

Possibilities of power flows control in electric power systems with use FACTS Devices

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<http://web.tuke.sk/fei-kee/kee-s.html>

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Outline

- Actual tendencies
- FACTS
- Simulation Model
- Control of power flow
- CONCLUSION

The actual tendencies of the electric power systems operation have the following character:

- Increasing capacities of the electric energy
- Increasing operating utilization of the transmission elements
- Increasing differences between physical and business electric energy flows
- Detect networks bottlenecks

What is FACTS?

- Flexible Alternating Current Transmission System
- These devices have been developed by Electrical Power Research Institute (EPRI) in the 80s
- FACTS devices are used to optimize already the existing transmission lines

FACTS devices are:

- Serial Controllers: Static Synchronous Series Compensator SSSC, Interline Power Flow Controller IPFC, Thyristor Controlled Capacitor TCSC, etc.
- Parallel Controllers: Static Synchronous Compensator STATCOM, Static Synchronous Generator SSG, Static Var Compensator SVC, etc.
- Serial - serial controllers:
- Series - parallel controllers: Unified Power Flow Controller UPFC, Unified Controller Phase Shifting Transformer TCPST, Interphase Power Controller IPC, etc.

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Software

The screenshot displays the NEPLAN software interface for a power system analysis. The main window shows a complex network diagram with various components and connections. The interface includes a menu bar (File, Insert, Edit, View, Analysis, Libraries, Tools, Options, Window, Help), a toolbar with numerous icons, and a status bar at the bottom.

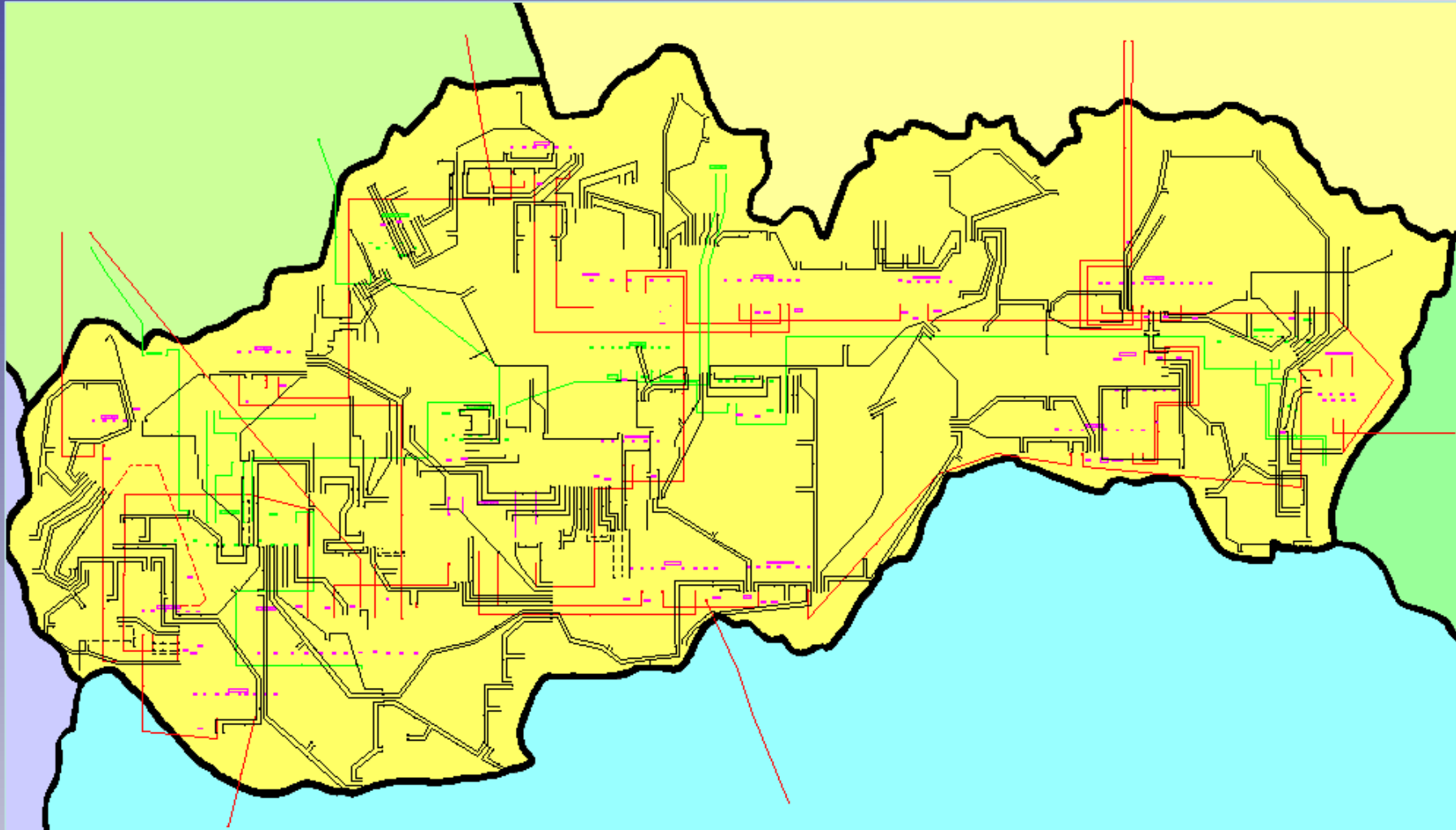
Diagram Details:
The diagram features a central busbar system with multiple feeders. Key components include:

- Generators:** Represented by circles with a tilde symbol, such as GEN_1, GEN_2, GEN_3, GEN_4, GEN_5, GEN_6, GEN_7, GEN_8, GEN_9, GEN_10, GEN_11, GEN_12, GEN_13, GEN_14, GEN_15, GEN_16, GEN_17, GEN_18, GEN_19, GEN_20, GEN_21, GEN_22, GEN_23, GEN_24, GEN_25, GEN_26, GEN_27, GEN_28, GEN_29, GEN_30, GEN_31, GEN_32, GEN_33, GEN_34, GEN_35, GEN_36, GEN_37, GEN_38, GEN_39, GEN_40, GEN_41, GEN_42, GEN_43, GEN_44, GEN_45, GEN_46, GEN_47, GEN_48, GEN_49, GEN_50.
- Transformers:** Represented by circles with a cross, such as TRF_1, TRF_2, TRF_3, TRF_4, TRF_5, TRF_6, TRF_7, TRF_8, TRF_9, TRF_10, TRF_11, TRF_12, TRF_13, TRF_14, TRF_15, TRF_16, TRF_17, TRF_18, TRF_19, TRF_20, TRF_21, TRF_22, TRF_23, TRF_24, TRF_25, TRF_26, TRF_27, TRF_28, TRF_29, TRF_30, TRF_31, TRF_32, TRF_33, TRF_34, TRF_35, TRF_36, TRF_37, TRF_38, TRF_39, TRF_40, TRF_41, TRF_42, TRF_43, TRF_44, TRF_45, TRF_46, TRF_47, TRF_48, TRF_49, TRF_50.
- Breakers:** Represented by rectangles with a vertical line, such as BRK_1, BRK_2, BRK_3, BRK_4, BRK_5, BRK_6, BRK_7, BRK_8, BRK_9, BRK_10, BRK_11, BRK_12, BRK_13, BRK_14, BRK_15, BRK_16, BRK_17, BRK_18, BRK_19, BRK_20, BRK_21, BRK_22, BRK_23, BRK_24, BRK_25, BRK_26, BRK_27, BRK_28, BRK_29, BRK_30, BRK_31, BRK_32, BRK_33, BRK_34, BRK_35, BRK_36, BRK_37, BRK_38, BRK_39, BRK_40, BRK_41, BRK_42, BRK_43, BRK_44, BRK_45, BRK_46, BRK_47, BRK_48, BRK_49, BRK_50.
- Capacitors:** Represented by rectangles with a vertical line and a horizontal line, such as CAP_1, CAP_2, CAP_3, CAP_4, CAP_5, CAP_6, CAP_7, CAP_8, CAP_9, CAP_10, CAP_11, CAP_12, CAP_13, CAP_14, CAP_15, CAP_16, CAP_17, CAP_18, CAP_19, CAP_20, CAP_21, CAP_22, CAP_23, CAP_24, CAP_25, CAP_26, CAP_27, CAP_28, CAP_29, CAP_30, CAP_31, CAP_32, CAP_33, CAP_34, CAP_35, CAP_36, CAP_37, CAP_38, CAP_39, CAP_40, CAP_41, CAP_42, CAP_43, CAP_44, CAP_45, CAP_46, CAP_47, CAP_48, CAP_49, CAP_50.
- Reactors:** Represented by rectangles with a vertical line and a horizontal line, such as REA_1, REA_2, REA_3, REA_4, REA_5, REA_6, REA_7, REA_8, REA_9, REA_10, REA_11, REA_12, REA_13, REA_14, REA_15, REA_16, REA_17, REA_18, REA_19, REA_20, REA_21, REA_22, REA_23, REA_24, REA_25, REA_26, REA_27, REA_28, REA_29, REA_30, REA_31, REA_32, REA_33, REA_34, REA_35, REA_36, REA_37, REA_38, REA_39, REA_40, REA_41, REA_42, REA_43, REA_44, REA_45, REA_46, REA_47, REA_48, REA_49, REA_50.

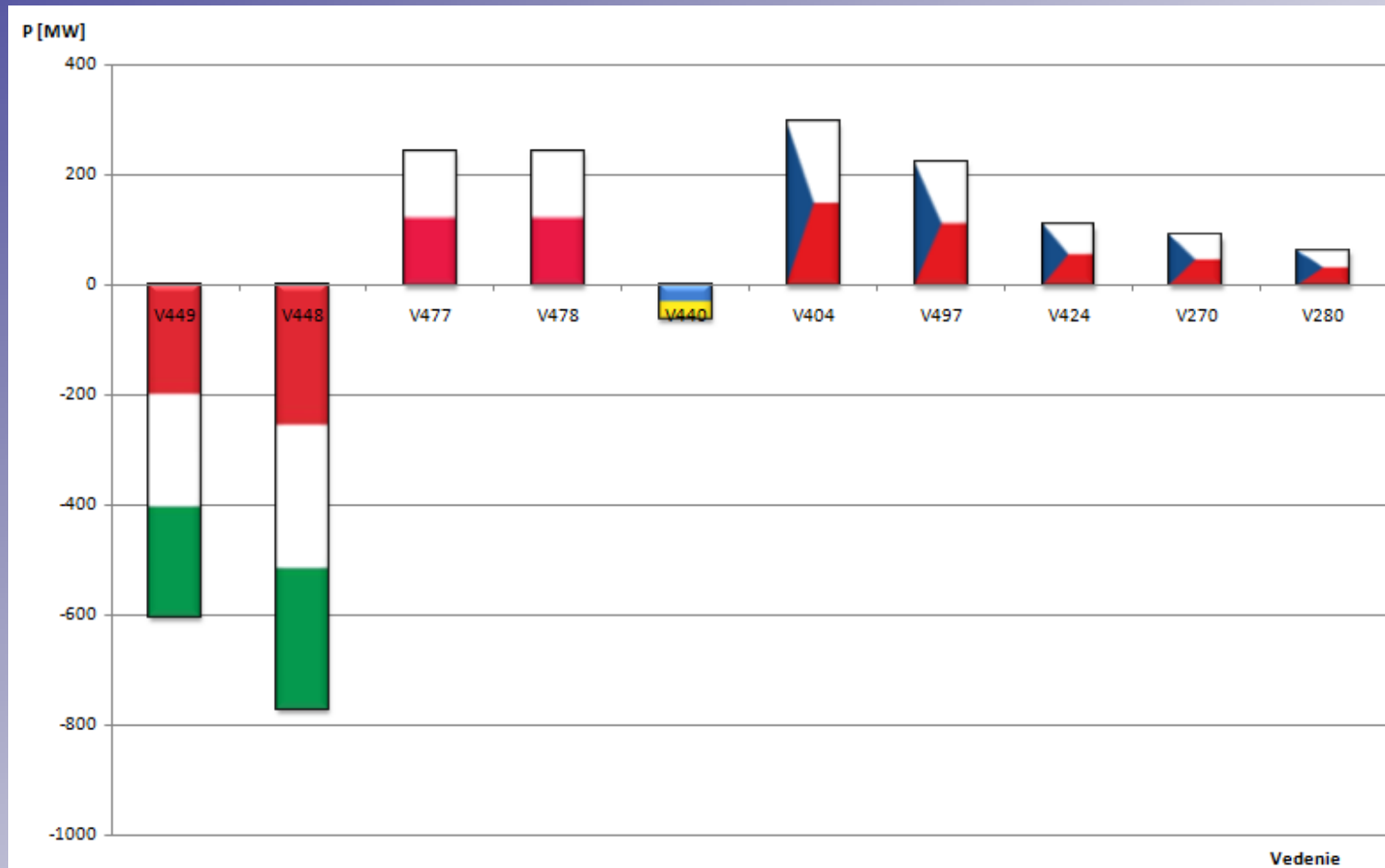
Interface Elements:

- Left Panel:** Shows a tree view of the project structure, including "Rootnet", "Diagram 0", and "Main_Window".
- Bottom Panel:** Displays "Overloaded Elements" and "Completed" status. The "Analysis" tab is active, showing "Messages", "Errors", and "Analysis" sub-tabs.
- Status Bar:** Includes "For Help, press F1", "X-Y", "Zoom=69,9", and "NUM" buttons.

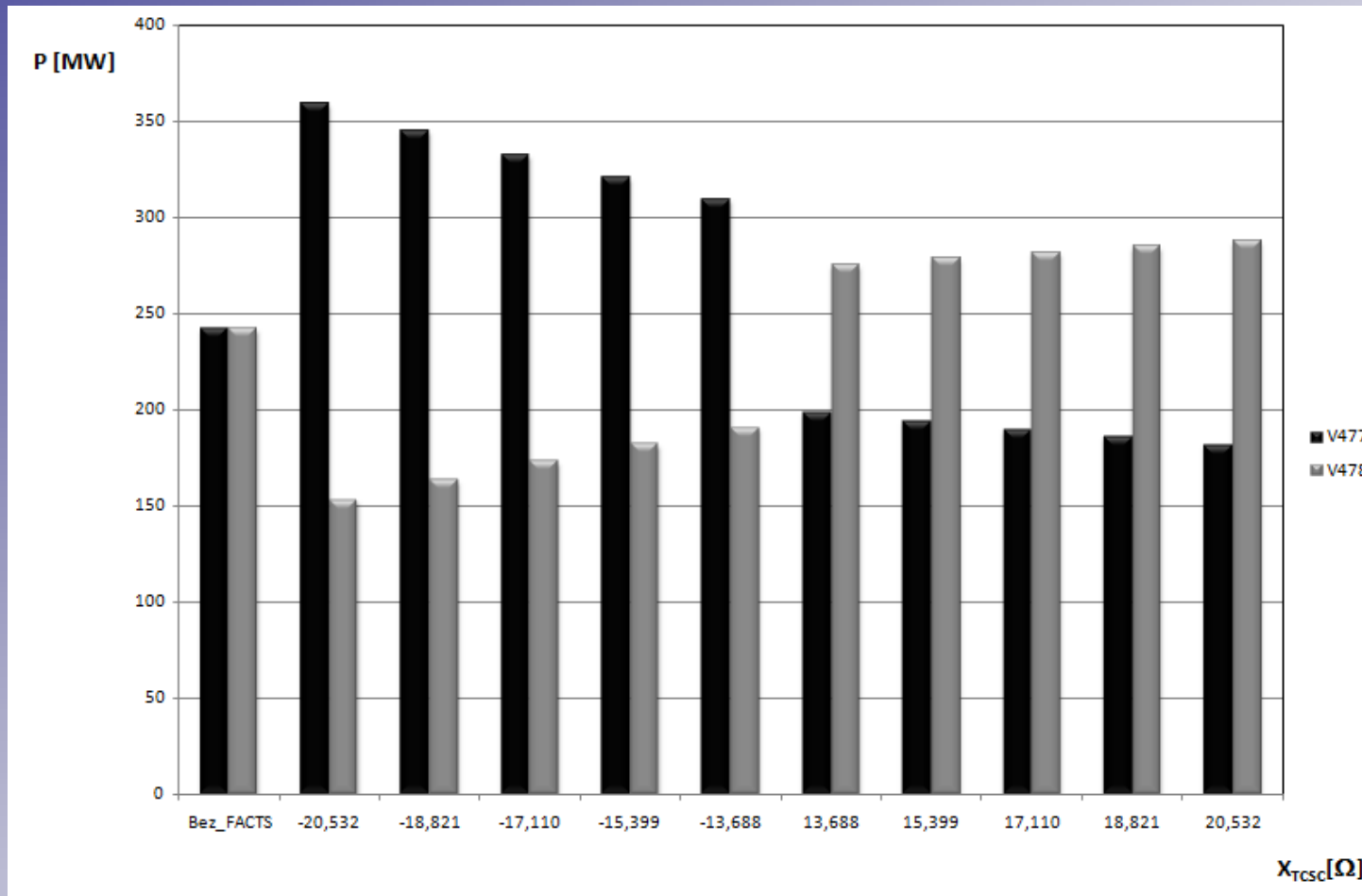
Power System of The Slovak Republic



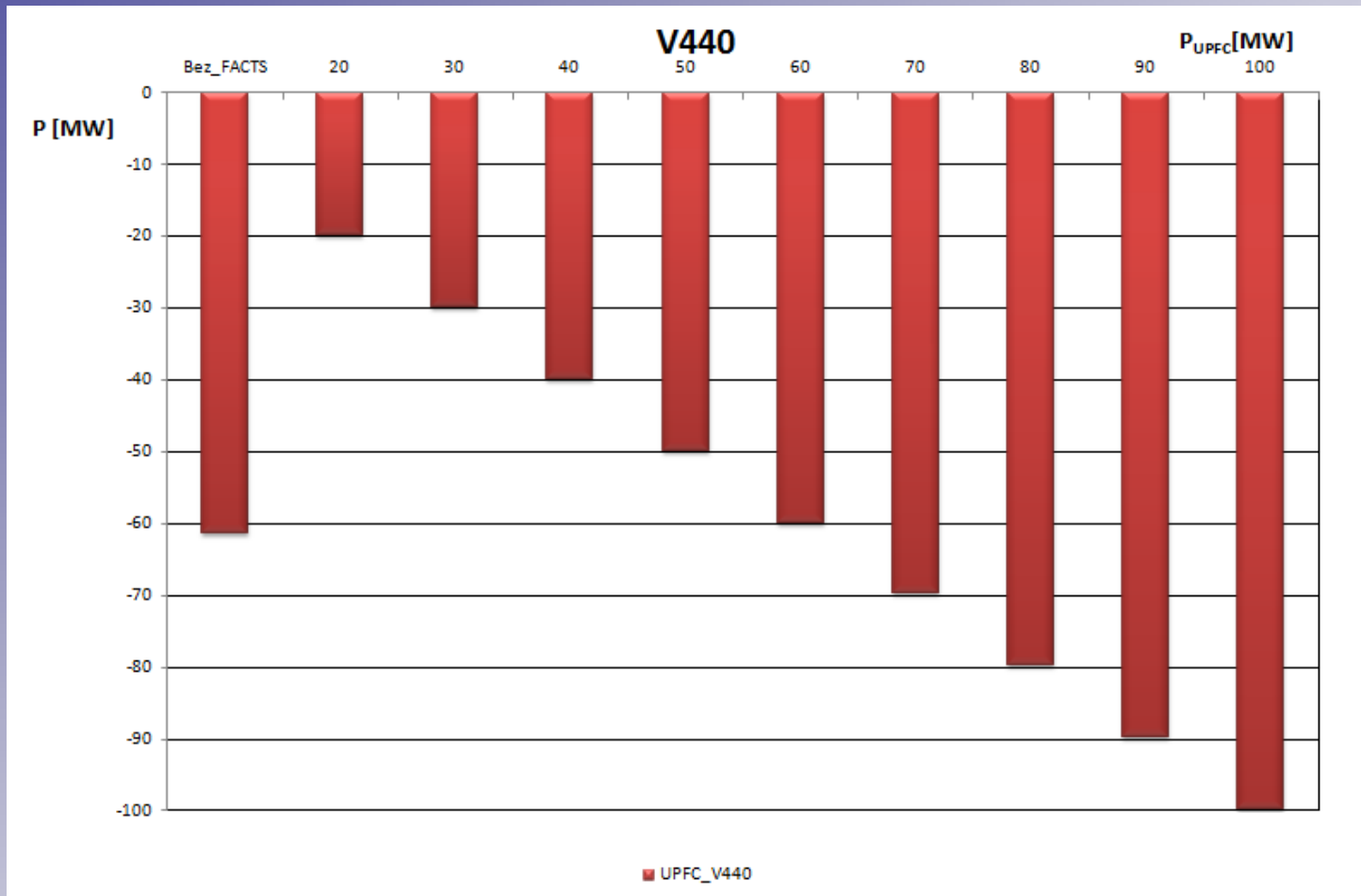
Active power



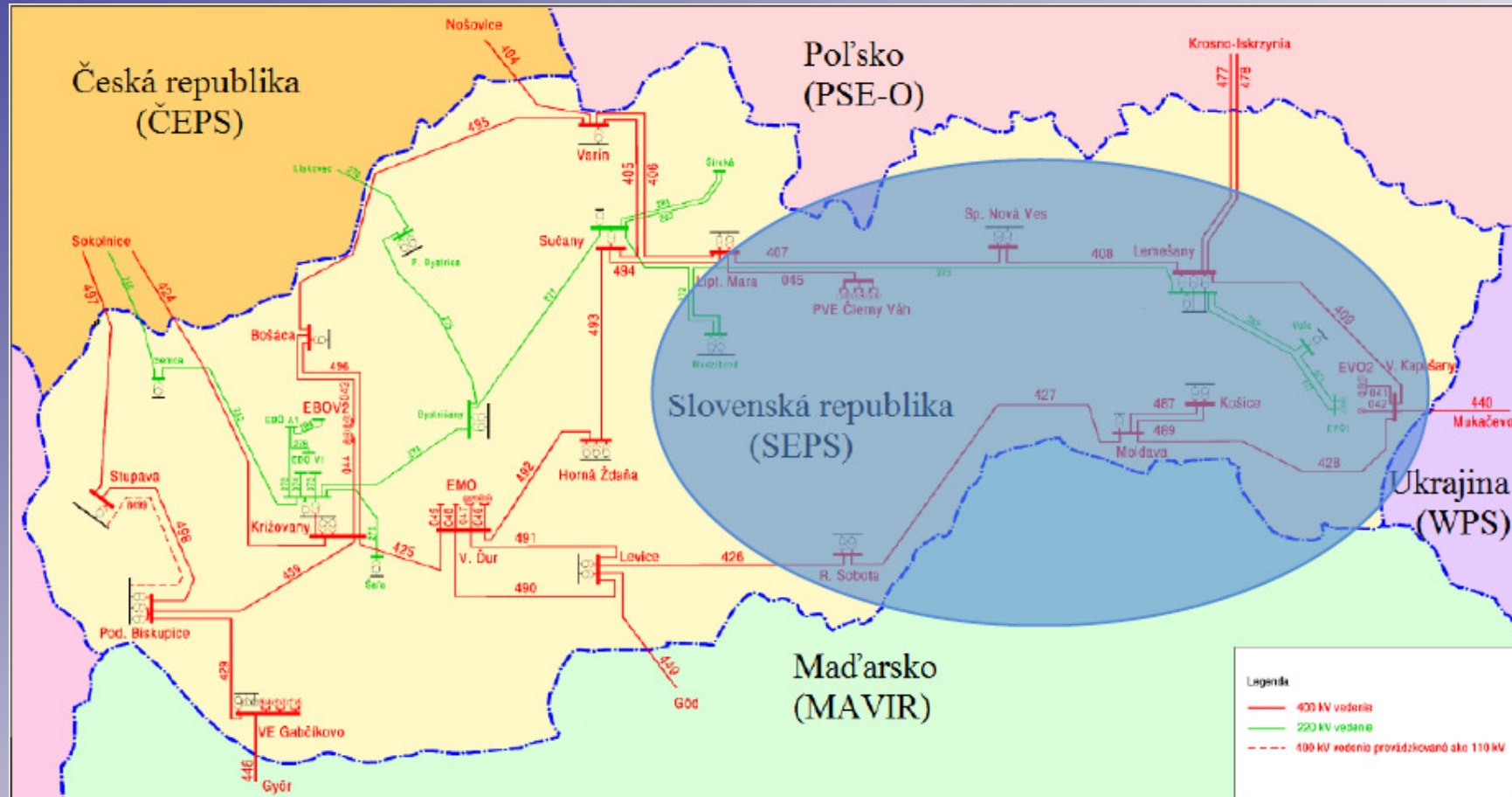
Control of power flow with TCSC



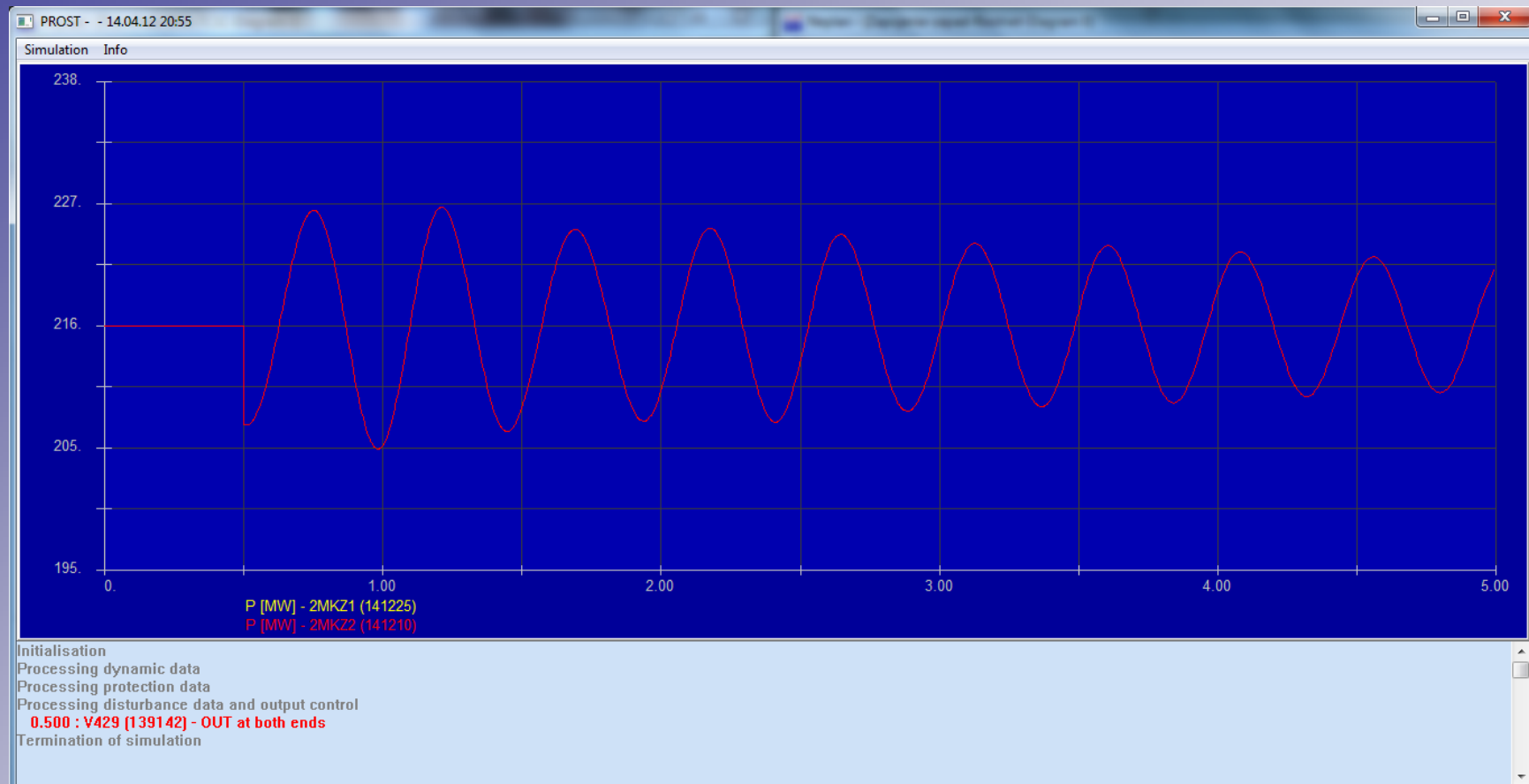
Control of power flow with UPFC



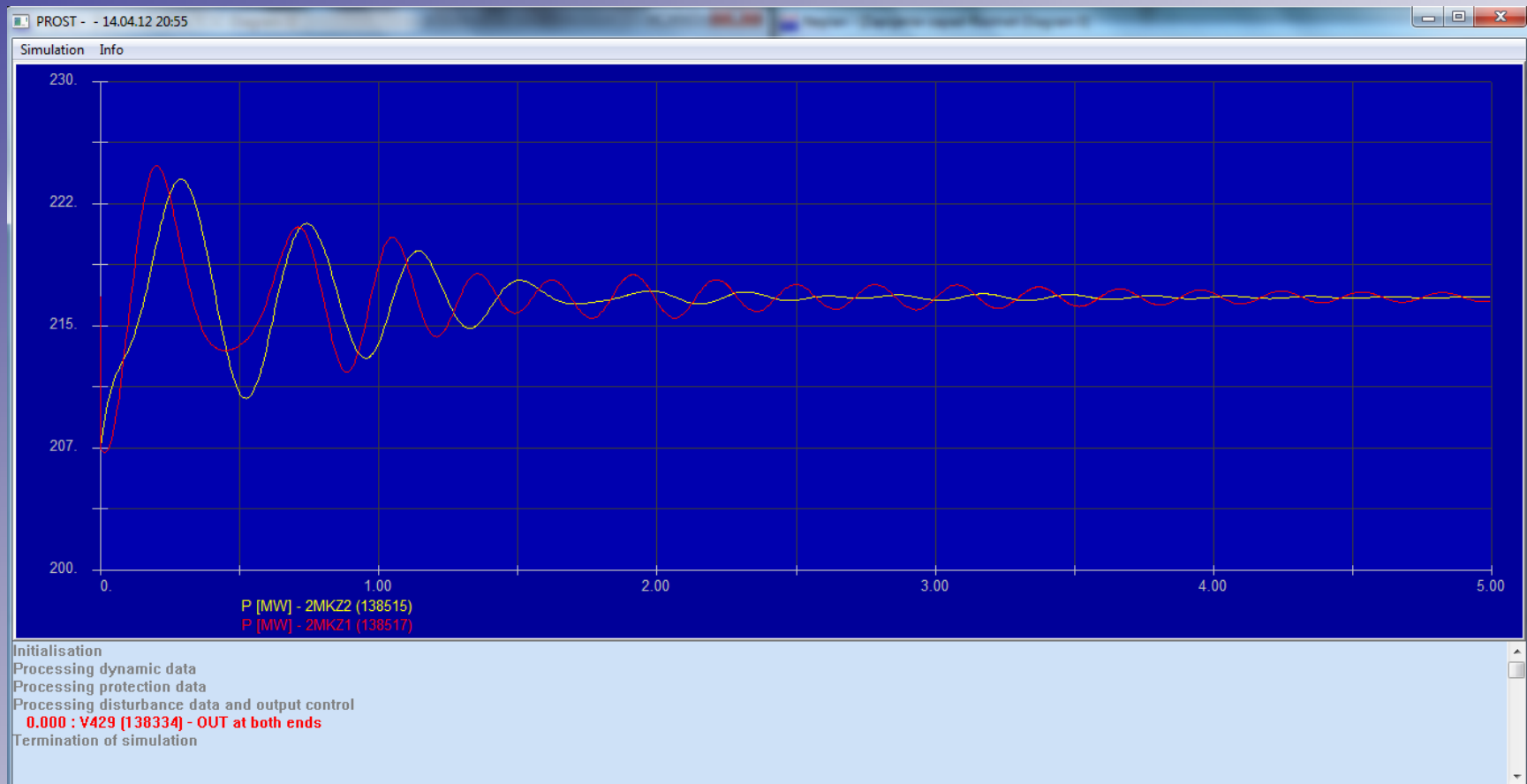
Control of voltage with UPFC



Transient stability



Transient stability



CONCLUSION

- UPFC belongs to the most integrated devices of the FACTS devices group.
- It is possible to use these devices for the control flows of active and reactive power
- FACTS devices contribute to improve of the limits of static, transient stability and voltage quality

***Thank you for your
Attention***