POSSIBILITIES OF POWER FLOWS CONTROL

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ABSTRACT

This article deals with special equipments set to power flows control in power systems. There is analyzed eleven nodes network, where is shown regulation of power flows in software package NEPLAN. With the constant increasing electricity consumption, the transmission system operators face new challenges and problems. One of the most important problems of today electric power engineering is significant load; possibly overload some of transmission lines. Building of new power lines can by the solution of these problems. This option is very economical but time consuming solution. So there is solution in form of using of new special equipments for power flows control.

1. INTRODUCTION

The problem of regulation of load flow the power system is currently becoming more and more discuss among professionals. Opening of an electricity market brought a much of advantages, but on the other hand, also much of drawbacks. Since commercially negotiated power flows are significantly different from the actual flows of trade laws and do not exceed the laws of physics, the question arises how to bring near these laws. As a result, of electricity trading has been increasing interstate transfers, often because of what some of the lines to the state, which are surcharge, while others are not fully utilized.

With reference to the market liberalization in the power industry, the actual tendencies of the electric power systems operation have the following character:

- Increasing capacities of the electric energy international exchanges in term of exportation from the sources, as well as in term of powers transit,
- increasing operating exploitation of the transmission elements, mainly international lines of interconnected electric power systems. This advanced form of the using of elements causes less reserves in case of the line surcharge. In background, the international lines were used mainly to increase the operation electric power system dependability in given area. Nowadays is overrides big business using, at what networks and their interconnections were not conceptually constructed,
- increasing differences between physical and business electric energy flows with the negative consequence to loss. These differences are still more expanding in last years,
- it exists relatively big unstableness and time changes of the transmission size. These processes are not possible to well predict,
- the networks operation is often adapted (by non-standard solutions too) to the business events,
- on these conditions, in any cases during the operation are beginning to detect networks bottlenecks, which can be limiting factor for the desired business changes. Sequentially, these situations can to cause the risk of the fail and breaking of the electric energy supply in areas.

The classic solution of the networks development (networks bottlenecks elimination), relative with the reinforcing and building of the new lines, is no wear as sufficient and quick in continuity with the problems to obtain of the new corridors and in connection with environmental problems. Therefore,

often sought the ways, which could to enable at least regionally affect the negative functioning of therein before present processes for the transmission networks operation.
One of the decision distributive companies into the future is production of renewable for each household. Such production may result in rotation of direction load flow. Actual situation is possible to change and load flow will not from the transmission system to distribution, but on the contrary.
To arrive to effective operation of lines and prevent congestion interstate lines we can use devices designed to power flows control. One of the practically usable devices, which can be used to electric power system control in interconnected power systems are flexible alternating current transmission system (FACTS). [1][2][3]

2. FACTS

Flexible electric transmission systems belong to progressive technologies in electro-energetic. FACTS devices are used to optimize already the existing transmission lines. These devices have been developed by Electrical Power Research Institute (EPRI) in the 80s.

FACTS device are:

- <u>Serial Controllers:</u> Static Synchronous Series Compensator SSSC, Interline Power Flow Controller IPFC, Thyristor Controlled Capacitor TCSC, Thyristor Switched Series Capacitor TSSC, Thyristor Controlled Series Reactor TCSR, Thyristor Switched Series Reactor TSSR
- <u>Parallel Controllers:</u> Static Synchronous Compensator STATCOM, Static Synchronous Generator SSG, Static Var Compensator SVC, Thyristor Controlled Reactor TCR, Thyristor Switched Reactor TSR, Thyristor Switched Capacitor TSC, Thyristor Controlled Braking Resistor TCBR
- <u>Serial - serial controllers</u>

<u>Series - parallel controllers:</u> Unified Power Flow Controller UPFC, Unified Controller Phase Shifting Transformer TCPST, Interphase Power Controller IPC

2.1. UPFC - Unified Power Flow Controller

Unified Power Flow Controller (UPFC) is used to control the power flow in the transmission systems by controlling of the impedance, voltage magnitude and phase angle. This controller offers advantages in terms of static and dynamic operation of the power system.

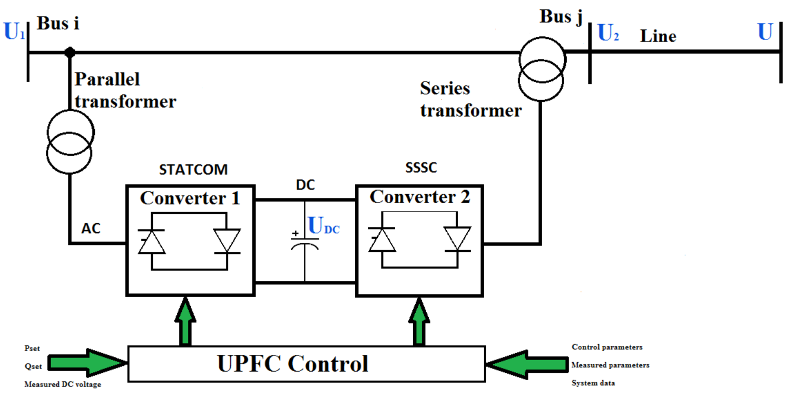

Figure 1 – Universal power flow controller (UPFC).

Figure 1 shows the schematic diagram of the three phases UPFC connected to the transmission line. The UPFC consists of two voltage source converters; series and shunt converter, which are connected to each other with a common DC link. Series converter (Converter 2) or Static Synchronous Series Compensator (SSSC) is used to add controlled voltage magnitude and phase angle in series with the line, while shunt converter (Converter 1) or Static Synchronous Compensator (STATCOM) is used to provide reactive power to the AC system, beside that, it will provide the DC power required for both inverter. Each of the branches consists of a transformer and power electronic converter. These two voltage source converters shared a common DC capacitor. The reactive power in the shunt or series converter can be chosen independently, giving greater flexibility to the power flow control. The coupling transformer is used to connect the device to the system [2].

2.2. TCSC - Thyristor-controlled series capacitor

TCSC configurations comprise controlled reactors in parallel with sections of a capacitor bank. This combination allows smooth control of the fundamental frequency capacitive reactance over a wide range. The capacitor bank for each phase is mounted on a platform to ensure full insulation to ground. The valve contains a string of series-connected high-power thyristors. The inductor is of the air-core type. A metal-oxide varistor (MOV) is connected across the capacitor to prevent overvoltages [4].

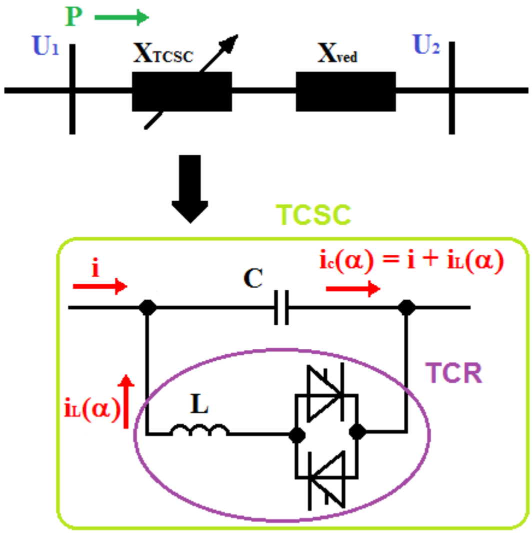

Figure 2 – Thyristor-controlled series capacitor (TCSC).

3. POWER SYSTEM OF THE SLOVAK REPUBLIC

Power system of the Slovak Republic was created in NEPLAN. With power system of Slovak republic were created power systems twenty-two other countries.

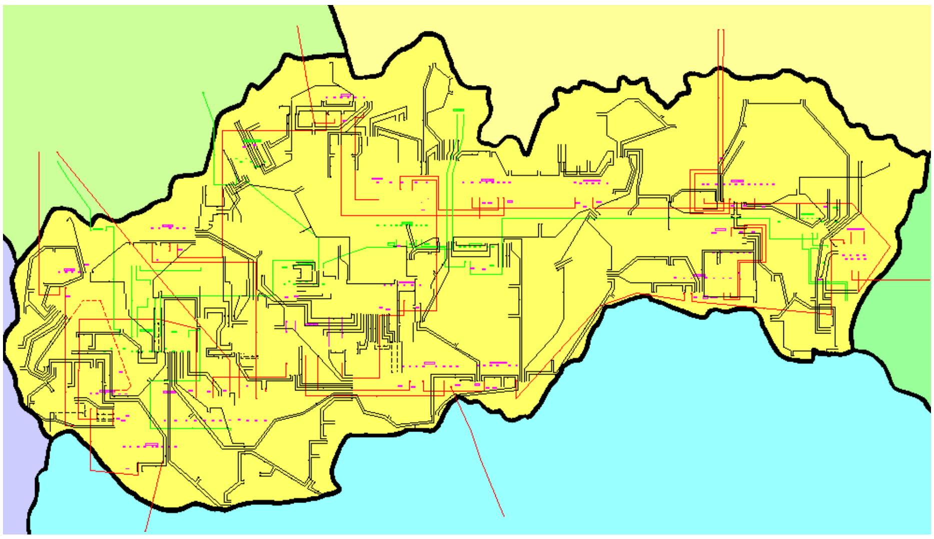

Figure 3 – Power system of the Slovak Republic in NEPLAN

TCSC between Slovak Republic and Hungary

Between Slovak Republic and Hungary are two interstate lines. These lines are very often overloaded. When we would use FACTS device, overloaded could be eliminated. Eliminate the overload can be achieved through regulation of power flow.

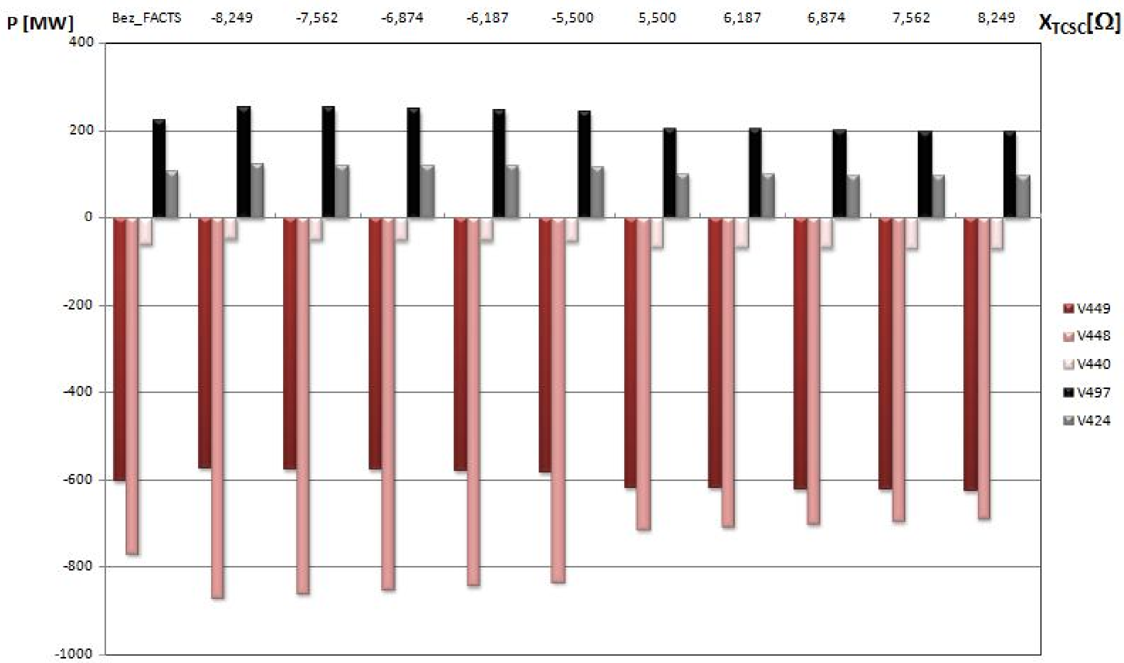

Figure 4 – Control of power flow with use TCSC device on line V448

4. CONCLUSIONS

UPFC belongs to the most integrated devices of the FACTS devices group. It is possible to use these devices for the in depended active and reactive power flows controlling. Its utilization in the electric power system control corresponds to their technical and economic demand. Currently, the investment cost not allows the mass installation of UPFC to the electric power system.

Gradually, however, will needs to introduce these devices more and more. Their benefits are not only in the regulation of power flows but help to improve the static and dynamic stability, oscillation damping and regulate voltage conditions.

So we can assume that Slovak Power system over time cannot be without these devices.

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