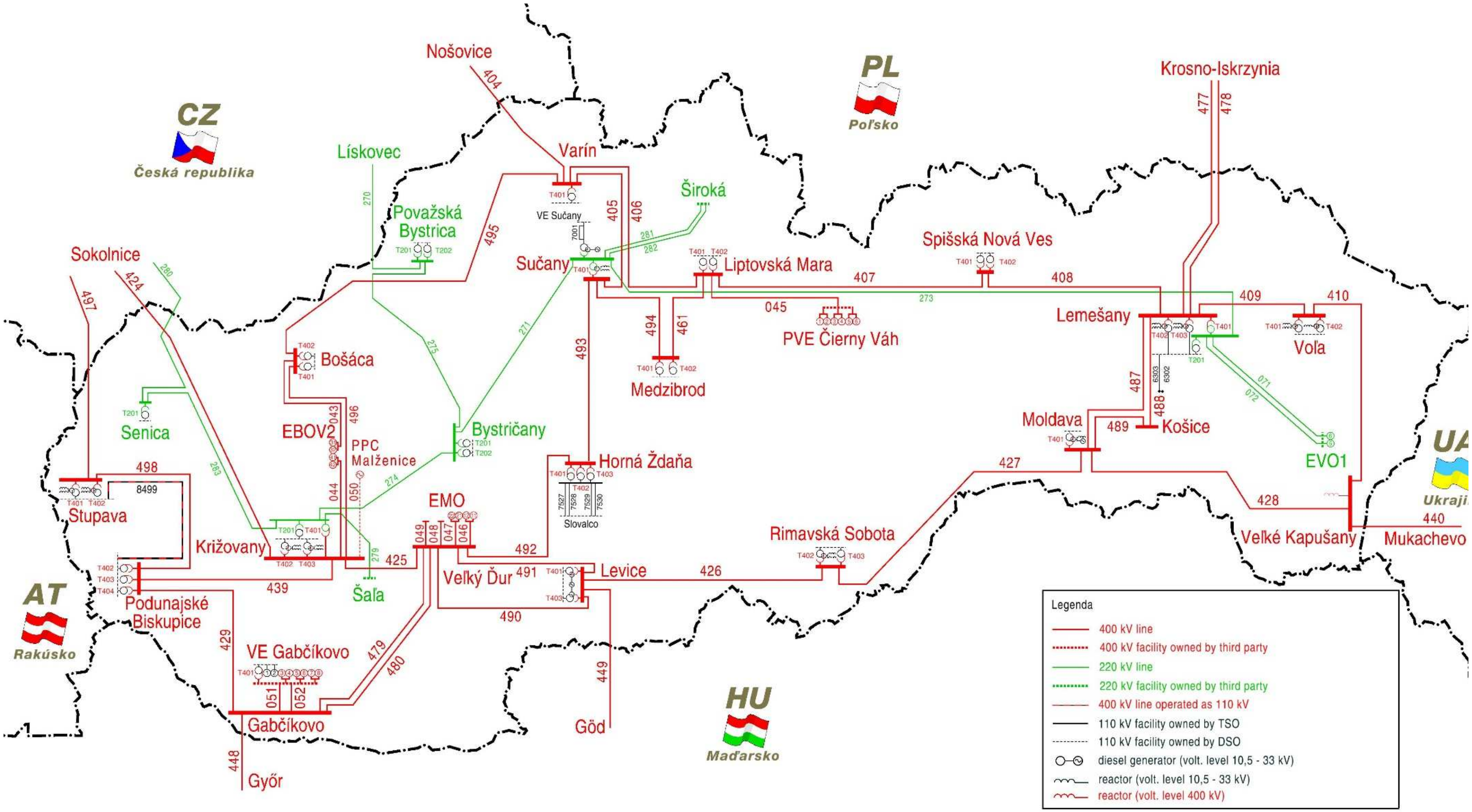


Fig. No. 1 Topology of TS SR

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:

- three ESt include 400 kV and 220 kV switchyards incl. TS/TS and TS/DS transformations,
- twelve ESt include 400 kV switchyards including PS/DS transformation,
- three ESt include 220 kV switchyards including PS/DS transformation,
- four substations with 400 kV switchyards without TS/DS transformation.

Within the renewal and upgrade, the ESt are gradually transferred to the remote control mode what means local operators need not be present for their operation in the substation and all actions concerning control of the ESt electro-energy facilities are being subject to distance control from the central dispatching of the TSO. Currently, SEPS has fourteen substations in distance control mode.

Substation	Remote control mode RCM	Local control mode[3] LCM	Manual regime[4] MR
Bošáca	✓	-	-
Bystričany	-	-	✓
Gabčíkovo	✓	-	-
Department	-	✓	-
Košice	✓	-	-
Križovany	✓	-	-
Lemešany	✓	-	-
Levice	✓	-	-
Liptovská Mara	-	-	✓
Medzibrod	✓	-	-
Moldava	✓	-	-
Podunajské Biskupice	-	✓	-
Považská Bystrica	-	-	✓
Rimavská Sobota	✓	-	-
Senica	✓	-	-
Spišská Nová Ves	-	-	✓
Stupava	✓	-	-
Department	-	-	✓
Varín	-	-	✓
Veľké Kapušany	✓	-	-
Veľký Ďur	✓	-	-
Voľa	✓	-	-
Total	**14**	**2**	**6**

Table No. 1 List of SEPS Substations

[3] "Local Control Mode" means controlling and operating the switchgear from the local dispatching desk directly in the substation

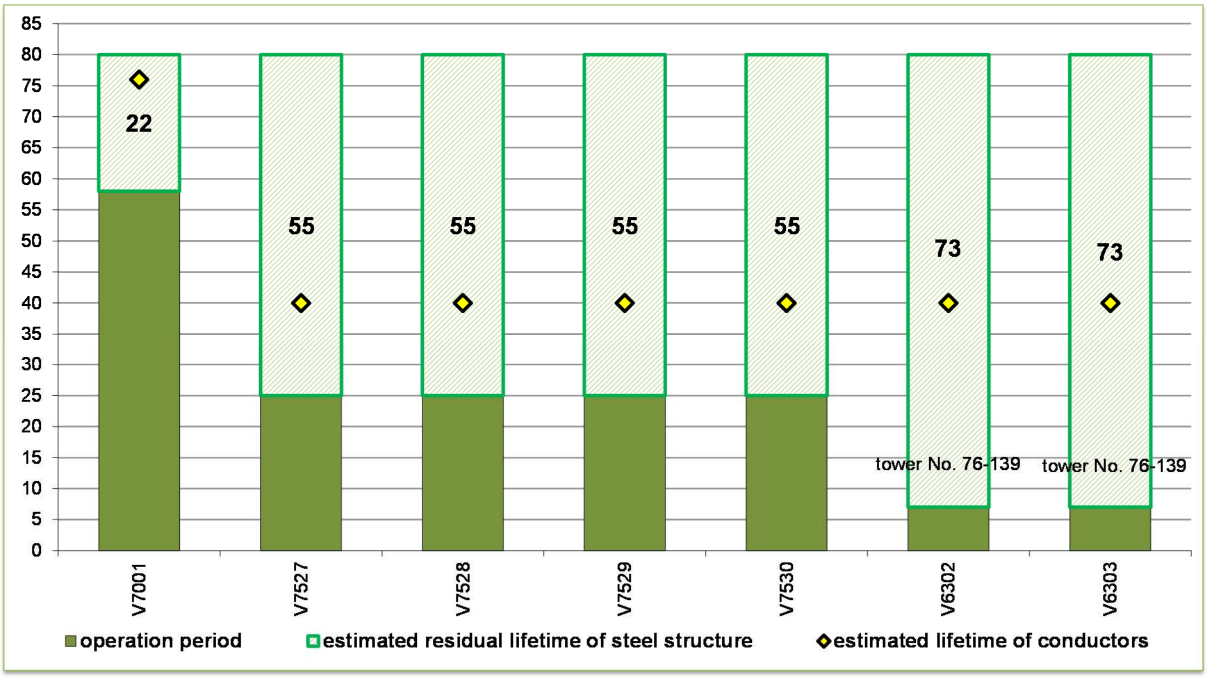
[4] „Manual Regime" means the operation of the switchgear manually by the competent stuff

The development of the number of switchyards in the period from 2008 to 2017 is available on the SEPS website (https://www.sepsas.sk/TechnickeUdaje.asp?kod=16; in Slovak only).

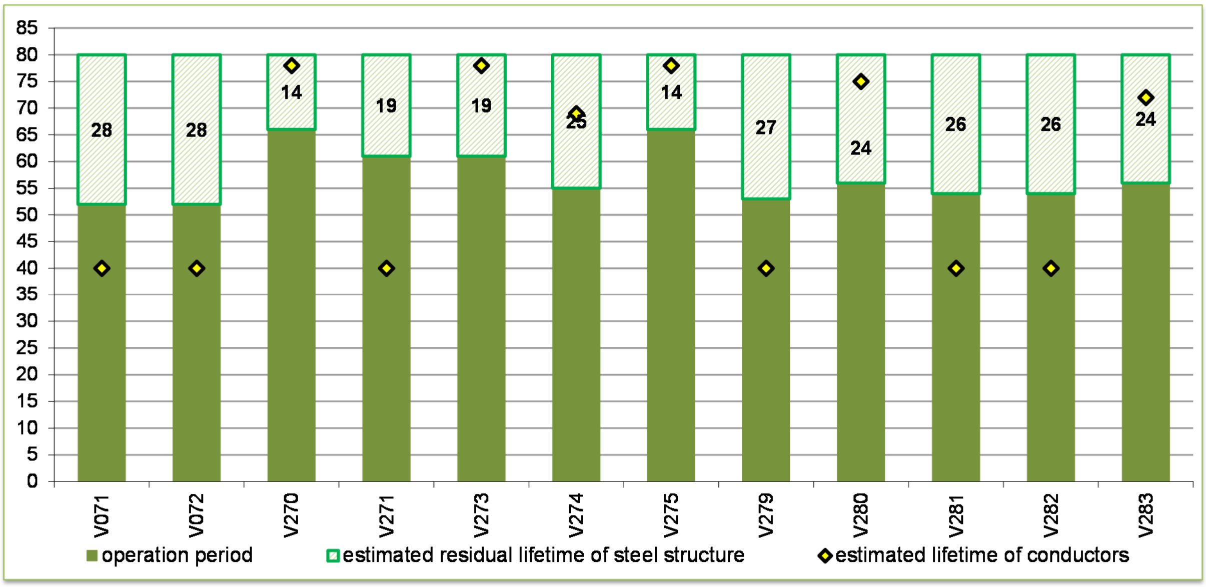
2.1.2 Electric Lines

Individual substations in TS SR are mutually galvanically interconnected via forty-six 400 kV transmission lines with length of 2,138 km, twelve 220 kV transmission lines with total length of 769 km and seven 110 kV transmission lines with total length of 80 km. Out of the total number of 400 and 220 kV transmission lines, TS SR disposes of eight 400 kV and two 220 kV cross-border electric lines jointly with 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 (https://www.sepsas.sk/TechnickeUdaje.asp?kod=16; in Slovak only).

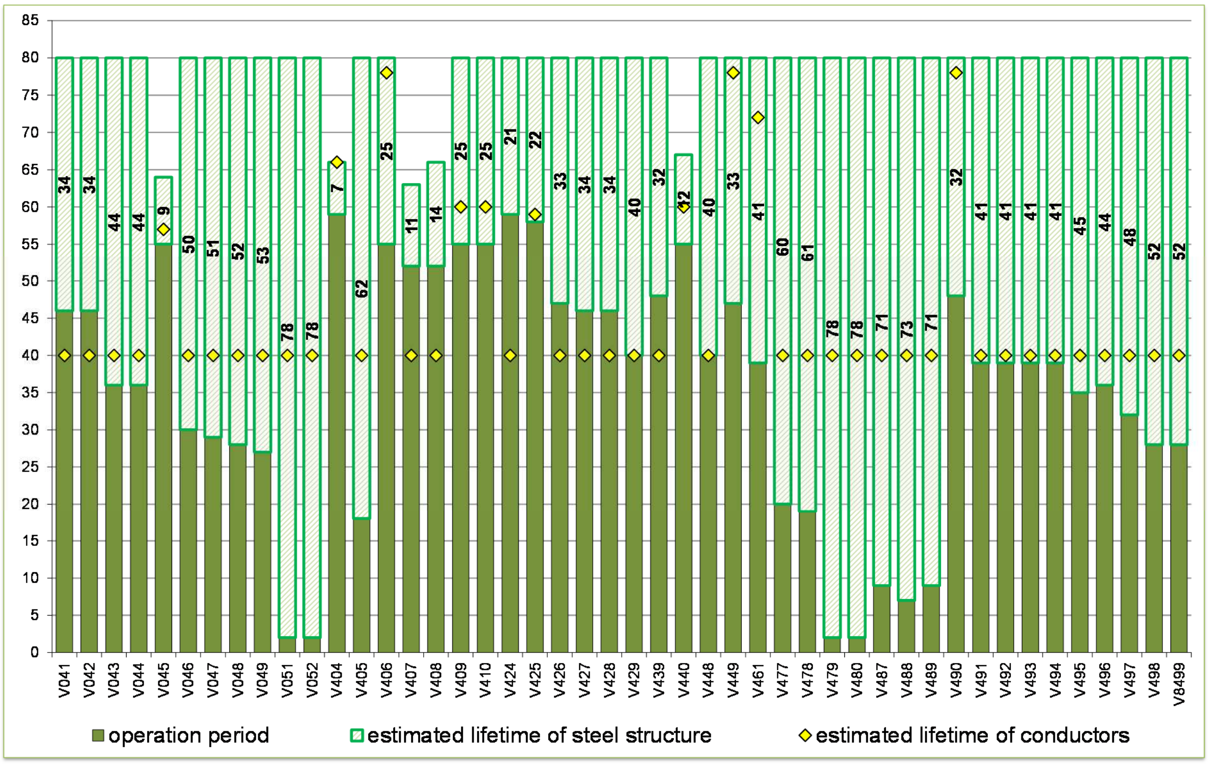
The following three graphs show the operation time of individual 110 kV, 220 kV, and 400 kV lines, estimated lifetime of the line wires (yellow label) and estimated residual lifetime of the tower steel structure. The estimated lifetime of the transmission line in the SEPS conditions equals the estimated lifetime of the tower steel structure. The provided information is important regarding the future SEPS technical-investment planning. E.g. after reaching the line age of 40 (or 80) years, wire replacement including insulator suspensions on the respective line is being considered by SEPS. If required so by the condition of wires and insulator suspensions, their replacement will be performed sooner or later.



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



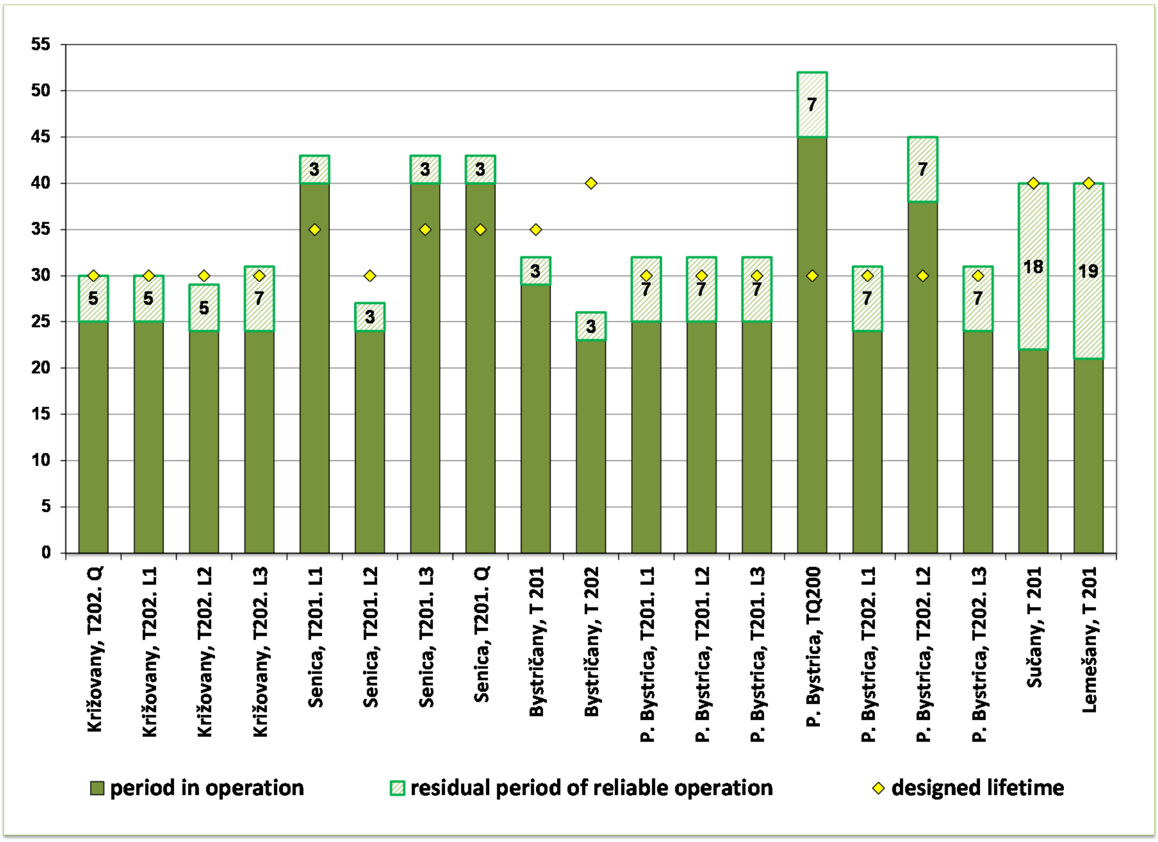
Graph No. 2 Overview of the Operation Period and Estimated Lifetime of 220 kV Lines (in years)



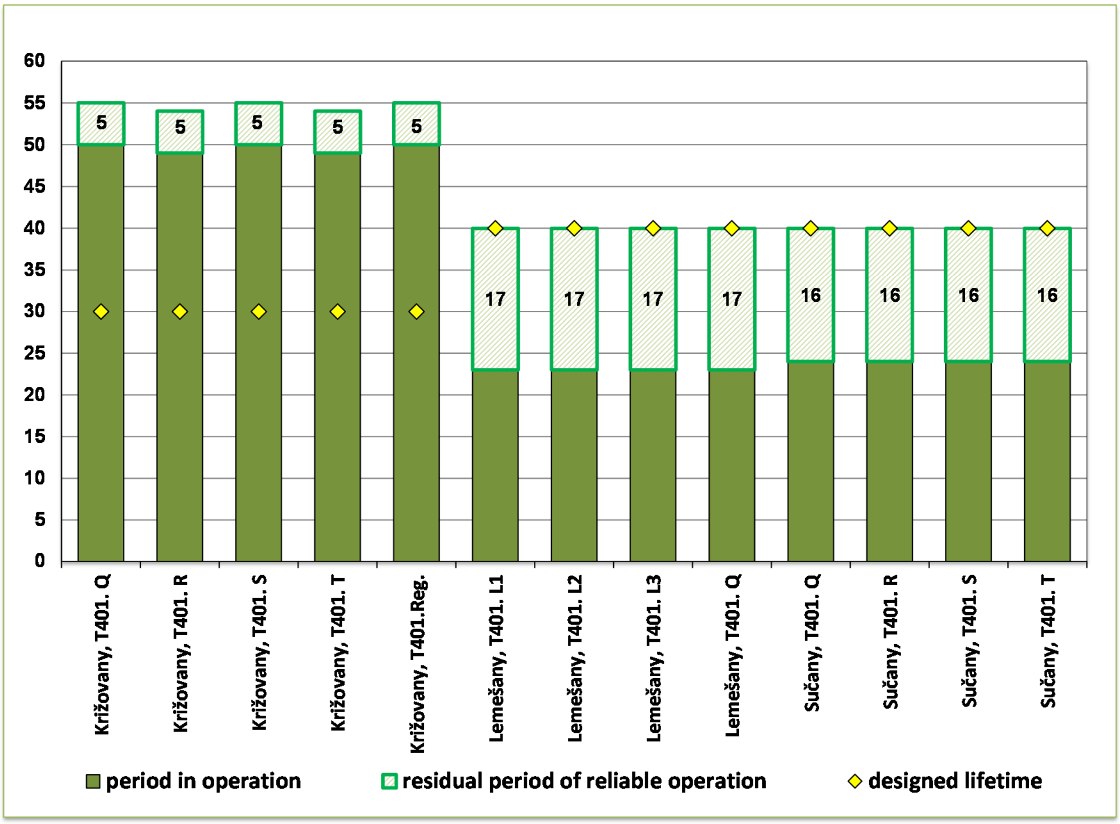
Graph No. 3 Overview of the Operation Period and Estimated Lifetime of 400 kV Lines (in years)

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

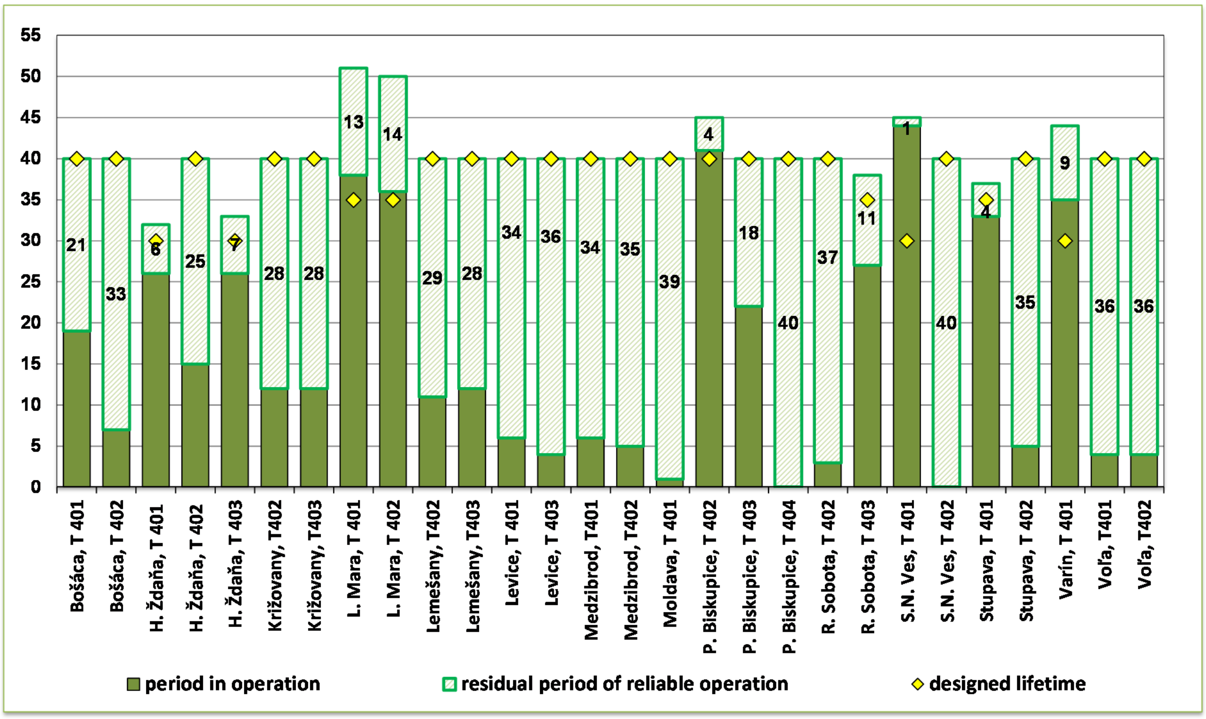
Power transformers which form the basis of the transmission system with the lines are installed almost in all substations except for the Veľký Ďur, Veľké Kapušany, Gabčíkovo, and Košice switching stations. The residual period of the reliable operation of SEPS transformers is verified based by regular diagnostic inspections. The detail information on the planned transformer replacements are described in Chapter 4.4 Internal Investment Projects. Further technical data is available on the SEPS website (https://www.sepsas.sk/TechnickeUdaje.asp?kod=16; in Slovak only).



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



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



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

2.1.4 Reactive Power Compensation Facilities

To compensate reactive power, only peaking coils which help to reduce voltage in the transmission system are used by SEPS. Directly on the 400 kV level, the compensation oil reactor only in ESt Veľké Kapušany is connected in TS SR.

Substation	Production year	Type	Operation period [years]	Q_n [MVAr]	Estimated residual period of reliable operation [years]
Veľké Kapušany, TL1. L1	1972	Oil	46	50	1
Veľké Kapušany, TL1. L2	1991	Oil	27	50	1
Veľké Kapušany, TL1. L3	1972	Oil	46	50	1
Veľké Kapušany, TL1. Q	1971	Oil	47	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 peaking coils in TS SR are connected in tertiary windings of TS/TS or TS/DS power transformers. Dry peaking coils in power series, in particular 45 MVAr (3x15 MVAr) are used but there are also power series 60 MVAr (3x20 MVAr) and 90 MVAr (3x30 MVAr) installed. Since these are maintenance-free devices and thus no diagnostics is performed as it is with oil-immersed type reactors or transformers, the residual period of reliable operation with dry peaking coils is not determined.

Transformer	Production year	Type	Operation period [years]	Q_n [MVAr]
Nominal voltage of the 33 kV system				
Križovany T402	2006	dry	12	2x45
Križovany T403	2006	dry	12	2x45
Lemešany T402	2007	dry	11	2x45
Lemešany T403	2007	dry	11	2x45
Moldava T401	1994	dry	24	1x60

Stupava T402	2013	dry	5	2x45
Sučany T401	1994	dry	24	1x60
	2003	dry	15	1x90
Rimavská Sobota T402	2015	dry	3	2x45
Voľa T401	2016	dry	2	2x45
Voľa T402	2003	dry	15	1x90
Nominal voltage of the 10 kV system				
Stupava T401	2005	dry	13	2x45

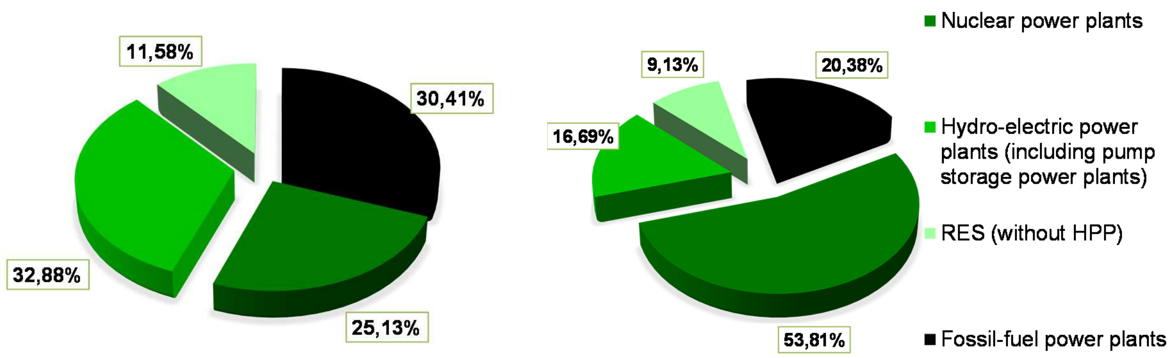
Table No. 3 Overview of Peaking Coils Connected to Tertiary Windings of Transformers

2.2 Current Situation of Electricity Generation Mix Installed Capacity and of Electricity Production

In terms of potential ensuring of generation mix appropriateness, ES SR in the generation mix has adequate installed capacity for electricity production. One third of the installed capacity consists of fossil-fuel power plants including heating plants and captive power stations with prevalence of fossil fuels co-combustion. The remaining part consists of nuclear power plants, hydro-electric power plants (hereinafter referred to as “HPP”) and renewable energy sources (hereinafter referred to as “RES”), the electricity generating facilities based on carbon-free technology.

Electricity Generating Facilities	Installed Capacity [MW]	Production [GWh]
Nuclear power plants	1,940	15,081
Hydro-electric power plants (including PVE - pump storage power plants)	2,539	4,677
RES (without HPP)	894	2,557
Fossil-fuel power plants	2,348	5,711
Total	**7,721**	**28,026**

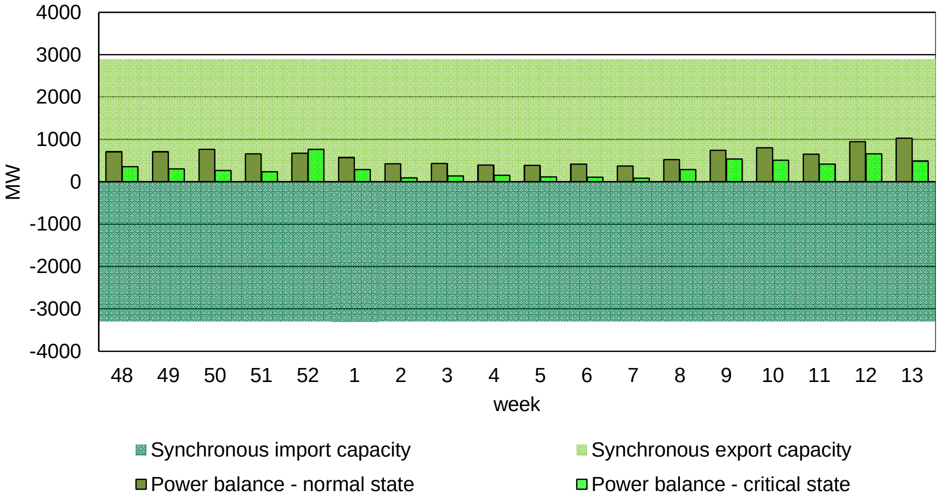
Table No. 4 Installed Capacity and Electricity Production of the Electricity Generating Facilities According to the Primary Energy Source (State as at 31.12.2017)



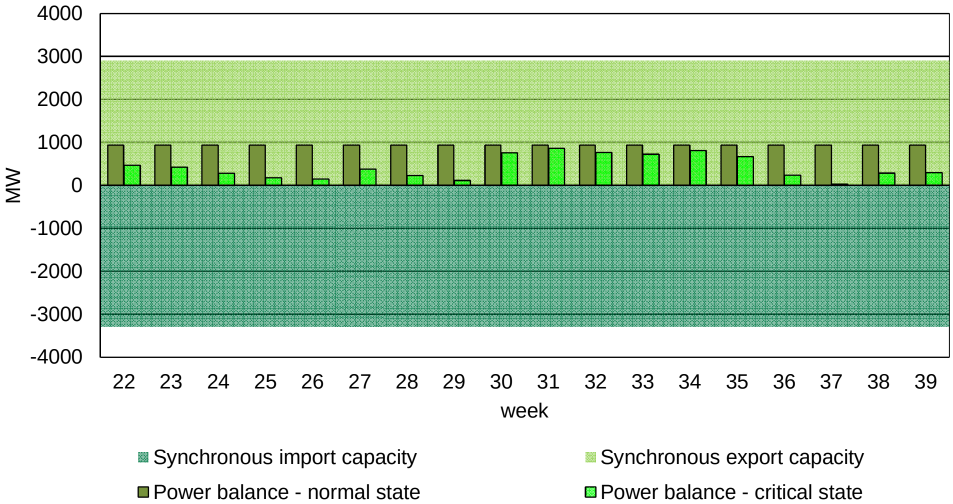
Graph No. 7 Percentage of the Installed Capacity (left side) and Produced Electricity (right side) of the Electricity Generating Facilities According to the Primary Source of Energy (State as at 31.12.2017)

In the course of the period 2008 – 2017, ES SR had import character (see Graph No. 10). Regarding toughening the emission limits due to EU goals in the field of climate, since 2012 gradual decommissioning of power plants on the basis of fossil, solid fuels (EVO I, units No. 1 and 2, ENO B units No. 3 and 4) had continued. In addition to these units, steam-gas power plants (PPC Bratislava and PPC Malženice) were decommissioned which proved high “operation flexibility” to maintain the system balance. In case of PPC Malženice, due to significant changes of market prices of commodities in 2018, re-commissioning for approx. 80 days occurred (10.07. – 28.09.2018). From 01.01.2019, it is in regular operation again.

Despite the aforementioned facts, there is an adequate production capacity ensured to cover electrical load in the Slovak Republic under standard and severe climate conditions. Similarly, the import capacity of TS SR is adequate to cover the peak loads in ES SR. However, in terms of cross-border lines loading and due to unplanned transit flows, there are situations occurring that endanger safe operation of the system (non-fulfilment of the N-1 criteria) which the TS SR operator resolves in cooperation with the neighbouring TSOs via remedial measures. Moreover, it is confirmed by the evaluation of the generation mix adequacy according to the ENTSO-E methodology by means of so called Seasonal Outlooks.[5, 6]



Graph No. 8 Evaluation of Generation Mix Adequacy in ES SR in Winter Period 2017/2018



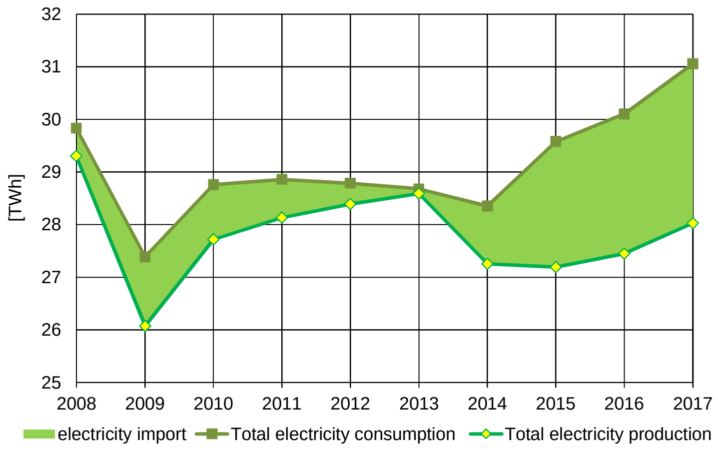
Graph No. 9 Evaluation of Generation Mix Adequacy in ES SR in Summer Period 2018

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

The total electricity consumption in the Slovak Republic on the level of 31,056 GWh in 2017 proves increase by 3.2 % against the previous year 2016. It is mainly due to persistent economic growth of SR. Despite minor increase of the electricity production in ES SR due to higher use of production in nuclear and fossil-fuel power plants, the import balance of ES SR increased to 3,030 GWh in 2017 what means 9.8 % of the total electricity consumption in Slovakia. The deficit was covered by electricity imported from abroad within the cross-border trading in electricity.

[5] https://www.entsoe.eu/outlooks/seasonal/

[6] Evaluation of generation mix adequacy, i.e. 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. 10 Development of Total Electricity Production and Consumption in Slovakia in the Period from 2008 to 2017

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 regarding the adverse development of ratio between their operating costs and market electricity prices unprofitable. Electricity traders profit more from purchasing electricity from abroad and its import than from electricity purchased from producers in Slovakia.

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

TS SR is interconnected with the surrounding TS but for Austria (hereinafter referred to as "AT") by ten cross-border transmission lines which are used for cross-border electricity exchanges. The directions of these exchanges are defined mainly by balances of individual electricity systems of Continental Europe and interconnections between them. The dominating directions of commercial and physical power flows on the Slovak cross-border profiles are from north or north-west to south and south-east where the exporting countries are the countries with the surplus production balance mostly in the north-west and north and the importing countries are importing ES to south or south-east of Slovakia. Due to aforementioned reasons, TS SR is loaded by transit flows which impose increased demands on the Slovak TSO to ensure safe operation of ES SR in every moment. The causes and consequences of transit flows will be analysed further in the text below.

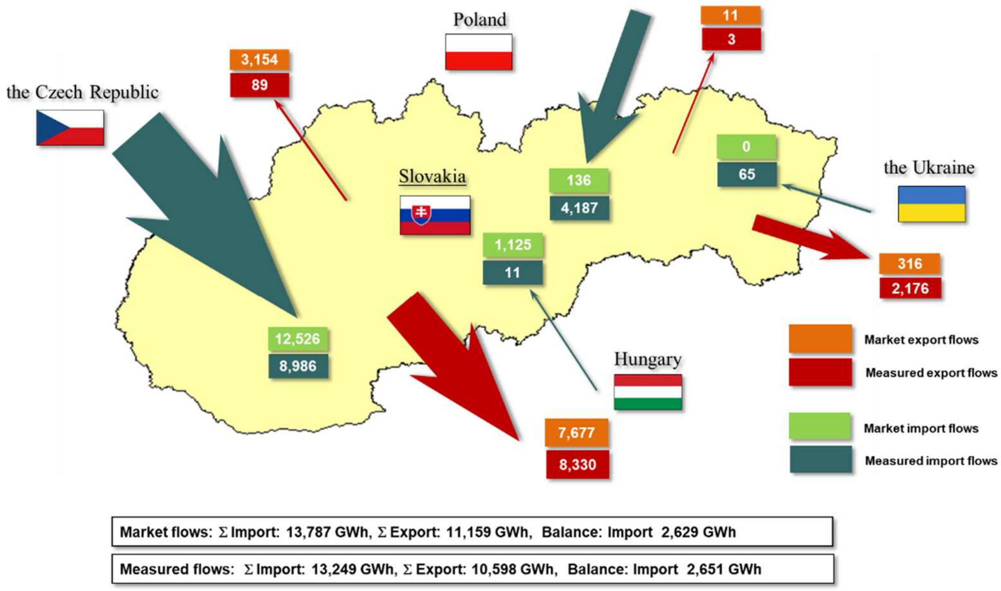
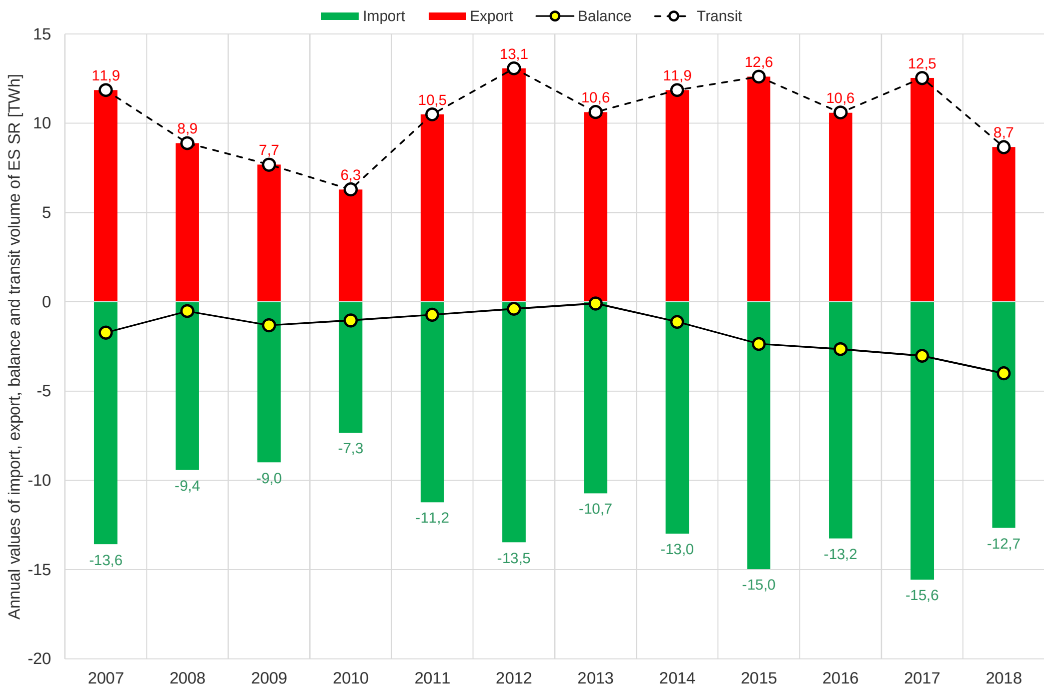


Fig. No. 2 Commercial and Physical Cross-Border Transmission Flows of ES SR in 2017

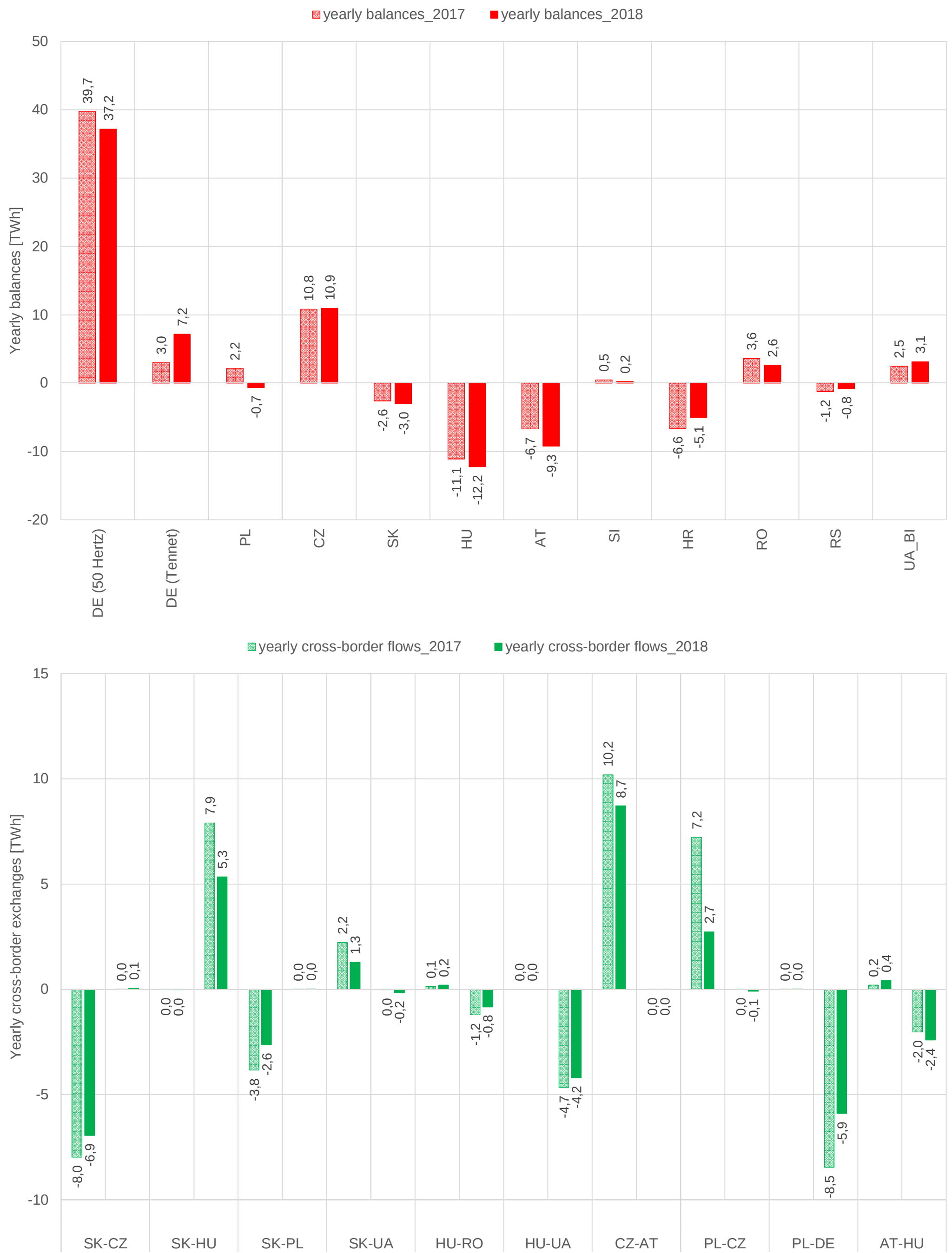
As in other years, in 2018, import flows were prevailing on the SK-CZ and SK-PL profiles and export flows were dominating on the SK-HU and SK-UA profiles. Compared to the year 2017, the decrease of both import and export flow volume occurred in 2018. Compared to the year 2017, the decrease of transit flow volume through TS SR occurred in 2018.



Graph No. 11 Import, Export, Balance of ES SR and Import and Export Physical Flows on the Slovak Cross-Border Profiles in 2018

The reasons for decrease of cross-border exchanges include:

- decrease of import from PL – decrease of PL balance – change of export character of balance in 2017 to import one in 2018 (see Graph No. 12). The reason is reduction of PL production from thermal coal power plants which form the substantial part of the PL generation mix what was caused by significant increase of prices of CO2 permits from the average annual value of 5 €/t (2017) to 15 €/t (2018),
- decrease of import from CZ, due to aforementioned reduction of PL balance (see Graph No. 12) since the PL-CZ profile is electrically very close to the CZ-SK profile and partially also due to reconstruction of the Nošovice (CZ) – Varín (SK) line (which has been thus out of operation).



Graph No. 12 Balances of ES in the CCE Region Together with Physical Cross-Border Electricity Transmissions in 2017 and 2018

The size of volumes of unplanned cross-border exchanges and transit flows are caused mainly by:

- values of production volumes or balances of surrounding interconnected ES,
- instability of electricity production from RES (especially electricity production from wind and photovoltaic power plants) with high total installed capacity in north-west Europe and its transmission to ES with the import balance in Central and South-East Europe what causes increase of demands for electricity transmission to long distances – increase of the distance between places of production and consumption,
- lagging and extending development of transmission infrastructure of interconnected TS in Central Europe in relation to the increased demand for electricity transmission as a consequence of liberalisation of the electricity market and due to sharp increase of the installed capacity of the electricity generating facilities from RES in recent years,

- configuration of market zones on the electricity market within Europe as well as currently valid mechanisms of calculation and allocation of cross-border capacities.

The unwanted consequences of planned and unplanned electricity flows which TSO must face are:

- great differences between physical and planned electricity flows,
- need of setting the higher value of the safety reserve TRM ("Transmission Reliability Margin") on the given cross-border profiles what causes reduction of freely tradeable capacity,
- increased demands to ensure safe and reliable operation of TS SR and increased losses on the transmission facilities in TS SR.

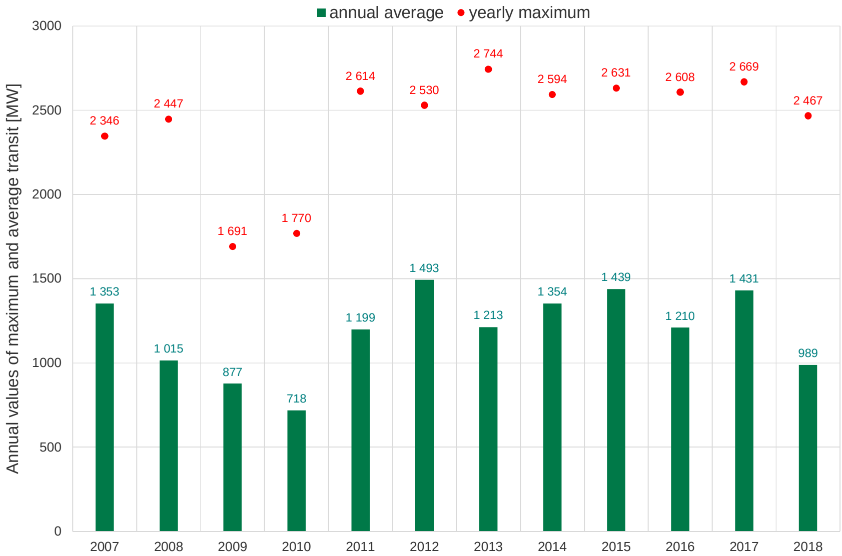
The Slovak TSO disposes of limited possibilities to settle the consequences of unplanned electricity flows as well as to ensure operational safety and reliability in this regard. TSOs are not allowed to interfere in market mechanisms in the environment of the liberalized electricity market, unless the system safety is threatened. Remedial measures which TSOs may use according to the RG CE ENTSO-E Operational Handbook are any measures applied by TSO in time to meet the N-1 criterion. The possibilities of use the remedial measures in ES SR are as follows:

- cancellation of planned works on TS facilities,
- reconfiguration in TS SR,
- tripping of lines in TS SR,
- re-dispatching
- counter-trade,
- reduction of tradeable capacities on cross-border profiles,
- restriction of electricity consumption in the control area of SR (implementation of consumption in ES SR is possible only after declaration of state of emergency in ES SR).

The unwanted consequence of applying the aforementioned remedial measures may include partial reduction of safety and reliability of operation of the given part of TS SR.

All remedial measures of the neighbouring TSOs which influence the TS SR operation should be consulted and coordinated with the Slovak national dispatch centre. The decision by the dispatcher is always subject to assessment of the actual situation in ES, impacts on the system operation safety, fulfilment of international obligations and economic impacts on SEPS.

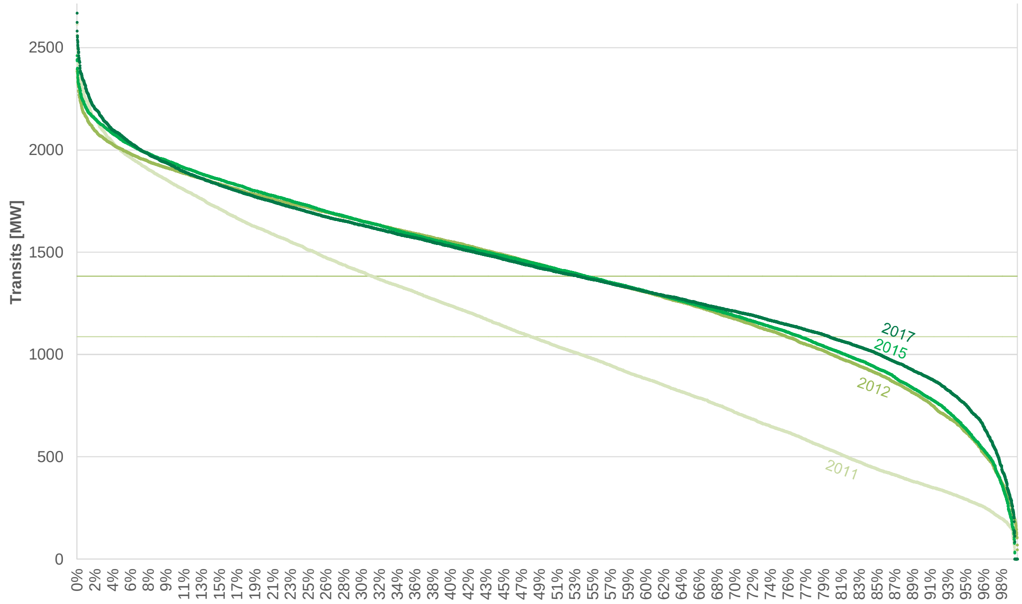
Disregarding the operational and business measures aimed at preventing the impact of transit flows on the ES SR operational safety, SEPS works also on long-term conceptual solutions and measures via investment projects consisting in strengthening internal and cross-border transmission infrastructure.



Graph No. 13 Average and Maximum Annual Values of Electricity Transits through ES SR in the Period 2011 - 2018

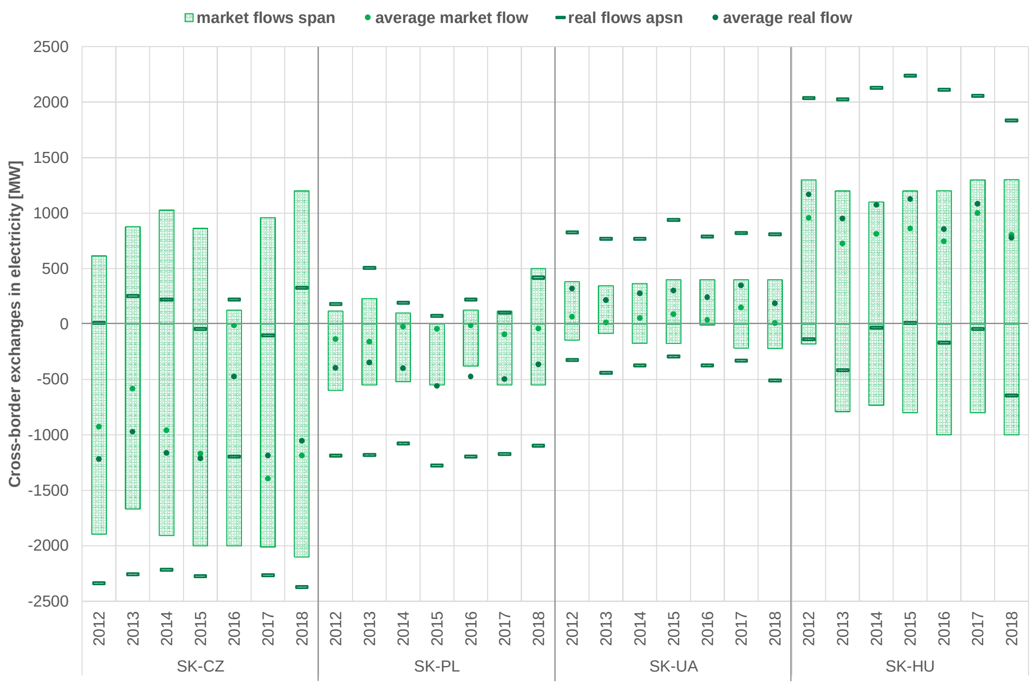
Graph No. 13 shows the development of maximum and average values of transit flows through TS SR. Average values of transit flows through TS SR proved the increasing trend in the period 2013 - 2015 as well as between the years 2016 and 2017, on the contrary, decrease of the transit flow volume through TS SR in the years 2017 and 2018 was recorded what is clearly proved by average values. Decrease of transits for TSO did not mean directly proportional reduction of complex operating situations in the year which they must cope with in the real operation since maximum values of transit flows have not changed significantly since 2011.

Graph No. 14 shows the transit flows duration curves in TS SR in the selected years from 2011 to 2017 which document and support the aforementioned conclusions.



Graph No. 14 Curves of Transit Flows Duration in TS SR in the Selected Years from 2011 to 2017

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



Note: The values of physical flows in 2018 will be finally adjusted in March 2019

Graph No. 15 Comparison of Ranges of Market and Physical Flows on SK Cross-Border Profiles in 2012 and 2017

Graph No. 15 shows asynchronous maximum and average absolute values of market and physical cross-border electricity exchanges on individual SK cross-border profiles in the year, in the period from 2012 to 2017. The graph shows that on majority of profiles, especially in the directions with prevailing physical flows, the real maximum values of power flows are much bigger than market flows. Moreover, average values of physical flows exceed those of market flows.

Note: in the year 2012, there are only 2,665 trading 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 there are only 2,665 trading hours in the year to maintain the same time windows and comparable values.
In recent years, there are 8,760 trading hours considered as 100 % of the annual time fund or total of 8,784 hours in the leap years 2012 and 2016.

Graph No. 16 Comparison of the Monitored Indicators of Functionality of the Interconnected Electricity Market on the SK Cross-Border Profiles which are a Part of 4M MC in the Period 2012 - 2018

Graph No. 16 evaluates functioning of 4M MC among CZ-SK-HU-RO for the period 2012 - 2018 focusing on the SK-CZ and SK-HU cross-border profiles. The graph evaluates annual percentage of trading hours with the identical and different prices on the two mentioned profiles. Different prices between two control areas with the joint cross-border profile indicate insufficient market transmission capacity on the respective cross-border profile in 4M MC. The percentage of trading hours with different prices from the total number of trading hours in a year on both SK profiles which form a part of 4M MC was growing in the period 2012 - 2015 and 2016 - 2017. In the period between 2017 and 2018, the drop in the number of hours with different prices, especially on the SK-HU profile occurred where this drop was 40 %, nevertheless, it indicates high demand for tradeable capacity and narrow cross-border profile in the central-eastern EU region. Also due to this reason SEPS and MAVIR (TSO in Hungary) plan strengthening of the SK-HU profile with new 400 kV cross-border lines. The drop on the SK-CZ profile reached 4 %. Development of adequacy or inadequacy of tradeable capacities on the Slovak cross-border profiles 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 and therefore all possible reasons of such development are explained in Chapter 3.4.

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. The process of its implementation into real operation is expected in the course of the year 2019.

The idea for the flow-based allocation of capacities is an effort to include the actual TS topology 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 minimization of differences between the market and physical flows in maximum extent what would minimize consequence of these differences, i.e. unplanned transit flows in electricity.

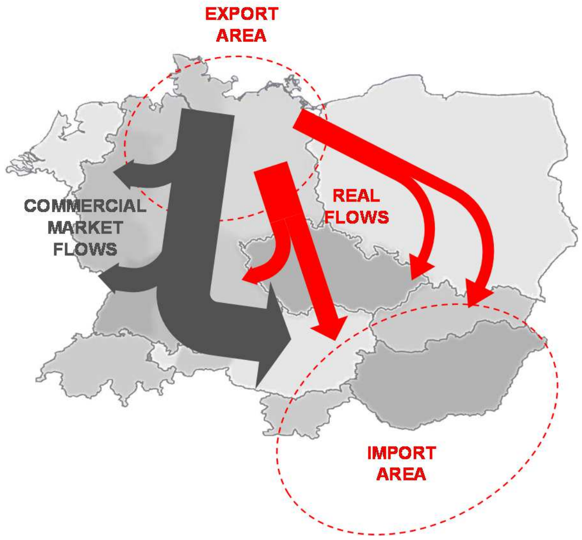


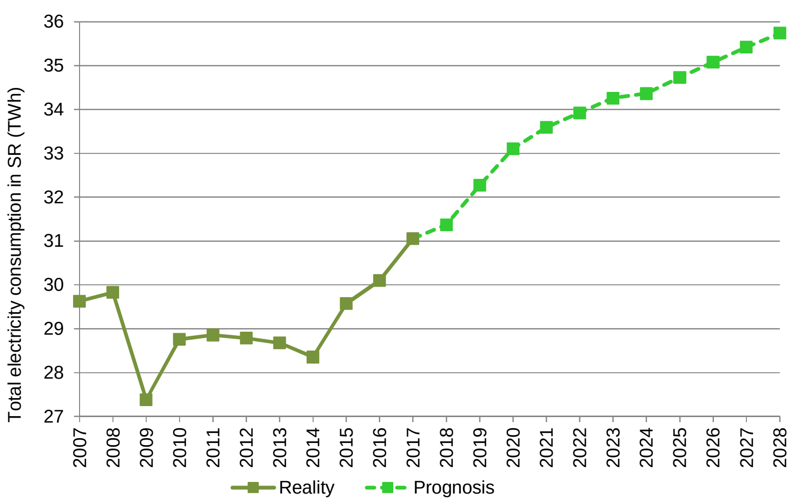
Fig. No. 3 Graphic Representation of the Circular Transit Flows in the CCE Region

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 (marked in red colour in Fig. No. 3) should be significantly close to market flows (marked in dark grey colour in Fig. No. 3). Further significant step to make market exchanges closer to the actual ones is division of the joint DE-AT market zone (valid from 1 October 2018). The impact of this step on the cross-border exchanges in the CCE region will be subject to the detailed analysis in the next year 2019.

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

3.1 Assumptions for Electricity Consumption in Electricity System of Slovakia

The total electricity consumption recorded in 2017 means current historical maximum of electricity consumption in the Slovak Republic. In the period by 2028, an average inter-annual increase in electricity consumption in the Slovak Republic on the level of 1.23 % is assumed based on the update of the electricity consumption forecast. Based on this assumption, the electricity consumption by 2028 would increase in the monitored period by 4.68 TWh what is 15.08 % growth compared to the year 2017. Based on the continuous monitored and evaluated statistical data by the date of processing this TYNDP, in 2018 the total electricity consumption on the level of the previous year is expected in the Slovak Republic. Even despite that, further increase of electricity consumption in the Slovak Republic of 33.11 TWh in 2020 and 34.73 TWh in 2025 is assumed.



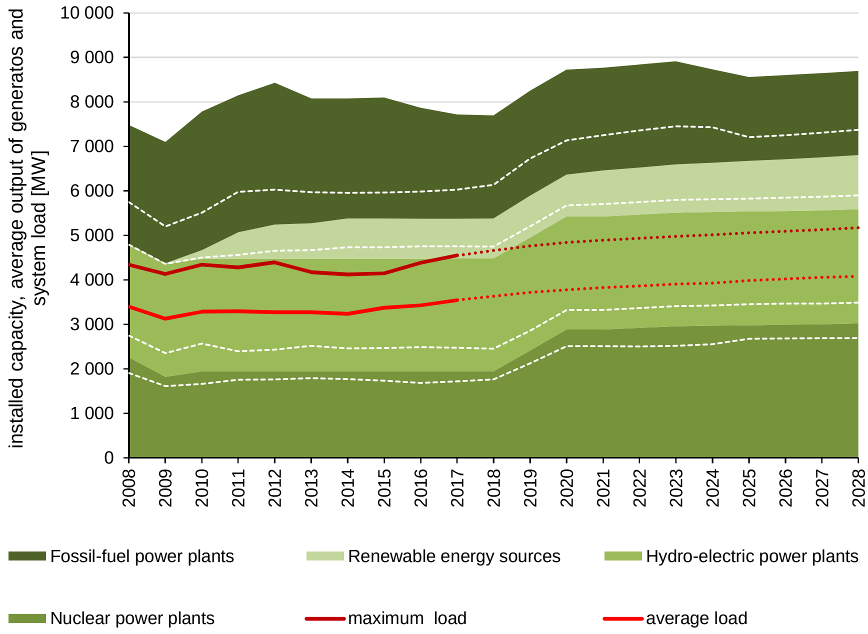
Graph No. 17 Prognosis of the Total Electricity Consumption Development in Slovakia

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 2 TWh in 2028.

3.2 Assumptions for Electricity Production in Electricity System of Slovakia

Within the monitored period of this TYNDP, even despite decommissioning of the existing generation capacities due to emission limits, the increase of the installed capacity of electricity generating facilities in the Slovak Republic by more than approx. 1,000 MW is expected, what according to the market simulation will mean increase by approx. 8 TWh in the electricity production. 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.

The following 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.

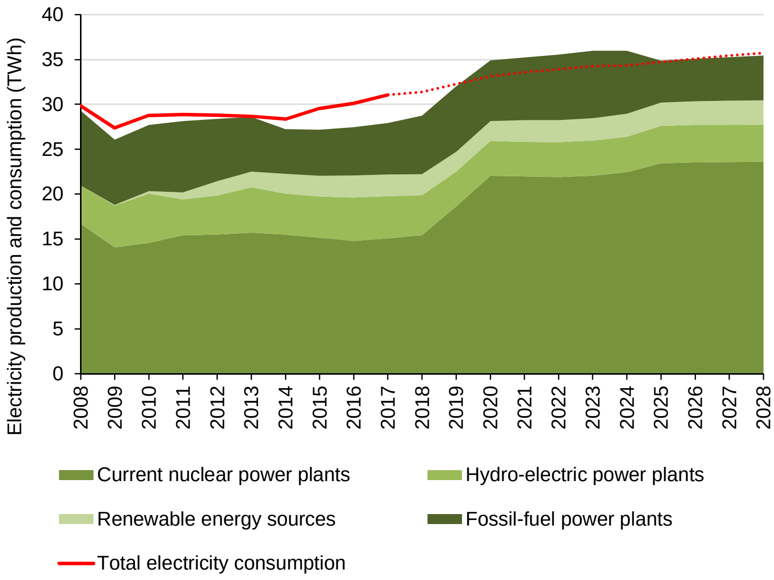


Graph No. 18 Assumed Development of Installed Capacity of Electricity Generating Facilities and Average and Maximum Load of the Slovak Republic by 2028 [MW]

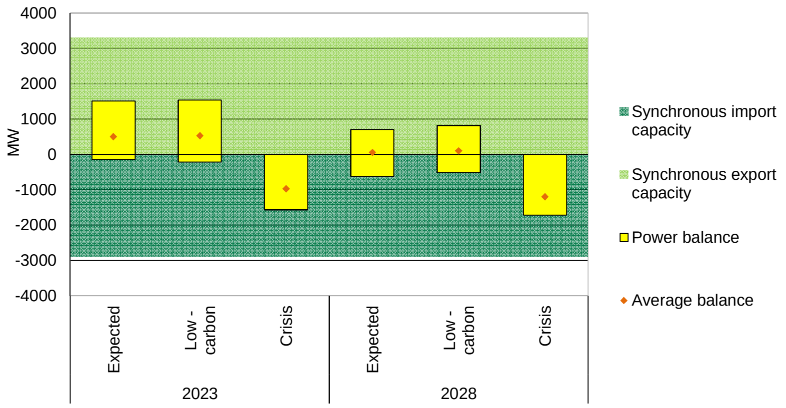
To ensure generation mix adequacy in ES SR, the conditions must be provided to include electricity generating facilities for load coverage with such technology that will be capable of flexible provision of adequate power reserve in the system, mainly at the time of peak load or also in cases of unexpected outages. The operation of such electricity generating facilities is inevitable in certain volume to cover the required volumes of ancillary services via which SEPS provides system services for all ES SR users. In case of facilities based on fossil fuel combustion the operation strongly depends on the economic indicators and emission limits. 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 electricity markets, 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 can be assumed in 2020 by 0.2 TWh and in 2025 even by 2.4 TWh compared to the assumptions of electricity production development according to the approved Proposal of Energy Policy of the Slovak Republic.

Ensuring adequate capacity of the electricity generating facilities to cover electricity consumption in the Slovak Republic (generation mix 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 building 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 mix adequacy of SR based on the market simulation according to the ENTSO-E[7] methodology as a range of the existing power balance in weekly maximum loads in cross-sectional years 2023 and 2028 for scenarios mentioned in Chapter 4.2. The shortage of power appears in the mentioned states in all scenarios.



Graph No. 19 Assumed Electricity Production and Consumption in the Slovak Republic by 2028 (weekly maximums) [TWh]



Graph No. 20 Evaluation of Generation Mix Adequacy in ES SR in Time Horizons of 2023 and 2028

TS SR, however, has adequate transmission capacity to ensure electricity import/export to cover expected load of the system (disregarding the influence of electricity transits through ES SR, loop flows, etc.).

In terms of securing inevitable volume of system services, based on the market simulation in weekly maximum loads of the system in the Slovak control area with unchanged conditions, approx. 20 % of the required regulation reserves (especially SRV) in dependence on the considered generation mix in the relevant scenario may not miss. These are extreme situations of instantaneous inadequacy of the regulation power which occur also at present. In extraordinary operational situations in case of non-coverage of the requirements of individual PpS to 100 %, TSO dealt with the situation by purchase of the guaranteed or non-guaranteed regulation electricity from abroad to ensure safe operation of ES SR.

Covering of electricity consumption additions and replacement of expired generation capacities should be resolved 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 electricity generation facilities, especially consideration of requirements for safe and reliable operation and management of ES SR and requirements for electricity supply safety in Slovakia.

3.3 Assumptions for Electricity Exchanges with Other 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 rate of uncertainty which shall be taken into consideration with such prognoses. In case of the following considerations, the allocated commercial transactions in 2017 and two possible scenarios of future development of the generation mix, electricity consumption and

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

development of market capacities in interconnected TS within ENTSO-E which is documented in the ENTSO-E database for the purpose of processing TYNDP served as a basis. In order to define assumptions of exchanges in electricity of the Slovak Republic with the neighbouring countries, the “Expected Progress 2020” scenario from 2016 TYNDP was used for the development time horizon 2023 and the “Best Estimate 2025” scenario from 2018 TYNDP was used for the development time horizon 2028.

The “Expected Progress 2020” and “Best Estimate 2025” scenarios represent the best possible estimate by all TSOs associated in ENTSO-E in terms of generation mix, transmission capacities and estimated consumption of individual TS and they include realistic fulfilment of the national action plans for energy from RES of individual EU member states or similar documents in case of the ENTSO-E members which are not EU members.

The following picture shows prognosis (results of simulations) of annual market cross-border electricity exchanges between the Slovak Republic and neighbouring TS for the monitored time horizons of 2023 and 2028 and evaluation of these exchanges in the form of summary annual volume of imported and exported electricity of the Slovak Republic and the resulting annual balance of the Slovak Republic. From the point of view of the Slovak Republic, compared to the year 2017 (see Chapter 2.4), the volume of exchanges is significantly lower especially in the CZ→SK and SK→HU directions. In general, the reason of such differences are input documents used in the ENTSO-E scenarios which include the development of the transmission infrastructure of individual TS, development/attenuation of generation mix, assumed price of CO2 emissions, primary fuels etc. The volume of exchanges is influenced especially by balances of individual ES, whether in the Slovak Republic but in this case mainly foreign ES, in particular DE and CZ with export balance significantly lower compared to 2017. In particular, DE has its export balance in both development time horizons lower by approximately 60 % against the year 2017 due to planned decommissioning of nuclear power plants. This is the main reason of significantly lower market exchanges on cross-border profiles of the Slovak Republic compared to the year 2017.

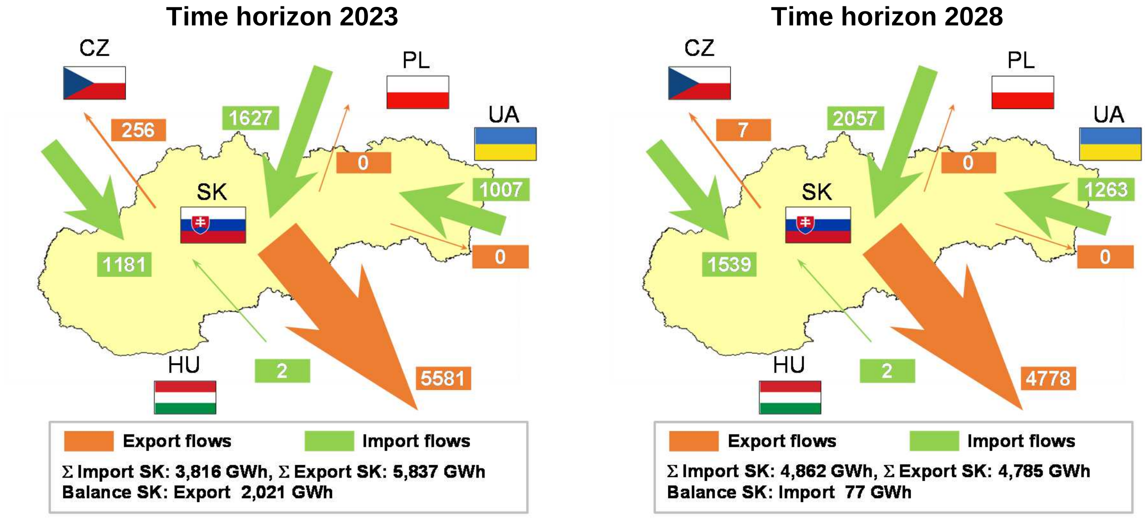


Fig. No. 4 Assumed Annual Volumes of Market Cross-Border Electricity Transmissions on SK Profiles for the 2023 and 2028 Time Horizons from the Simulation Models of the ENTSO-E Generation Mix Operation (Without Consideration of Transit and Loop Flows)

Though based on the results of simulations for 2023 and 2028 it is possible to assume the volume of market cross-border transmissions of electricity will drop, however, due to growing installed capacity of RES with intermittent character of electricity generation, it is still necessary to take into account presence of physical transit flows (Graph No. 14) and the related increased intermittent transmitted power (physical) through TS SR (Graph No. 15), what results in the increased load of some of TS SR elements.

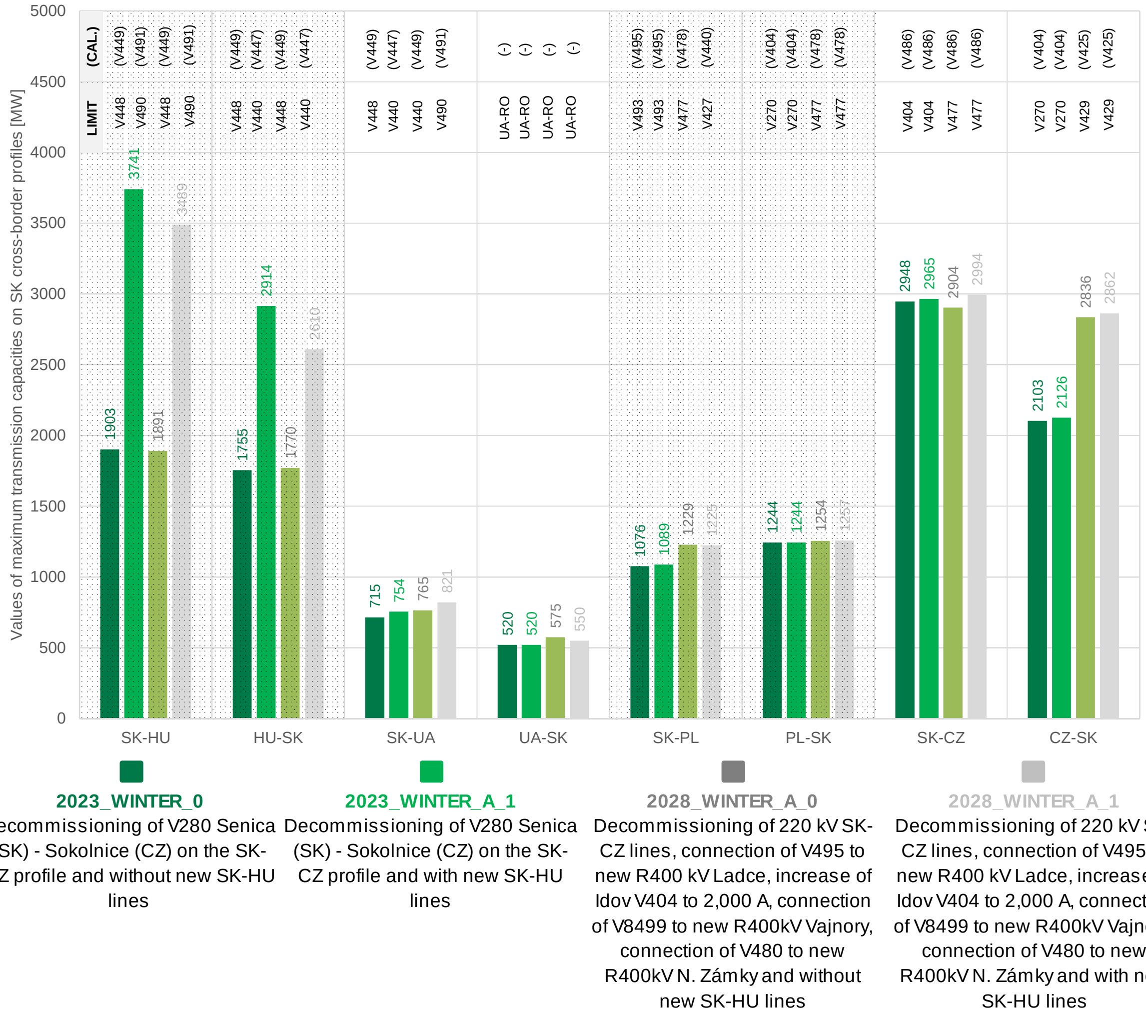
It is possible to conclude the provided assumptions of volume and direction of electricity flows from ES SR confirm the proposed solutions for strengthening the transmission infrastructure on the cross-border profiles. Moreover, it is obvious that volume and direction of power flows depend on development of the transmission infrastructure, generation mix as well as on political decisions not only in the Slovak Republic but also in the countries the TSOs of which are ENTSO-E members. The current and expected development of cross-border electricity flows is one of the main drivers of the decisions on building a new cross-border lines.

3.4 Cross-Border Transmission Capacities Development

The calculations of transmission capacities on individual cross-border profile were performed in all import and export directions despite the fact that at the time of processing this document, and, moreover, in the results of the stabilized operation of ES SR in individual scenarios and time horizons of this national TYNDP, power flows through ES SR in the direction from north or north-west to south prevail.

The values of maximum transmission capacities on individual cross-border profiles were calculated for development time horizons 2023 and 2028 both for import and export direction of power flows while considering the restrictions only in TS SR, i.e. validity of the basic N-1 safety criterion is verified only on the TS SR components. The calculation of values of transmission capacities on cross-border profiles depends especially on the system topology and connection, location and deployment of production on electricity generating facilities and on maximum permitted current loads of lines.

The values of maximum transmission capacities of SK cross-border profiles are calculated for the basic state of the system connection, generation mix operation and loads considered for individual development time horizons (R+5 and R+10). The values of operational transmission capacities set for the current situation, maximum for R+1 are calculated also with considering current connection of the system, deployment of generation mix (maintenance of power plants and transmission elements) and loads in the given calculated hour. For the current situation or for time horizons R+1, the tradeable (net) transmission capacities are set that consider also inevitable safety reserves for the unexpected events and for occurrence of big differences between market and physical power flows, so called loop flows. Along with consideration of these situations, the quantification of which is very difficult to estimate for future years, the calculated values of the tradeable transmission capacities for the time horizons 2023 and 2028 would be lower compared to the provided values of maximum transmission capacities.



Graph No. 21 Development of Maximum Transmission Capacity Values on the SK Cross-Border Profiles in Time Horizons of 2023 and 2028 in Both Import and Export Direction

Based on the results of calculation of transmission capacities of the SK cross-border profiles in time horizons 2023 and 2028, 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. 47 % in the import direction. Commissioning of these new SK-HU lines has minimal or negligible impact on maximum transmission capacities of other SK cross-border profiles.

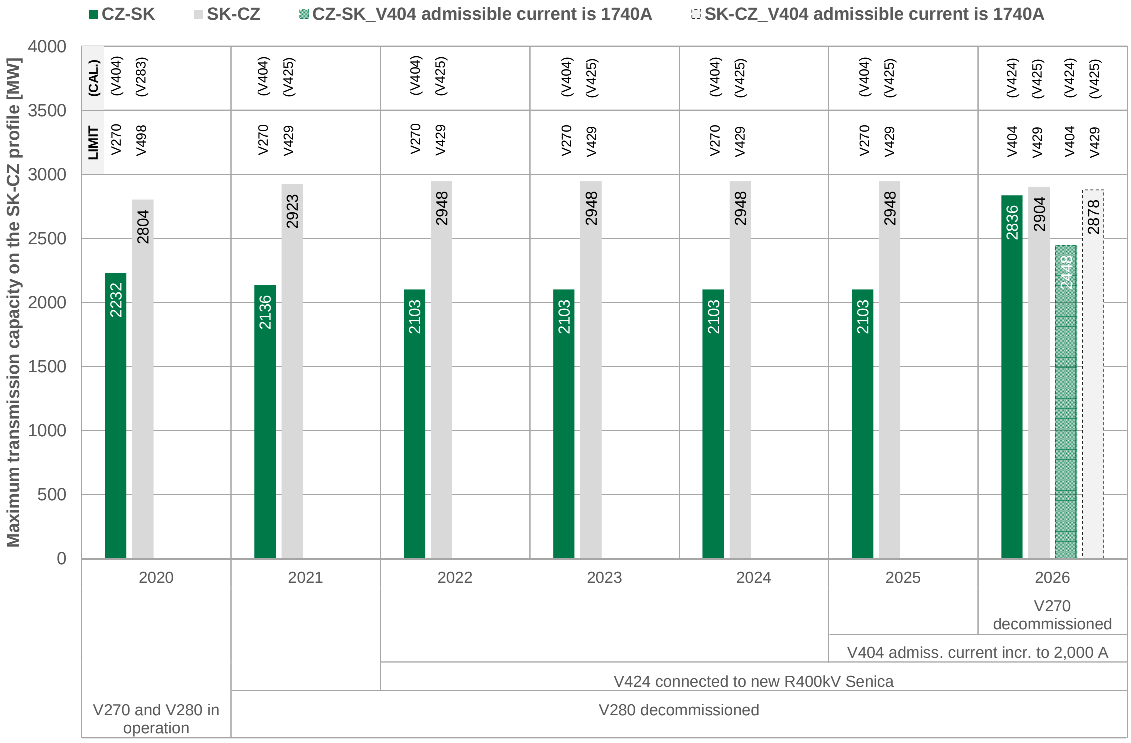
Decommissioning of the 220 kV system in the Central and West Slovakia regions, especially 220 kV cross-border lines on the SK-CZ profile and increase of maximum current loading of the V404 Varín (SK) – Nošovice (CZ) line to 2,000 A, compared to the time horizon 2023 with the decommissioned 220 kV cross-border line on the SK-CZ profile V280 Senica (SK) – Sokolnice (CZ) and the new R400kV Senica connected to the existing line V424 Križovany (SK) - Sokolnice (CZ) will cause increase of the maximum transmission capacity on the SK-CZ profile in the import direction by 35 % while the increase in the export direction is negligible. Decommissioning of the 220 kV system in the western part of TS SR and increase of permitted current loading of the V404 line proves minimum or negligible impact (maximum 3 %) on other assessed cross-border profiles.

Within the time horizon of 2022, SEPS considers decommissioning of the cross-border 220 kV line V280 Senica (SK) – Sokolnice (CZ) on the SK-CZ profile as a part of the process of the planned gradual decommissioning of the 220 kV part of TS in the Central and West Slovakia regions. Within the time horizon of the year 2026, SEPS considers decommissioning of the 220 kV cross-border line V270 Považská Bystrica (SK) - Lískovec (CZ). These topological changes may reduce maximum transmission capacity in both import and export direction on this profile approximately by 10 % from the current maximum value what was, moreover, confirmed by the results of calculations of the joint SEPS and ČEPS study. To achieve the biggest reduction of the period with the reduced value of maximum transmission capacity on the CZ-SK profile due to full decommissioning of the 220 kV cross-border lines, one of the main general recommendations of this Study for both companies is synchronization of the planned investment measures both in technical solution and timing. To eliminate consequences of reduction of the maximum transmission capacity on the CZ-SK profile, by 2025 the increase of the maximum permissible current loading on the V404 Nošovice (CZ) – Varín (SK) cross-border 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 a new simple 400 kV line. Based on implementation of the above-mentioned 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 maximum transmission capacity 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 as possible to achieve the biggest reduction of the period with the reduced value of maximum transmission capacity on the CZ-SK profile due to full decommissioning of the 220 kV cross-border lines.

Graph No. 22 shows the development of the 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 concerning strengthening the V404 Varín (SK) – Nošovice (CZ) line. Graph No. 22 clearly shows that:

- after decommissioning the 220 kV cross-border line V280 Senica (SK) – Sokolnice (CZ) in 2021, maximum transmission capacity on the CZ-SK profile in the import direction will drop by 96 MW (approximately by 4 %). On the contrary, in the export direction maximum transmission capacity will increase by 119 MW (approx. by 4 %) since the limiting element of the calculation was the V280 Senica (SK) – Sokolnice (CZ) line.
- After increase of maximum current loading of the V404 Varín (SK) – Nošovice (CZ) cross-border line from the current 1,740 A to approximately 2,000 A in 2025, no increase of the transmission capacity on the SK-CZ profile will occur. The reason is that the limiting element at TTC calculation in the direction from CZ to SK is 220 kV cross-border line V270 Považská Bystrica (SK) – Lískovec (CZ) in case of outage of V404. In the export direction the value of the maximum transmission capacity will not change or the change is negligible.
- As soon as at the moment of decommissioning of the V270 Považská Bystrica (SK) – Lískovec (CZ) line, the maximum transmission capacity will grow by 733 MW (approximately by 35 %) in the import direction since the limiting component will not be V270 but the strengthened V404 line.

If the V270 Považská Bystrica (SK) – Lískovec (CZ) line was decommissioned even prior to increase of the maximum permitted current loading of the V404 Varín (SK) – Nošovice (CZ) line, the maximum transmission capacity in the import direction would grow by 345 MW, approximately by 16 %. In the export direction the value of the maximum transmission capacity will not change or the change would be negligible.



Graph No. 22 Development of Transmitted Capacities on the SK-CZ Profile by Individual Years While Considering Gradual Steps of Decommissioning the Cross-Border 220 kV Lines Including the Planned Investment Concerning Strengthening the V404 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 2028 is expected on those cross-border profiles.

All considerations and assumptions on development of maximum transmission capacities of individual cross-border profiles of TS SR in the time horizons of the years 2023 and 2028 described above stem from the SEPS and ENTSO-E analyses and assumptions. The provided values of maximum transmission capacities of the analysed development time horizons (2023 and 2028) should 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 closest period are or will be specified by the national dispatch centre.

3.5 The Transmission System Development Plan for the Entire EU and Regional Investment Plans

TS SR is a part of the synchronously connected and operated European transmission system ENTSO-E. Within ENTSO-E, a ten-year network development plan describing the possibilities and possible direction of development of the entire transnational ENTSO-E network for the coming ten years is being elaborated every two years. In December 2018, fourth 2018 ENTSO-E TYNDP was published. In general, ENTSO-E TYNDP is a non-binding document aimed at ensuring greater transparency regarding investments to the infrastructure in the entire European interconnected TS 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, ENTSO-E 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 European importance projects attributed to them within ENTSO-E TYNDP will form the basis for selection of the priority European projects addressed 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 2018 document is as follows:

- 2x400 kV Gabčíkovo (SK) – Gönyű (HU) – Veľký Ďur (SK) line,
- 2x400 kV Rimavská Sobota (SK) – Sajóivánka (HU) line equipped with one circuit,
- The fourth SK – CZ 400 kV cross-border interconnection

The union-wide list of PCI projects is adopted by the delegated regulations of EC. The Union-wide list of PCI projects always stems from the last valid ENTSO-E TYNDP in the year following the year in which the list of projects of pan-European interest in the ENTSO-E TYNDP document was issued. The current 3rd Union-Wide List of PCI Projects from 2017 is based on 2016 ENTSO-E TYNDP and it includes the following PCI projects with SEPS being their promoter or co-promoter:

- 2x400 kV Gabčíkovo (SK) – Gönyű (HU) – Veľký Ďur (SK) line,
- 2x400 kV Rimavská Sobota (SK) – Sajóivánka (HU) line,

At present, 4th Union-Wide List of PCI Projects is being prepared into which in addition to the projects of the SK – HU cross-border profiles, a new project of the cross-border interconnection between Slovakia and the Czech Republic seeks to be included. The assumed approval date of 4th List of PCI Projects stemming from the recent valid 2018 ENTSO-E TYNDP is till October 2019.

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 so that the national regulator weighted these projects adequately upon forming a regulatory framework regarding the pan-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.

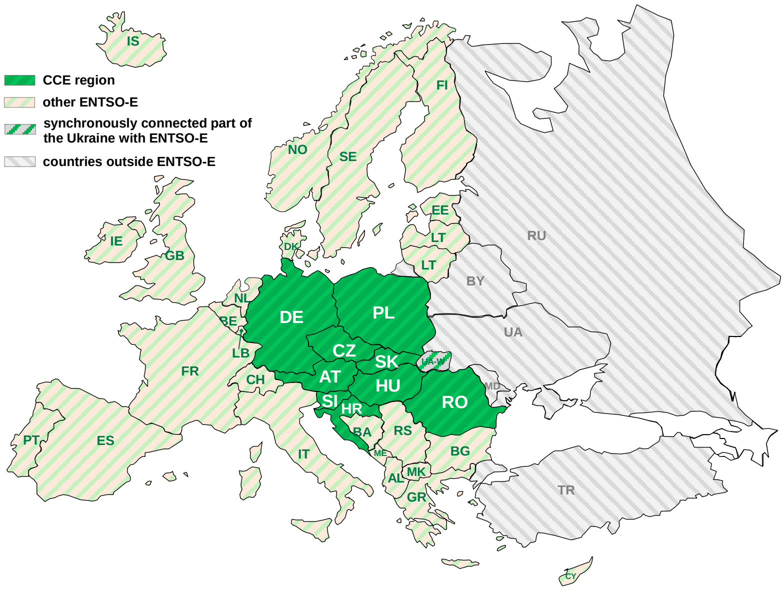


Fig. No. 5 Map of the CCE Region and Other European and ENTSO-E Countries

There is also RgIP being elaborated within the CCE region together with the ENTSO-E TYNDP report[8]. It identifies the Projects of Regional and National Significance which are not or will not be a part of the ENTSO-E TYNDP document since they fail to meet the status of projects of European interest and finally they do not correspond to the PCI interest, however, they still play an important role at planning of transmission system infrastructure development in the region in order to ensure safe operation of interconnected TSs.

In RgIP CCE 2017, SEPS has the following investment projects:

- 400/110 kV Senica transformer station,
- Reconstruction of ESt Bystričany to 400 kV,
- 2x400 kV line Križovany – Horná Ždaňa (with looping one circuit to new 400 kV switching yard Bystričany),

[8] https://docstore.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/rgip_CCE_Full.pdf

- Doubling of 400 kV line Lemešany – Veľké Kapušany including extension of 400 kV Lemešany and Veľké Kapušany switchyards.

4. National Ten-Year Network Development Plan for the Period 2020 – 2029

The projects of the SEPS ten-year investment plan by the year 2029 are verified by the SEPS network calculations for the considered scenarios and variants of the electricity system development for the time horizon 2029. 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.

4.1 Transmission System Development and Requirements of TS SR 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 from TS or electricity producer connected to TS leading to the need of the TS SR topology strengthening are usually submitted to SEPS "directly" via an application for connection to TS or via the request for the SEPS statement 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 Plan 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 Plan since pursuant to Act No. 251/2012 Coll. and the document Technical Conditions for Access and Connection, Transmission System Operation Rules (i.e. SEPS Connection Code; Document N, Chapter N1) all TS SR users are obliged to submit inputs to process the SEPS Development Plan. Moreover, the SEPS Development Plan considers the development of the neighbouring TS operators and it is in compliance with the ENTSO-E TYNDP.

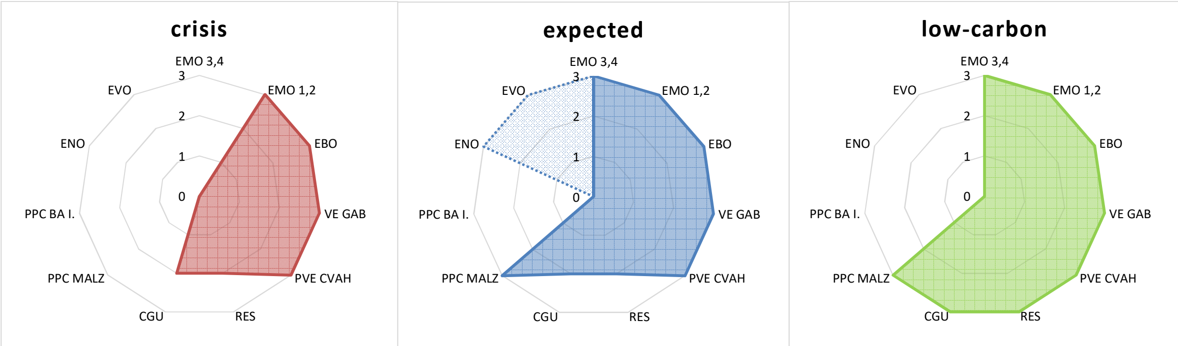
As for the requirements of the existing distribution system operators, these have an option to ask SEPS to strengthen the transmission system in compliance with the Operation Rules of the Transmission System Operator Slovenská elektrizačná prenosová sústava, a. s. (i.e. SEPS Operational Code). Electricity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

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

SEPS as TSO pursuant to Art. 28, par. 2, subpar. d) of Act No. 251/2012 Coll. is obliged to provide for system coordination and development. For the purpose of TS SR development planning, all entities directly connected to TS SR are obliged to provide SEPS with inputs within the range defined by the SEPS Connection Code publicly available on the SEPS website[9]. 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 the 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 SEPS Development Plan. Moreover, detailed network models of ES SR for the time horizons 2023 and 2028 and for individual variants of the possible development 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. Scenarios specify probable development of the generation mix in the Slovak Republic and its impact on ensuring safe and reliable operation of ES SR in the monitored period. Altogether, there were three scenarios of the possible development of the generation mix in ES SR elaborated while the electricity consumption deployment is identical for all scenarios. The next graph shows varying of generation mix per the scenario. The corners of the polygons (representing individual scenarios) mean considered assumptions and their quantification.

[9] https://www.sepsas.sk/TechPod.asp?kod=281 (in Slovak only)



Graph No. 23 Graphical Representation of Scenarios and Quantification of Considered Assumptions for ES SR Development in Cross-Sectional Years of 2023 and 2028

The expected scenario is the most probable development of the ES SR generation mix from the TSO's perspective. The scenario considers completion and commissioning of both Units No. 3 and No. 4 of the Mochovce nuclear power plant (EMO 3,4) according to the current time schedule. Furthermore, it considers the profitable operation of PPC Malženice. PPC Bratislava I. will be operated only for provision of ancillary services. In the medium-term horizon, the Nováky and Vojany power plants will be decommissioned due to non-profitable operation of those power plants. Slight increase of decentralized production on the basis of gas is considered and after the year 2021 slight increase of RES (according to the assumptions of SEPS by approx. +380 MW in the installed capacity, of which FVE +160 MW and VTE 100 MW) is expected.

The crisis scenario is to 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 PPC Malženice, PPC Bratislava I, Vojany, Nováky and, concurrently, at delay of completion of EMO 3,4 (postponement of commissioning for the later period).

The low-carbon scenario considers high increase of the installed capacity in RES and CGU based on the SEPS estimate as a substitution for the current fossil fuels. Commissioning of EMO 3,4 is considered as well as the operation of PPC Malženice. The scenario is to verify adequacy of regulation reserves in the system due to high increase of RES (total addition of approx. +1,130 MW, of which FVE +560 MW and VTE +230 MW).

The status 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 detailed 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 through TS SR.

Main objectives, input assumptions and the preparation process of individual time horizons, scenarios and variants which were subject to network analysis and analysis of generating mix operation and calculations in a two-year process of the 2018 TYNDP preparation within ENTSO-E, are mentioned in the final report "2018 ENTSO-E TYNDP Scenario"[10].

4.3 Investment Needs for Transmission System Development

In case of reconstructions of the existing substations and building new substations, 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 the requirements for sufficiently long trouble-free operation of this equipment with minimum demands for performance of revision and maintenance activities. The same applies to erection or reconstruction of transmission lines and to all secondary 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 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.

10 https://tyndp.entsoe.eu/tyndp2018/scenario-report/

Line designation	Assumed Year of Decommissioning
V274, V280	2021
V071, V072	2022
V283	2023
V273	2025
V270, V271, V275	2026[11]

Table No. 5 Overview of Decommissioning of 220 kV Lines

Termination of TS 220 kV operation in a particular place will not mean automatic direct replacement of the decommissioned 220 kV facility by the similar 400 kV facility. In cases when importance of such replacement is not proved and SEPS should perform definite decommissioning of such facility, the use of some 220 kV facilities on the distribution system level (operated on 110 kV) 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 joint bilateral and multilateral meetings.

Name of substation with respective R220 kV	Assumed Year of Decommissioning
Bystričany	2021
Križovany, Senica	2023
Lemešany	2025
Považská Bystrica[12]	2026[13]
Department	2036

Table No. 6 Overview of Decommissioning of 220 kV Substations

SEPS assumes that immediately after the year 2026, 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 SSD) will be in operation in ES SR on the 220 kV voltage level as the last ones. All other 220 kV lines including cross-border lines V270 and V280 will be decommissioned. The future of connection of direct consumers DUSLO, a. s., and OFZ, a. s. to TS after decommissioning of 220 kV TS SR is subject to separate negotiations. In both cases, mutually satisfying solution for maintaining supply for these consumers from the TS level is subject to joint search. Eventual decommissioning of 220 kV lines will not influence stability of supply for direct consumers.

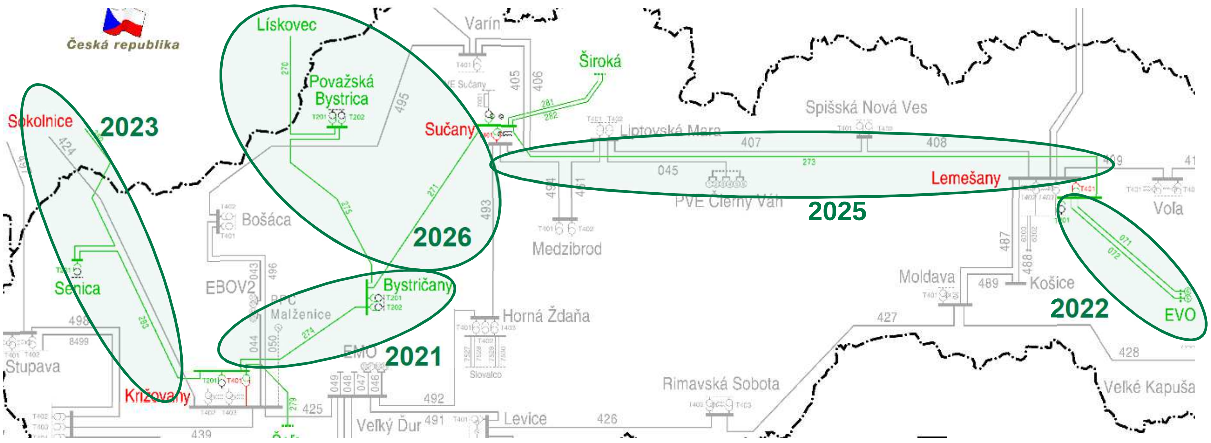


Fig. No. 6 Graphic Representation of Gradual Decommissioning of the 220 kV TS SR

SEPS will continue in reconstruction of its substations concerning remote control mode. Concurrently, 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 in remote control mode out of 22 substations owned by SEPS. By 2028, SEPS considers introduction of the remote control mode in the 400 kV Podunajské Biskupice

[11] The exact date will depend on the final technical solution of the 400/110 kV Ladce transformation.

[12] Particular investment measure will be added in the SEPS investment plan only after evaluation of the Study results (Chapter 4.4).

[13] The exact date will depend on the final technical solution of the 400/110 kV Ladce transformation.

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, no remote control is considered.

The controlled gradual attenuation of the 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 TS facilities and replaces them by up-to-date 400 kV TS facilities, if necessary. Moreover, further such investments also include replacement of TS/DS transformers since current 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 towers' static and dynamic assessment 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 own electricity infrastructure of SEPS.

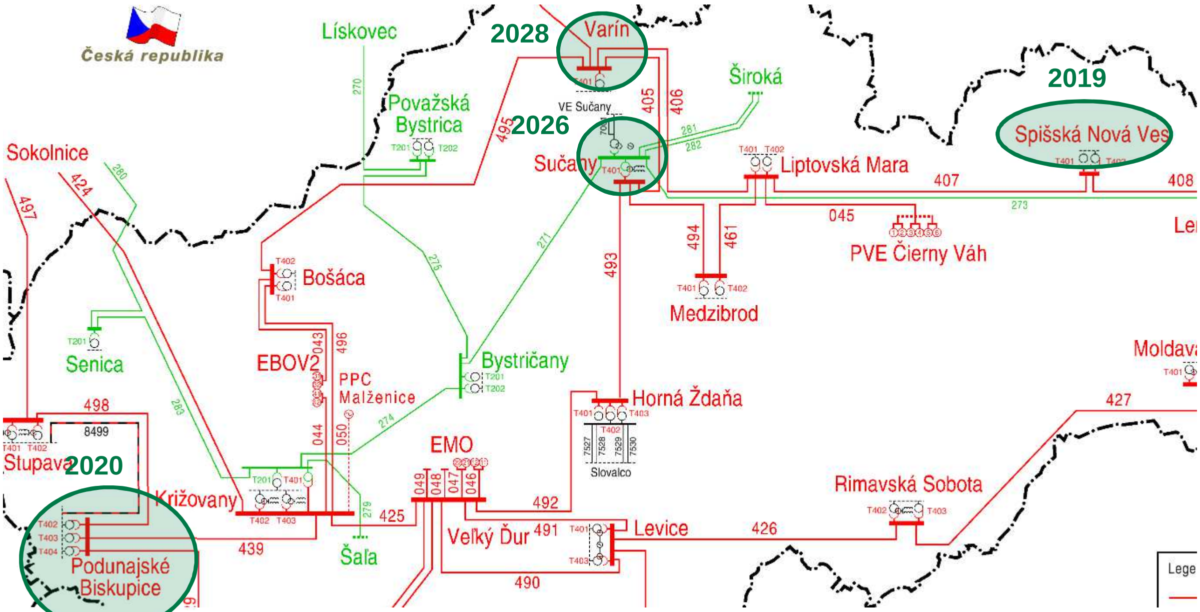


Fig. No. 7 Graphic Representation of Substations in which Remote Control is Planned

4.4 Internal Investment Projects

Within gradual controlled attenuation of the 220 kV TS SR, Bystričany substation and Senica substation will be subject to significant changes by 2023, i.e. they will change from 220/110 kV transformation to 400/110 kV transformation including RCM thus causing natural decommissioning of these 220 kV substations. In the Považská Bystrica substation there is planned transition from the 220/110 kV transformation to the 400/110 kV transformation with RCM as well. Based on the results of the "Feasibility Study of the 400/110 kV Transformation in the Považská Bystrica Substation and in the Ladce Location", building a new Ladce substation with new 400 kV switchyard and the new 400/110/33 kV transformation as a substitution of the P. Bystrica substation is planned. The existing 400 kV line V495 (Bošáca - Varín) is planned to be looped in the new Ladce substation. The final technical solution for power evacuation to touched distribution system is subject to discussions with SSD the result of which is expected in Q1 of 2019. The temporary condition for the power evacuation will make partial use of the new 110 kV lines and the partial use of the existing 220 kV lines V270 and V275 operated on the 110 kV voltage level which will supply R110 kV in the P. Bystrica substation owned by SSD.

Implementation of the ongoing project "Transformation of 400/110 kV Bystričany" will result in 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 investments includes the following parts:

1. 400 kV switchyard Bystričany,
2. 2x400 kV line Horná Žďaňa – Oslany area,
3. 400 kV switchyard Horná Žďaňa – extension,

4. 2x400 kV line Bystričany – Križovany,
5. 400 kV switchyard Križovany – extension,
6. transformation 400/110 kV Bystričany – T401 and T402 transformers.

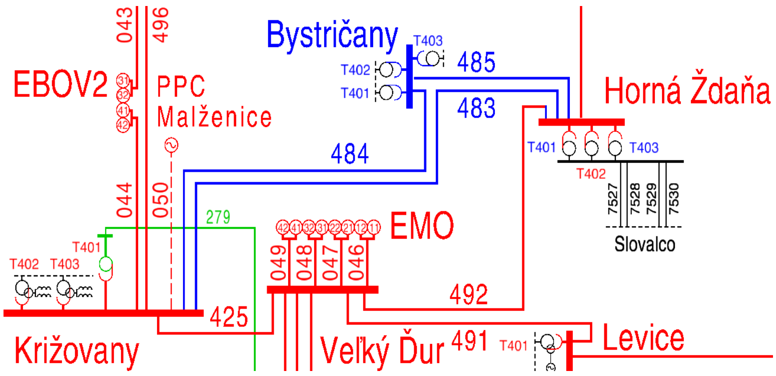


Fig. No. 8 Graphic Representation of the Planned Investments in the Bystričany Substation

One circuit of the prepared 2x400 kV line Bystričany – Križovany will 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 400 kV line Bystričany – Križovany and it will be interrupted in the Oslany area and connected to R400 kV 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 investments. Completion of the entire set of investment items is expected in 2021. At present, the project is in the implementation phase or in the design phase (it covers 2x400 kV line Križovany - Bystričany) and it is carried out in close coordination with SSD.

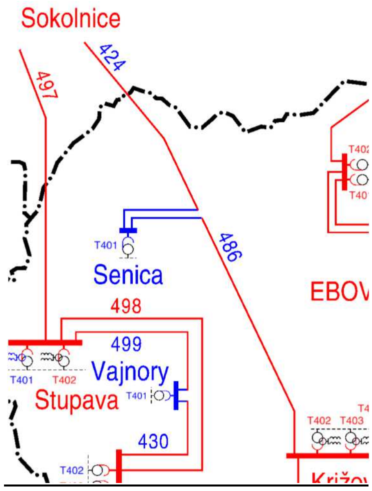


Fig. No. 9 Graphic Representation of the Planned Investments in the Senica Substation

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

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

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 will be ensured by building the new 400 kV switchyard of five bays, by looping the existing 400 kV line V424 (Križovany – Sokolnice) and by installing new 400/110 kV, 350 MVA transformer. At the same time, construction of R400 kV Senica will lead to definite decommissioning of the existing R220 kV Senica. At present, the documentation for the zoning and planning decision is being processed. The project is being prepared in close coordination between SEPS and ZSD.

Further one is currently carried out investment project "**Remote 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 LCM to the RCM is carried out. At the same time, the transition of the existing R400 kV Podunajské Biskupice substation to the new type of the switchyard with tube bus bars and width of bays 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 was accomplished in 2018. Replacement of the T404 transformer was caused by the ZSD requirement for increase of the transformation capacity in the Podunajské Biskupice connection point. The implementation of the entire project should be completed in 2020. The project is carried out in close coordination with ZSD.

In addition to the two running projects, there are investment projects of building the Vajnory and Nové Zámky substations considered in this part of TS which are a common activity of SEPS and ZSD. These are potential development projects which are at the time of processing of this 2029 TYNDP analysed via the joint technical-economic study by SEPS and ZSD. Its results should be available by the end of 2019. The "Vajnory" project is already preliminarily included in the SEPS investment plan in the period from 2024 to 2029, the "Nové Zámky" project follows immediately after Vajnory (2026 to 2031). The Study should prove which substation will be built or whether both substations will be built. It is strengthening of the TS/DS transformation in the West Slovakia Region due to expected increase of load in this location. Moreover, it is related to possible cancellation of supply from the Gabčíkovo node and the need to ensure reliability and safety of supply of DS users including Bratislava as the capital of the Slovak Republic.

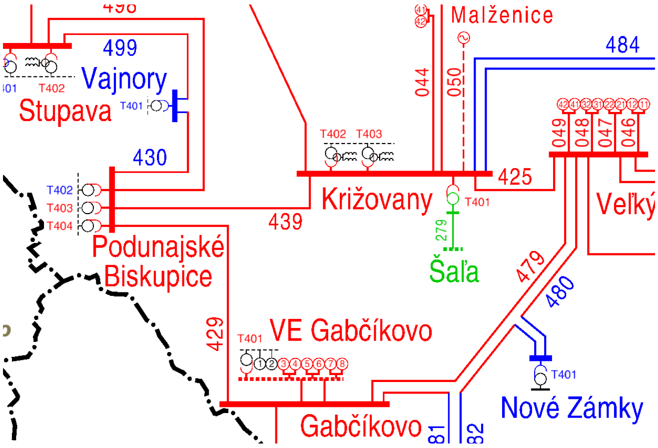


Fig. No. 10 Schematic Graphic Representation of the Planned Investments in the Podunajské Biskupice, Vajnory and Nové Zámky Substations

In the Varín substation, two IPRs (investment project) will be implemented in the period 2022 – 2028. Within first IPR, with the assumed completion of implementation approx. in 2022, 2x45 MVAr or 1x60 MVAr peaking coils will be connected to tertiary winding of the existing T401 through the newly-built 10 kV switchyard.

In the period 2025 - 2028 reconstruction of the existing R400 kV to the new type of switchyard will be carried out including transition of the Varín substation to the RCM. Within this IPR, a new operational building will be erected and the existing T401 transformer will be replaced by a new one with capacity of 350 MVA and located in the position of the reserve transformer while in its 33 kV tertiary winding 2x45 MVAr peaking coils will be installed through the newly-built 33 kV switchyard.

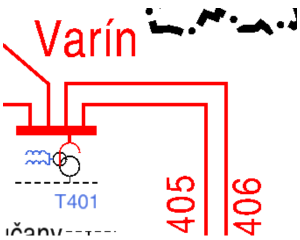


Fig. No. 11 Graphic Representation of the Planned Investments in the Varín Substation

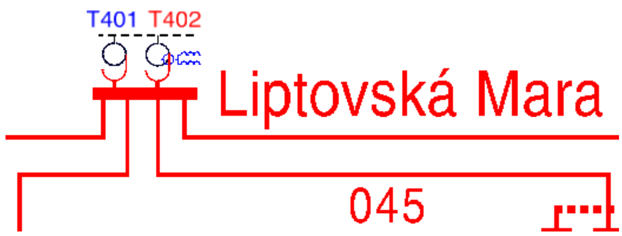


Fig. No. 12 Graphic Representation of the Planned Investments in Liptovská Mara Substation

By 2030, the replacement of the T401 and T402 transformers in the Liptovská Mara substation and transition of this station to the RCM by 2032 is planned. At present, this project is in the projecting phase. In regard to Liptovská Mara, it is in the phase of selection of the contractor for engineering and projecting for the investment project covering installation of 2x45 MVAr peaking coils to the T401 and T402 tertiary windings. This is a project aimed at installation of peaking coils in this part of TS SR within the horizon of the year 2021 at latest to be able to reduce high voltage on TS SR lines with overlap to abroad (the Czech Republic) effectively.

An important plan in terms of supply safety of company OFZ, a.s., which is a direct consumer of electricity from TS and company SSD**,** is the planned implementation of T402, 400/110 kV, 350 MVA transformation within the project "**Transition of the Sučany substation to the remote control mode**".

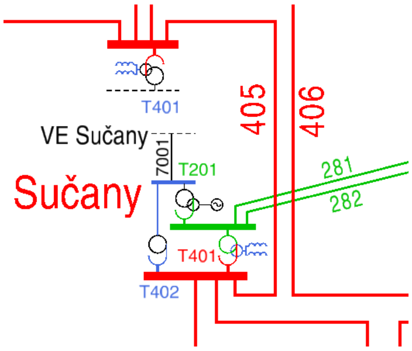


Fig. No. 13 Graphic Representation of the Planned Investments in the Sučany Substation

The project is in the preparatory phase of the Investment request. The project implementation in the Sučany substation for increase of the compensation capacity from 120 MVAr to 180 MVAr was commenced. In first step, in December 2018, first group of 33 kV, 3x30 MVAr peaking coils moved from the Lemešany substation was connected to the tertiary winding of the existing T401 transformer. Within the project "Transition of the Sučany Substation to RCM" the second group of 33 kV, 3x30 MVAr peaking coils moved from the Voľa substation will be connected to the tertiary winding of the existing T401 transformer. The project implementation is planned between 2020 – 2026. Original peaking coils from T401 (2x3x20 MVAr) will be moved to the Moldava substation (one group, in operation from December 2018) or to the Voľa substation (2. group).

In the eastern part of TS SR the implementation of the investment project "**Replacement of T401, T402 transformers and remote control mode in the Spišská Nová Ves substation**" commenced within which transition of the substation to the RCM will be performed along with replacement of the T401 and T402 transformers reaching the end of their lifetime by new ones with nominal power of 250 MVA (T402 was replaced in 2018, T401 will be replaced in 2019). Project is implemented in close cooperation with VSD and its assumed completion is in 2020.

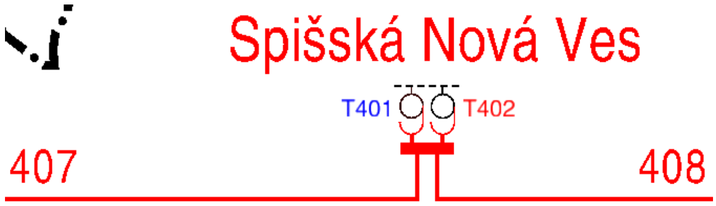


Fig. No. 14 Graphic Representation of the Planned Investments in the Spišská Nová Ves Substation

By 2029, in the field of TS/DS transformation, supplementation or replacement of physically obsolete transformers with which it is assumed their technical condition after their lifetime expiry will not allow their further safe and reliable operation is expected. In addition to the aforementioned replacements of transformers within other IPRs, the following projects are concerned: "Replacement of T401 in the Stupava substation", "Replacement of T402 in the Podunajské Biskupice substation" and "Replacement of T401 and T403 in the Horná Ždaňa substation".

4.5 Cross-Border Investment Projects

The most expected cross-border projects to be implemented by 2029 are 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) with the assumed commissioning date of both lines in December 2020.

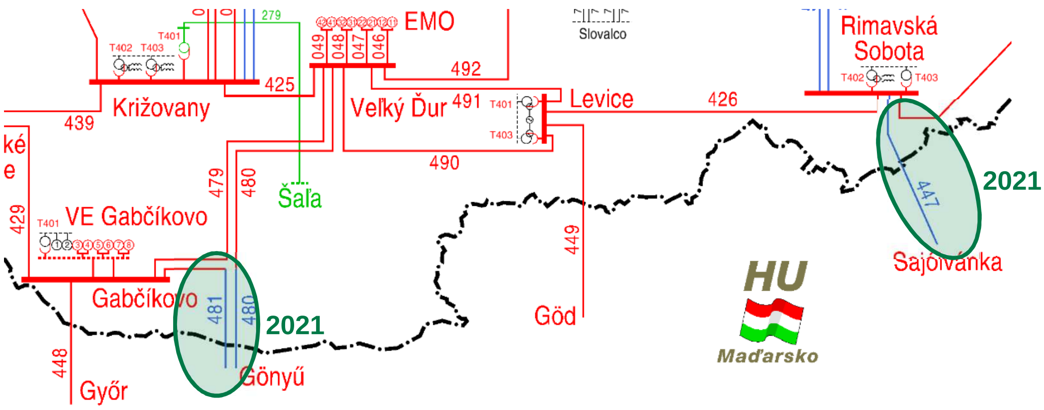


Fig. No. 15 Graphic Representation of the Planned Investment Item Concerning Building New Cross-Border Lines on the SK-HU Profile

On the SEPS side, with a financial contribution from the "Connection Europe Facility" instrument of the European Union, the designing and engineering works on both lines were finished. Since these are projects having a status of the PCI Project, the European Commission pays increasingly more intense attention to them. In June 2018 or in November 2018, SEPS obtained valid building permits for their construction. At the time of processing this document, public procurement for the construction contractor is carried out.

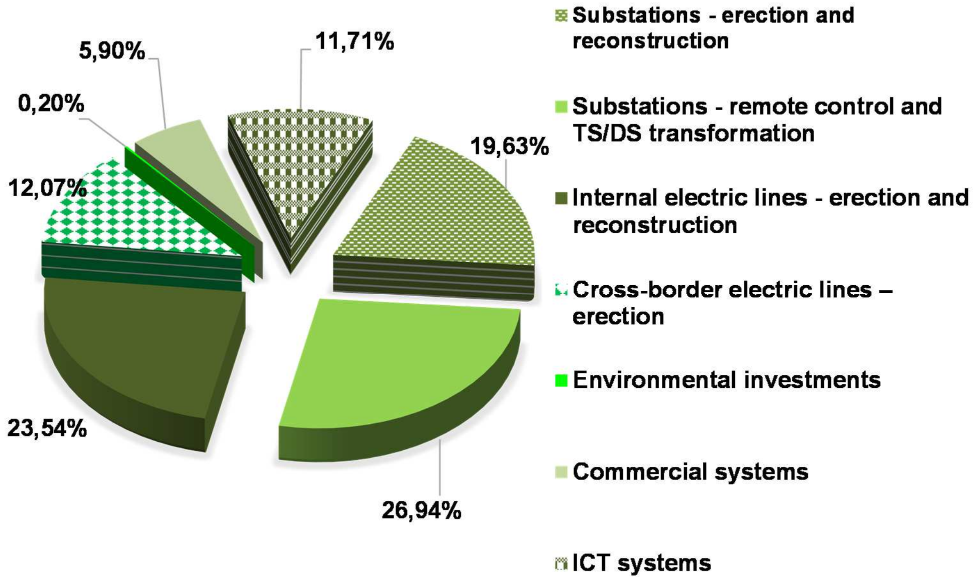
By 2027, SEPS does not plan to strengthen other cross-border profiles with new lines, however, in the years 2024 and 2025 a reconstruction of the cross-border line V404 Varín (SK) – Nošovice (the Czech Republic) is scheduled. There will also be maintenance works and investments in renewal of the existing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

In case of development of cross-border interconnections, it is necessary to consider it is related mainly to the situation and development of electricity consumption in ES SR and installed capacity of electricity generation mix or their production in ES SR as well as the situation and development of ES of the surrounding countries, the interest and access of their operators and support of development of international electricity exchange or trading in electricity within EU and electrically attached economies. In this sense, thus SEPS further maintains and develops coordination activities with TSOs of Hungary, Poland, the Czech Republic and the Ukraine. Both on the ENTSO-E and on the bilateral level. It is, however, necessary to state that after a longer pause, the communication with the TSO in the Ukraine, NPC "Ukrenergo" was successfully established. The Slovak - Ukrainian cross-border profile is often a bottleneck (together with the Hungarian profile) in case of cross-border electricity transmissions and it causes operational and control problems to the Slovak dispatch centre. The project "Reconstruction of the 400 kV line Mukacheve (UA) – Veľké Kapušany (SK)" was included in the PECI / PMI 2018 List approved by the ministerial board within the Energy Community in November 2018. The expected deadline of the complex reconstruction of the V440 line on the territory of Slovakia is the year 2030.

Moreover, it is inevitable to notify the development and construction of new interconnections must be in compliance with the development and possibilities of internal lines while new interconnections can be built to such extent so as not to threaten safety and reliability of TS SR or ES SR operation.

4.6 Investment Plan for the Period 2020 - 2029

SEPS intends to invest approximately EUR 614.89 mil. via investment projects mentioned in the Ten-Year Investment Plan what means annual average amounting to EUR 61.5 mil. to ensure inevitable increase of the existing capacities and inevitable upgrade of the main parts of the transmission system. The distribution of SEPS investments in individual categories pursuant to the Ten-Year Investment Plan is shown in the following graph.



Graph No. 24 Percentage Distribution of the SEPS Investment Needs By 2029

The particular investment projects are listed in the table below and the principal drawing of national and cross-border investment projects are shown in the following picture.

Table No. 7 Overview of Implementation of Investments in the Transmission System for the Period 2019 to 2029

Order No.	Investment project	Identification number	Beginning and end of investment projects		Assumed costs [EUR mil.]	Incurred costs by 31.12.2018 [EUR mil.]	Project situation
	Substations - erection and reconstruction						
1	400 kV switchyard Bystričany – construction of a new 400 kV switchyard **code RGI: 297**]	2013-5	2014	2020	11.240	8.007	
2	400 kV switchyard Horná Ždaňa – extension [**code RGI: 845**]	2013-6	2014	2019	4.949	4.647	
3	400 kV switchyard Križovany – extension [**code RGI: 845**]	2013-7	2015	2021	5.555	0.882	
4	Decay automation in Veľký Ďur	2013-14	2016	2019	0.443	0.264	
5	Replacement of bus bar and upper interconnections in R400 kV Veľký Ďur	2015-3	2016	2019	2.852	2.187	
6	Lemešany substation - innovation of RIS 220 + 400 kV and replacement of protections in R400 kV	2013-16	2017	2021	3.03	0.100	
7	Innovation of CIS facilities for control of 110 kV switchyard in ESt Horná Ždaňa	2013-18	2017	2021	2.502	0.116	
8	New station and 33 kV bay for 90 MVAr reactors in the Sučany substation	2016-3	2017	2019	0.488	0.484	
9	400 kV switchyard Rimavská Sobota - extension **code RGI: 695] [code TYNDP: 48.695] [code PCI: 3.17]**	2013-9	2017	2020	4.784	0.266	
10	Adjustments in related facilities in Gabčíkovo and Veľký Ďur substations [**code RGI: 214] [code TYNDP: 48.214] [code PCI: 3.16]**	2015-1	2018	2020	0.129	0.014	
11	Replacement of bus bar wires in substation Levice	2015-5	2018	2020	2.179	0.137	
12	Refurbishment of secondary technology in R400 kV Bošáca - replacement of protections and RIS innovation	2014-1	2018	2021	5.133	0.193	
13	Replacement of a circuit breaker in the bay No. 6 of R400 kV Levice and supplementation of lightning conductors on towers of busbar steel construction	2019-1	2018	2020	0.405	0.033	
14	Change of connection of FORTISCHEM a.s. to TS in the Bystričany substation	2019-2	2018	2020	3.064	0.196	
15	Replacement of the ATB1, ATB2 main batteries in the Veľké Kapušany substation	2019-3	2018	2019	0.098	0.021	
16	Reconstruction of 220kV switchyard in Sučany	2015-8	2018	2021	4.615	0.051	
17	Innovation of CIS - central station in the Košice switching station	2015-11	2019	2020	0.421		
18	Innovation of CIS - central station in the Veľké Kapušany substation and refurbishment of secondary technology	2015-12	2019	2021	0.791		
19	Refurbishment of secondary technology in the Križovany substation - protection and CIS innovation,	2015-26	2019	2022	4.505		
20	Compensation of reactive power in the Liptovská Mara substation	2017-1	2019	2021	3.397		
21	Replacement of ATB1, ATB2 main batteries in the Veľký Ďur substation	2019-4	2019	2019	0.094	0.010	
22	Refurbishment of secondary technology and CIS innovation - central station in the Horná Ždaňa substation 400 kV	2015-13	2019	2022	1.241		
23	Simplified monitoring system of T402 transformer in the Liptovská Mara substation	2019-5	2019	2019	0.066		
24	Innovation of telecommunication information exchange network in SEPS substations	2015-29	2020	2020	0.193		
25	Innovation of CIS - central station in the Veľký Ďur substation	2015-15	2020	2021	0.550		
26	Innovation of CIS - central station in the Levice substation	2015-16	2020	2021	0.520		
27	Refurbishment of secondary technology and CIS central station innovation – Stupava substation	2015-32	2021	2022	0.840		
28	Innovation of CIS - central station in the Medzibrod substation	2015-17	2021	2022	0.450		
29	Innovation of CIS - central station in the Voľa substation	2015-18	2021	2022	0.480		
30	400 kV Ladce switchyard	2016-1	2022	2026	19.200		
31	Innovation of CIS – central station in the Rimavská Sobota substation	2016-5	2022	2023	0.520		
32	Refurbishment of secondary technology and CIS of R400 kV Lemešany innovation	2015-20	2022	2024	2.830		
33	Refurbishment of secondary technology and Veľké Kapušany substation CIS innovation	2015-19	2023	2024	2.530		
34	Refurbishment of secondary technology in the Horná Ždaňa substation and R400 kV CIS innovation	2015-33	2023	2026	3.230		
35	Refurbishment of secondary technology and Moldava substation CIS innovation	2015-37	2023	2025	2.000		

Order No.	Investment project	Identification number	Beginning and end of investment projects		Assumed costs [EUR mil.]	Incurred costs by 31.12.2018 [EUR mil.]	Project situation
36	400 kV Vajnory switchyard	2019-6	2024	2028	17.800		
37	Refurbishment of secondary technology in the Rimavská Sobota substation - differential protection of bus bars	2015-38	2025	2025	0.140		
38	Refurbishment of secondary technology in the Spišská Nová Ves substation - differential protection of bus bars	2015-39	2025	2025	0.140		
39	Refurbishment of secondary technology in the Levice substation - differential protection of bus bars	2015-40	2025	2025	0.150		
40	Refurbishment of secondary technology and SSt Košice CIS innovation	2016-6	2025	2026	1.800		
41	Innovation of telecommunication information exchange network in SEPS substations	2016-8	2026	2026	0.303		
42	Refurbishment of secondary technology in the Bošáca substation	2017-3	2026	2027	0.300		
43	Refurbishment of secondary technology and the Levice substation CIS innovation	2019-7	2027	2028	2.470		
44	Refurbishment of secondary technology and the Medzibrod substation CIS innovation	2019-8	2028	2029	1.960		
45	Refurbishment of secondary technology and the Veľký Ďur substation CIS innovation	2019-9	2028	2031	3.410		
46	Refurbishment of secondary technology and the Stupava substation CIS innovation	2019-10	2029	2031	2.280		
47	Refurbishment of secondary technology and the Rimavská Sobota substation CIS innovation	2019-11	2029	2030	1.530		
48	Refurbishment of secondary technology and the Voľa substation CIS innovation	2019-12	2029	2030	2.550		
49	400 kV switchyard Veľké Kapušany – extension	2019-13	2029	2031	5.375		
Substations - remote control mode and TS/DS transformation							
50	Remote control mode and replacement of T404 transformer in the Podunajské Biskupice substation, transition of 400 kV switchyard Podunajské Biskupice to the switchyard of a new type	2013-20	2004	2020	39.775	24.247	
51	Replacement of T401, T402 transformers and remote control in the Spišská Nová Ves substation	2013-24	2006	2020	27.002	16.853	
52	Transition of the Sučany substation to the remote contro model	2013-25	2006	2026	41.343	0.324	
53	Reactive power compensation in the Varín substation	2013-27	2012	2021	2.104	0.154	
54	Transition of the Varín substation to the remote control mode	2019-14	2023	2028	32.262		
55	Transformer 400/110 kV Bystričany – T401	2013-31	2016	2021	10.920	0.622	
56	Transformer 400/110 kV Bystričany – T402	2014-4	2017	2021	7.203	0.353	
57	400/110 kV Senica transformer station	2014-3	2018	2023	25.407	0.282	
58	Replacement of T402 transformer in the Podunajské Biskupice substation	2013-29	2020	2023	7.200		
59	Replacement of T401 transformer in the Stupava substation	2013-32	2021	2025	6.200		
60	Ladce TR 400/110 kV	2016-13	2021	2026	12.200		
61	Replacement of T401 and T403 in the Horná Ždaňa substation including transformers of self-consumption	2013-30	2022	2026	11.980		
62	400/110 kV Vajnory transformation	2019-15	2024	2029	6.200		
63	Replacement of T403 transformer in the Rimavská Sobota substation	2016-10	2025	2029	6.200		
64	400/110 kV Nové Zámky transformation	2019-16	2026	2031	6.200		
65	Remote control mode and replacement of T401 and T402 transformers in the Liptovská Mara substation	2013-26	2026	2032	36.500		
Internal electric lines - erection and reconstruction							
66	2x400 kV line Bystričany – Križovany **code RGI: 845]**	2013-35	2012	2021	54.668	11.563	
67	2x400 kV line Horná Ždaňa – Oslany **[code RGI: 845]**	2013-36	2012	2021	33.299	2.006	
68	Connection 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	4.834	0.174	
70	Replacement of insulators, conductors and earth wires on the V498 Stupava - P. Biskupice line, tower No. 126 - P. Biskupice substation	2013-45	2017	2019	1.148	1.108	
71	Replacement of insulators and conductors on the V425 Križovany - Veľký Ďur line, towers from No. 1 to 6z	2013-43	2018	2019	7.221	3.823	

Order No.	Investment project	Identification number	Beginning and end of investment projects		Assumed costs [EUR mil.]	Incurred costs by 31.12.2018 [EUR mil.]	Project situation
72	Insulators replacement of 400 kV line V497 Sokolnice - Stupava in the section of state border SR/the Czech Republic – Stupava substation	2019-17	2018	2019	1.273	0.072	
73	Looping of the 400 kV line V424 to the Senica substation	2014-7	2018	2022	7.824	0.180	
74	Replacement of conductors, insulators replacement of the 400 kV line V424 Križovany - SR/the Czech Republic state border	2013-44	2019	2022	10.213		
75	V428 insulators and conductors replacement	2015-49	2020	2022	10.000		
76	Replacement of conductors, insulators replacement of V448 SS Gabčíkovo - SK/HU state border	2013-47	2021	2023	1.700		
77	Insulators replacement of V044 line	2013-48	2021	2023	1.300		
78	Insulators replacement of V043 line	2013-49	2021	2023	2.470		
79	Insulators replacement of V496 line	2013-50	2021	2024	3.460		
80	Insulators replacement and replacement of V429 conductors	2013-46	2021	2023	6.000		
81	Innovation of V408 line	2013-52	2026	2033	36.000		
82	Insulators replacement of 220 kV line in V071 Lemešany – Vojany	2017-2	2019	2020	1.100		
83	Innovation of V407 line	2013-51	2023	2030	32.000		
84	Looping of V495 in the Ladce substation	2016-17	2023	2026	1.600		
85	Innovation of V045 line	2016-12	2022	2028	10.000		
86	Reconstruction of the V406 line in the Ružomberok – Liptovská Mara section	2017-7	2028	2035	12.578		
87	1x400 kV line Veľký Ďur - Levice	2019-18	2028	2034	9.945		
88	Looping of the 400 kV line V480 to the Nové Zámky substation	2019-19	2028	2031	1.000		
89	2x400 kV line Gabčíkovo - Gönyű (HU) - Veľký Ďur (the part Veľký Meder – state border with HU) **[code RGI: 214] [code TYNDP: 48.214] [code PCI: 3.16]**	2013-53	2015	2021	19.333	0.844	
90	2x400 kV line Rimavská Sobota – Sajóivánka (HU) (the part up to the state border with HU) **[code RGI: 495] [code TYNDP: 48.495] [code PCI: 3.17]**	2013-54	2012	2021	25.702	1.010	
91	Innovation of V404 line	2016-14	2018	2026	30.402	0.053	
92	1x400 kV line Ladce substation - state border with the Czech Republic	2019-20	2028	2035	15.200		
93	Innovation of V440 line	2019-21	2027	2031	8.063		
Electric lines – combined earth wires							
94	Second optical interconnection of SEPS headquarter Bratislava - Podunajské Biskupice substation	2016-16	2016	2019	0.537	0.037	
95	Partial replacement of earth wire on 2x220 kV line V281_2 Sučany-Široká	2019-22	2018	2019	0.271	0.033	
Environmental investments							
96	ESt Lemešany - waste water treatment plant	2015-57	2018	2019	0.557	0.007	
97	Connection of drinking water for the Horná Ždaňa substation	2019-23	2019	2019	0.100		
98	Liptovská Mara substation - waste water treatment plant	2015-58	2021	2021	0.420		
99	Križovany substation - waste water treatment plant	2015-59	2021	2021	0.420		
100	Moldava substation - waste water treatment plant	2015-60	2022	2022	0.420		
Commercial systems							
101	Innovation of measurement sets	2013-64	2017	2021	1.964	0.052	
102	Innovation of the quality measurement system	2013-60	2019	2021	2.600		
103	New SEPS trading system	2015-61	2019	2021	8.000		
104	Innovation of the information billing system and of trading systems	2013-66	2019	2021	2.200		
105	HW infrastructure	2017-8	2019	2019	0.400		
106	Use of WAMS in the SEPS environment	2017-9	2019	2020	0.350		
107	Innovation of network communication devices	2019-24	2020	2021	1.900		

Order No.	Investment project	Identification number	Beginning and end of investment projects		Assumed costs [EUR mil.]	Incurred costs by 31.12.2018 [EUR mil.]	Project situation
108	Innovation of the ASZD System	2015-63	2021	2023	6.000		
109	Modifications of ASZD System according to the requirements of legislation and users	2013-58	2022	2023	2.850		
110	Innovation of the information billing system	2015-64	2026	2027	1.500		
111	Modifications of ASZD System according to the requirements of legislation and users	2013-65	2028	2029	4.000		
112	Innovation of the ASZD System	2017-10	2027	2029	6.000		
113	Innovation of measurement systems	2019-25	2029	2031	4.000		
114	Innovation of the quality measurement system	2019-26	2029	2031	2.700		
ICT systems							
115	Upgrade of CIS SED	2013-67	2012	2019	17.744	9.009	
116	Data backup centre in Podunajské Biskupice	2016-15	2016	2019	2.175	0.191	
117	Upgrade of F-MUX facilities	2013-71	2018	2019	2.661	2.325	
118	Innovation of remote SCADA clients of CIS ESt for operating administrations	2017-11	2016	2019	0.965	0.837	
119	Optimization, increase of safety and availability of telecommunication information exchange network protections	2017-12	2017	2020	2.919	0.424	
120	Innovation of IIS servers	2017-14	2018	2019	0.371	0.003	
121	Simulators of self-consumption for TS Západ (West) including the programme of MEGADATABASES	2017-15	2018	2020	0.360	0.006	
122	Implementation of safety systems resulting from legislation requirements - GDPR	2017-16	2018	2019	1.005	0.266	
123	Reconstruction of mechanical guards on critical infrstructire components	2017-25	2018	2022	4.005	0.060	
124	Optimization of detection of critical infrstructire component disturbance - 1st phase	2017-24	2018	2019	1.970	0.061	
125	Application for maintenance and diagnostics of substations and electric lines in the SAP FIORI environment	2019-27	2018	2019	0.360		
126	Increase of CIS ESt SEPS security	2019-28	2018	2021	2.753		
127	Implementation of Cisco - ISE	2017-20	2019	2019	0.216		
128	Optimization of authentication of domain users	2017-21	2019	2019	0.400		
129	Monitoring system of ICT assets	2017-22	2019	2019	0.130		
130	Complex ensuring of logical perimeter of network infrastructure	2017-23	2019	2019	0.600		
131	Implementation of safety systems resulting from legislation requirements - Act on Cyber Security - 1st phase	2017-17	2018	2019	1.254		
132	Implementation of security systems - 1st phase	2019-29	2019	2019	1.500		
133	Upgrade of security systems - 1st phase	2019-30	2019	2019	0.800		
134	Technologies for a new Podunajské Biskupice data centre	2017-29	2019	2021	1.000		
135	Creation of central monitoring of networks	2019-31	2019	2019	1.000		
136	Innovation of transmission devices for protection signals	2019-32	2019	2019	0.115		
137	CGMES-OPDE database calculation programme	2019-33	2019	2020	1.100		
138	Optimization of detection of CI component disturbance - 2nd phase	2019-34	2020	2021	3.940		
139	Implementation of security systems	2017-26	2020	2033	26.200		
140	Upgrade of security systems	2017-27	2020	2033	11.602		
141	Development of supporting systems	2017-28	2020	2021	2.000		
142	Upgrade for the system for coordinate security analyses - AMICA	2017-30	2021	2021	0.300		
143	Innovation of CORE switches	2017-31	2022	2022	1.500		
144	Replacement of LAN infrastructure	2017-32	2022	2022	1.400		
145	Innovation of IIS applications	2017-33	2022	2026	0.500		
146	Innovation of transmission devices for protection signals	2017-34	2023	2023	0.300		

Order No.	Investment project	Identification number	Beginning and end of investment projects		Assumed costs [EUR mil.]	Incurred costs by 31.12.2018 [EUR mil.]	Project situation
147	Upgrade of CIS SED	2015-65	2023	2025	20.000		
148	Innovation of IIS servers	2017-35	2024	2024	0.400		
149	Innovation of transmission devices for protection signals	2017-36	2024	2024	0.300		
150	Upgrade of load-bearing DWDM telecommunication network	2017-37	2026	2026	4.000		
151	Upgrade of access telecommunication network	2017-38	2027	2027	2.000		
TOTAL Investment Projects					**929.865**	**94.591**	

Investments"

investments to be implemented in the following three years

investments already decided upon by the TSO

other investments related to the transmission system upgrade

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

there are execution works performed

there are project and engineering activities performed

works on the project have not started yet

[code PCI: x.xx] - PCI projects [code RGI: x.xx] - 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 will be updated.
2. A list of investments in the transmission system for the period 2019 to 2029 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.

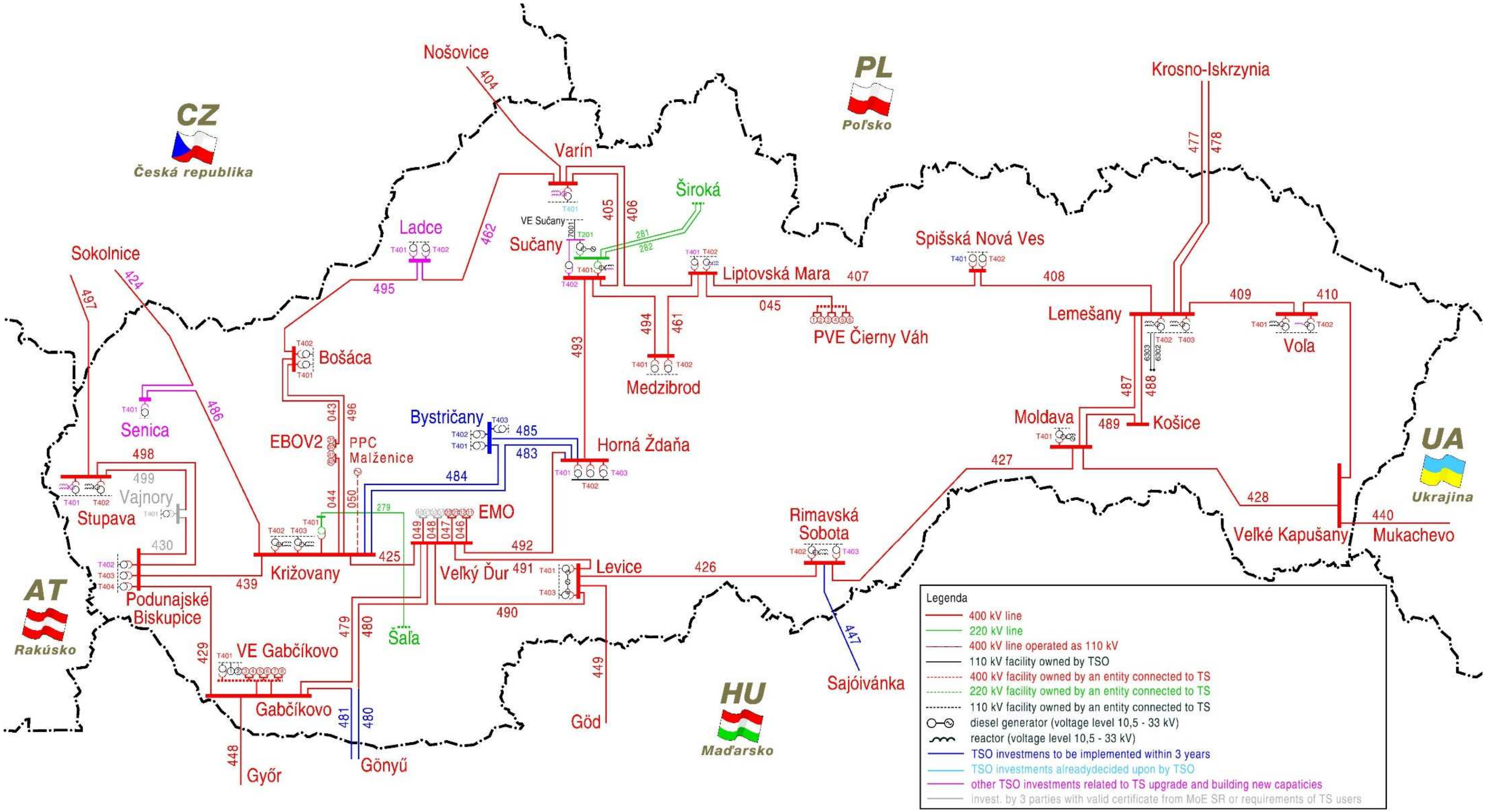


Fig. No. 16 Assumed Situation of the Transmission System in 2029

5 Conclusion

At preparation of this national 2029 TYNDP, 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 electricity exchanges 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 ENTSO-E TYNDP document including the regional investment plan for the CCE region). This document, however, reflects the SEPS Development Plan, respective approved SEPS investment plans and the recent valid national 2027 TYNDP approved by RONI. The document was subject to the comment procedure by all TS users, RONI and MoE of SR. All these assumptions and starting points are described and considered in the national 2029 TYNDP appropriately to the current knowledge and information available to SEPS as to the Slovak TSO, as at the time of the national 2029 TYNDP handover to RONI for its opinion.

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 national TYNDP should show which direction should be followed in order to ensure this strategic objective.

The substantial and long-term decisions of SEPS in the field of further development and use of the Slovak transmission system includes building new facilities only on the 400 kV voltage level. It is still applicable that the Slovak transmission system 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 dismantling of parts of 220 kV TS these parts will not be replaced by similar facilities of the same voltage level but SEPS will build only 400 kV facilities and only if based on thorough consideration it is inevitable in terms of the 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 current criteria and requirements for efficient electricity transmission. All such reconstructed substations are built as modern, operator-free substations in remote control mode while using proved most up-to-date solutions and technologies. Reaching this operational and control mode in all substations is a long-term strategic objective of SEPS.

Regarding the neighbouring countries, SEPS long-term priority is building new 400 kV interconnections towards Hungary which were included in the European PCI list. This confirms their significance and importance not only for Slovakia and Hungary but also for the wider CCE region. After obtaining building permits for line construction, public procurement for construction contractor is carried out.

The SEPS priorities in the next ten years will include, based on the aforementioned, investment projects which will serve to ensure:

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

The main SEPS investment projects provided in this national 2029 TYNDP are not only in compliance with the aforementioned priorities but they also correspond to the ENTSO-E 2018 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 Plan for the years 2020 – 2029 with the use of inputs from all concerned entities within the Slovak Republic.

6 List of used abbreviations

ASZD	-	Automated System for Data Collection
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)
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
HU	-	Hungary (ISO code)
MAVIR	-	Hungarian transmission system operator
MoE SR	-	Ministry of Economy of SR
N	-	Number of the system elements in basic load
NTC	-	Net Transfer Capacity
PCI	-	Projects of Common Interest
PL	-	Poland (ISO code)
PVE	-	pump-storage hydroelectric power plant
TSO	-	transmission system operator
TS SR	-	Transmission System of SR
R	-	Switchyard
RgIP	-	Regional Investment Plan
RES	-	renewable energy sources
RO	-	Romania (ISO code)
RONI	-	Regulatory Office for Network Industries
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
SSD	-	Stredoslovenská distribučná, a.s.
SSt	-	switching station
T	-	transformer
TL	-	reactor
TR	-	transformer station
TRM	-	Transmission Reference Margin (safety reserve on the transmission profile)
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
UA	-	the Ukraine (ISO code)
V	-	line
VE	-	hydroelectric power plant
VSD	-	Východoslovenská distribučná, a.s.
ZSD	-	Západoslovenská distribučná, a.s.