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Impact of TCSC on generator operation

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INTRODUCTION

- The main goal and their duty is to ensure a reliable, safe and economical supply of quality electricity to all consumers with the highest economic operation and the lowest possible losses or impact on the environment.
- FACTS (Flexible Alternating Current Transmission System) systems are increasingly being used to solve problems associated with the management of the operation of transmission and distribution systems.
- FACTS technologies have small dimensions and minimal impact on the environment.
- The project implementation time and the construction of this system are significantly lower than the choice of the construction of an alternative to the construction of new transmission lines or new power plants.

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FOCUS OF...

- research of FACTS devices, specifically TCSC regulators.
- The TCSC element is implemented in the design in two places, namely in stations with generator outlets in program NEPLAN.
- The result is the processing of dynamic stability data at a set short circuit with and without a TCSC device, as well as how this affects the CCT (Critical clearing time).

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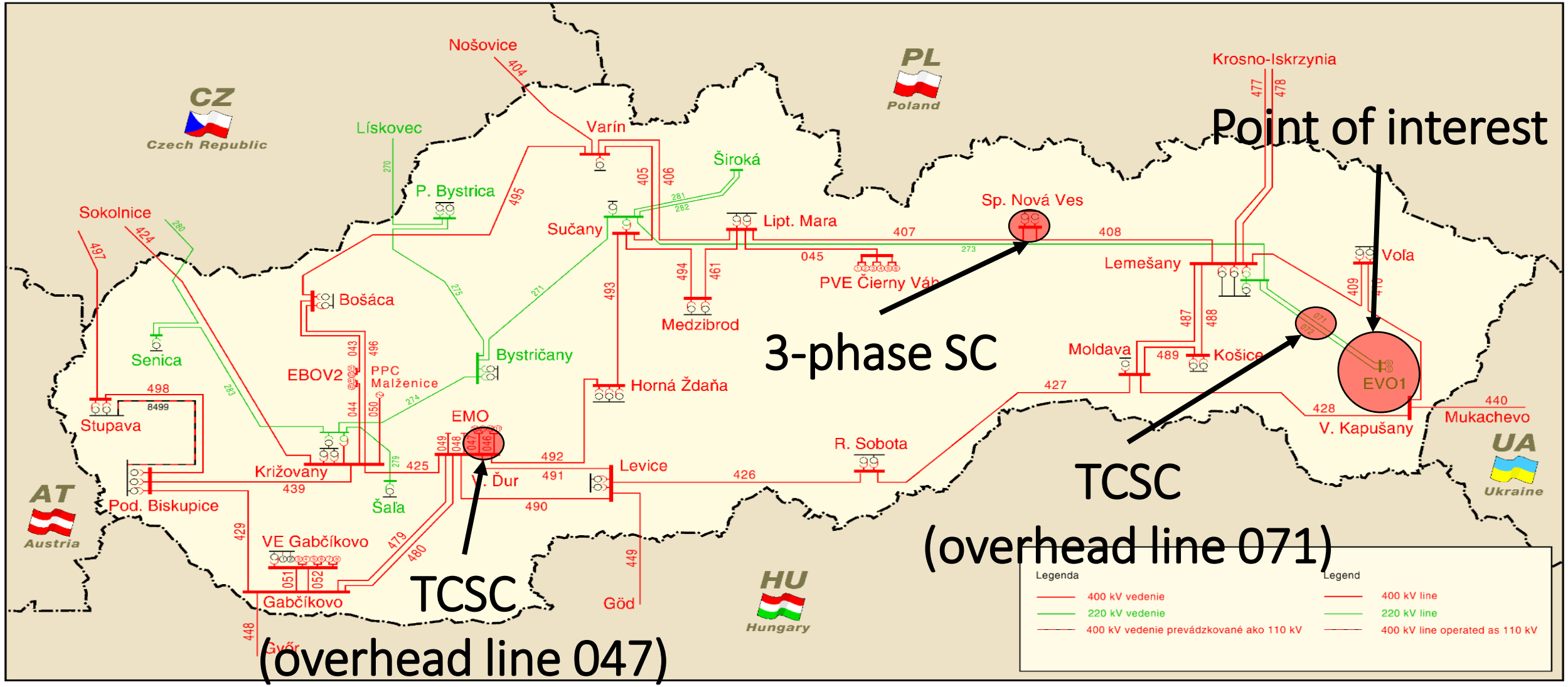
Power System of The Slovak Republic



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Vyhotovil: Odbor sieťových výpočtov,
SEPS
Technická spolupráca: sféra, a.s.

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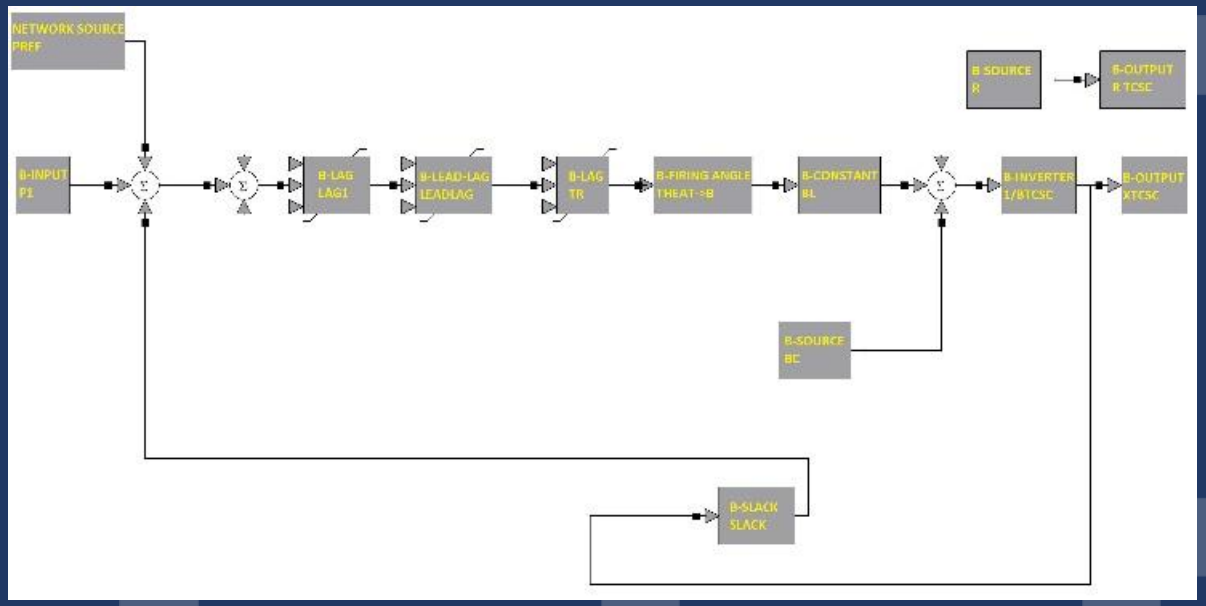
Controller of TCSC system



- two values are entered for the input, namely the reference value of the active power - entered in MW and the second input is the active power entered in proportional units.
- the output is then connected to the mathematical inverter and then to the output value that controls the TCSC module impedance Z (variable value inductance (XL). connected members that enter the TSCS resistance value.
- Each of the FACTS devices is designed for the purpose of controlling or controlling the parameters in the system. Thus, the regulator may have entered different input values (voltage, current, power, etc.), which it monitors during operation and thereby controls the output value by means of the members included in the diagram, which may also differ from other regulators (susceptance - change of admittance, inductance - impedance change and others).

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IMPLEMENTATION TCSC DEVICES IN SLOVAK POWER SYSTEM

- the busbar system of a 400 kV substation in Spišská Nová Ves drawn in the NEPLAN program, while a three-phase short-circuit is set on the busbar "SPNV_400_W1", which is removed in 0.25 s.
- With this short circuit, we can observe a transient event of active and reactive power on our selected generator (EVO TG5).
- which at the time supplied 33.4 MW and 11 MVAr (inductive).
- Since we deal with the implementation of FACTS systems and their ability to improve, for example, the dynamic stability of the generator, the FACTS component is built into the scheme.
- The result is a compared process without a FACTS compensation device and with a compensation technology of the TCSC system type. can be realized by means of many other solutions using FACTS systems and the use of suitable regulators for a specific type of equipment.

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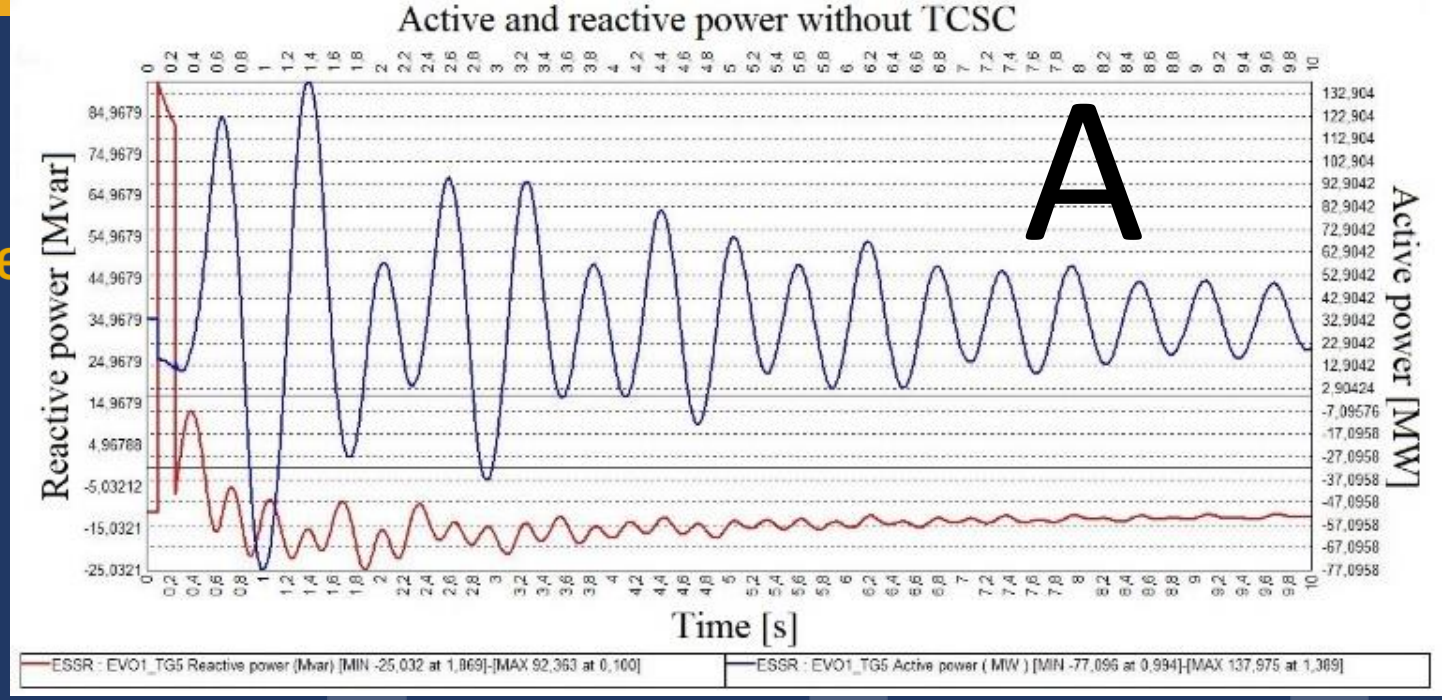
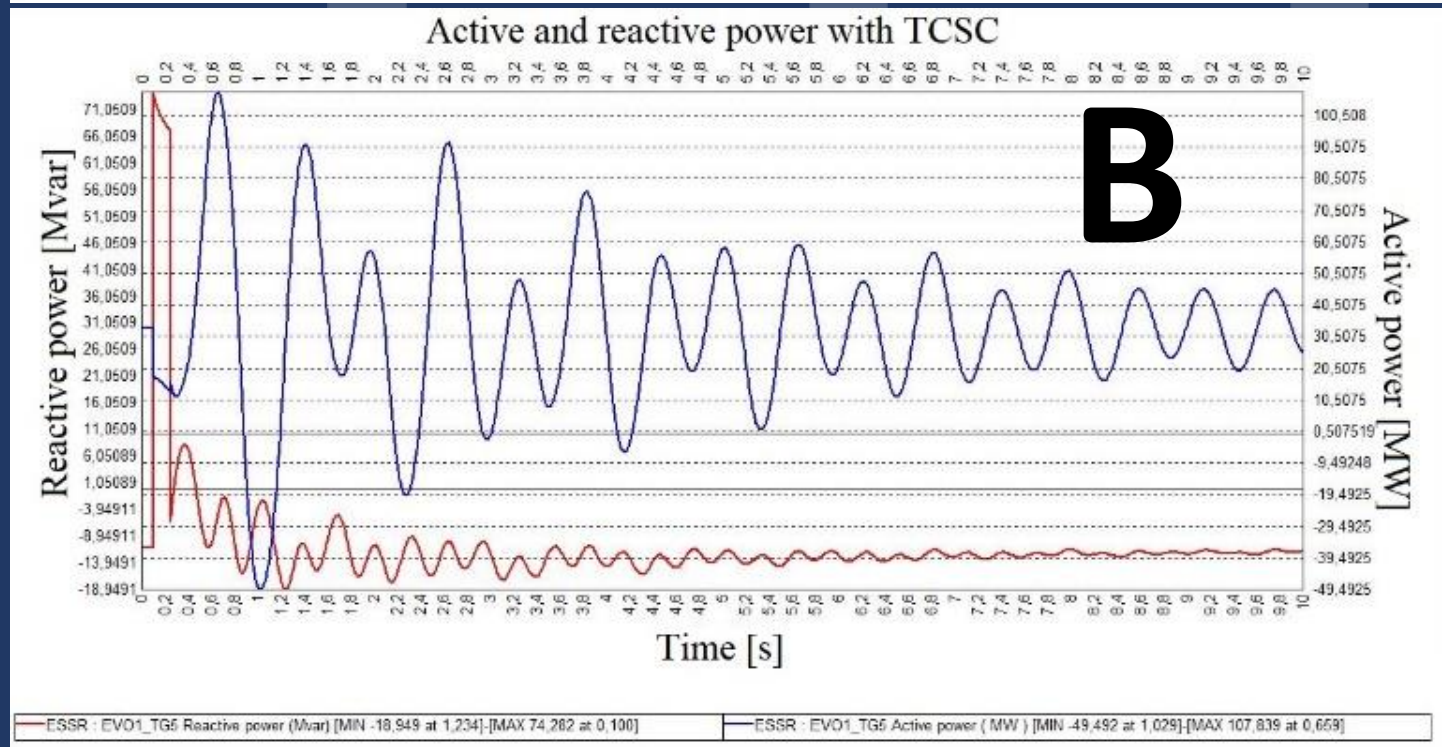
- In the case „A“, the maximum amplitude of the active power on the "EVO_TG5" generator after a short circuit is approximately <u>138 MW.</u>
  - Subsequently all other oscillations oscillate and settle with a higher amplitude than in the case of using TCSC technology.
- With TCSC we can monitor the changes in the simulation „B“, and thus the effect of the FACTS device as it affects the oscillation of the generator.
  - Using the TCSC element, which was able to reduce the oscillation of the generators and dampen their amplitudes.
- We achieved a change in the maximum amplitude to approximately 110 MW.





- The maximum amplitude after short circuit was around +15 MVAr (capacitive) and -25 MVAr (inductive) without of FACTS.
- With the use of TCSC it is a value of approximately +9 MVAr (capacitive) and -19 MVAr (inductive).

TCSC	**Active power EVO1_TG5**				
	Supply [MW]	Max eave [MW]	Time [s]	Min wave [MW]	Time [s]
Without	33,359	137,975	1,389	-77,096	0,994
With	33,361	107,839	0,659	-49,492	1,029
Difference	0,002	30,136	0,730	27,604	0,035

TCSC	**Reactive power EVO1_TG5**				
	Supply [MVAr]	Max wave [MVAr]	Time [s]	Min wave [MVAr]	Time [s]
Without	-12,346	92,363	0,100	-25,032	1,869
With	-12,425	74,282	0,100	-18,949	1,234
Difference	0,079	18,081	0,000	6,083	0,635

- This is a comparable difference and a visible improvement of dynamic (transient) processes using FACTS systems based on power electronics.

SPNV_400_W1 Setting a 3 phase short-circuit fault Time: 0,100000
SPNV_400_W1 Removing a short-circuit fault Time: 0,275000

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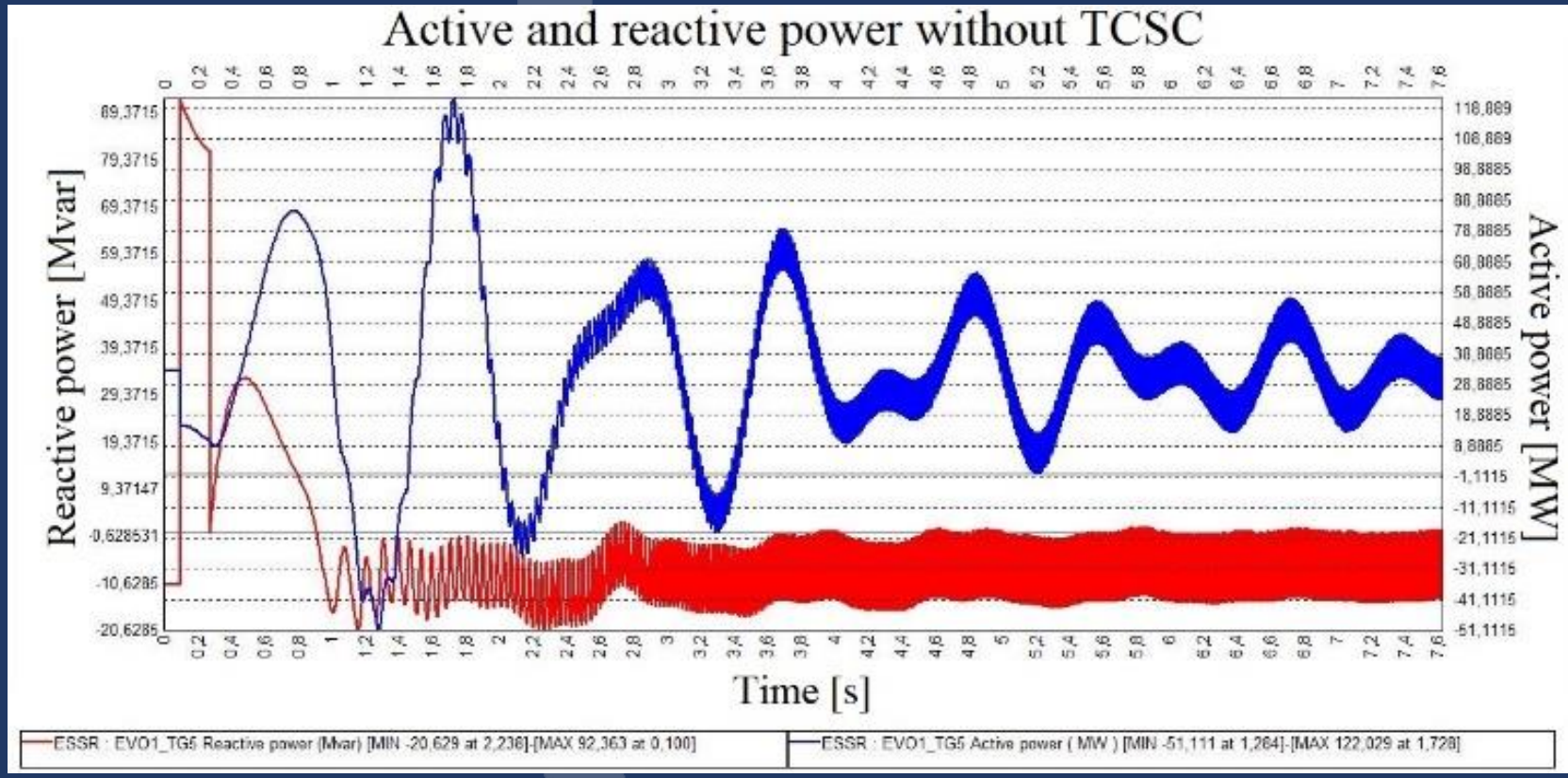
IMPACT OF TCSC FOCUS OF CCT

- From the course, we assume that the hard network, which supplies our electricity system of the Slovak Republic, helped the generator to stabilize, but as can be seen in this figure, generators would continue to oscillate uncontrollably (sway) and subsequently it would be necessary to shut it down from this transmission system - there would be a failure from synchronism.



- At this set short-circuit duration, we can observe that the TG5 generator we observed at the Vojany power plant could not stabilize and would fall out of synchronism.

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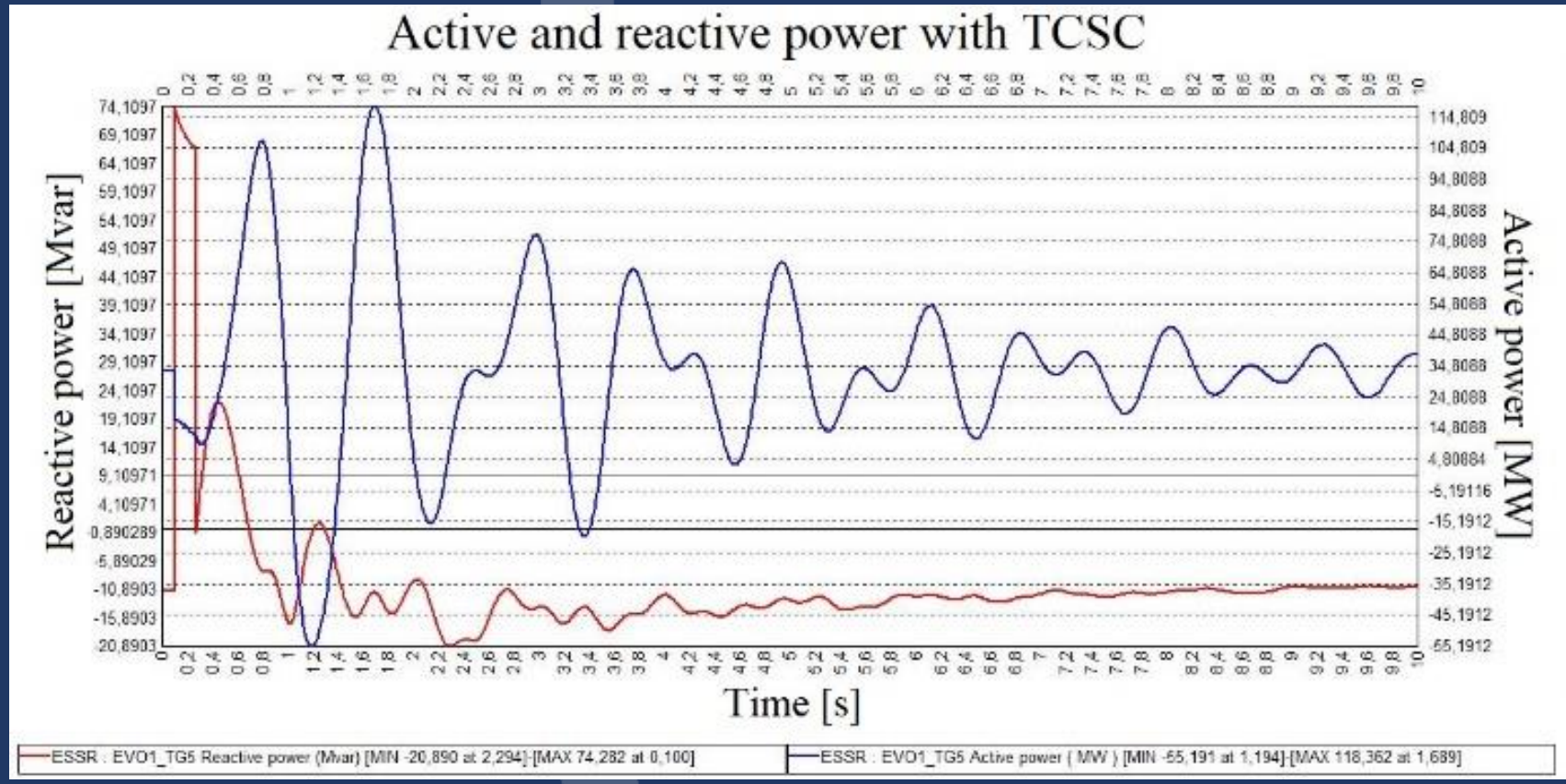

- At this set duration of the short circuit, we can observe that the TG5 generator observed by us at the Vojany power plant could not stabilize and would fall out of synchronism.

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ANALYSIS OF RESULTS

- In order to observe the oscillation of the generator on the EVO_TG5 unit (turbogenerator of the Vojany power plant) at the set 3-phase short circuit in the SPNV_400_W1 substation, the influence of the TCSC device is observed.
- The output is processed the results of how the TCSC technology can dampen and stabilize the oscillation of the generator, and thus the whole system in real design.
- The TCSC system is able to eliminate generator oscillation (active and reactive power) in the event of a short circuit and thus help prevent the failure of a block or group of generator blocks operating into the system.
- The application of FACTS systems to the Slovak transmission power system also has an impact on the CCT (critical time), which gives a kind of time reserve for disconnecting the short circuit for protections.
- This analysis concluded that the FACTS system helps to improve the dynamic stability, reliability and increase the robustness of power systems.

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THANK YOU FOR YOUR ATTENTION