

Dynamic Interaction of Large Offshore Wind Farms with the High Voltage Transmission Network

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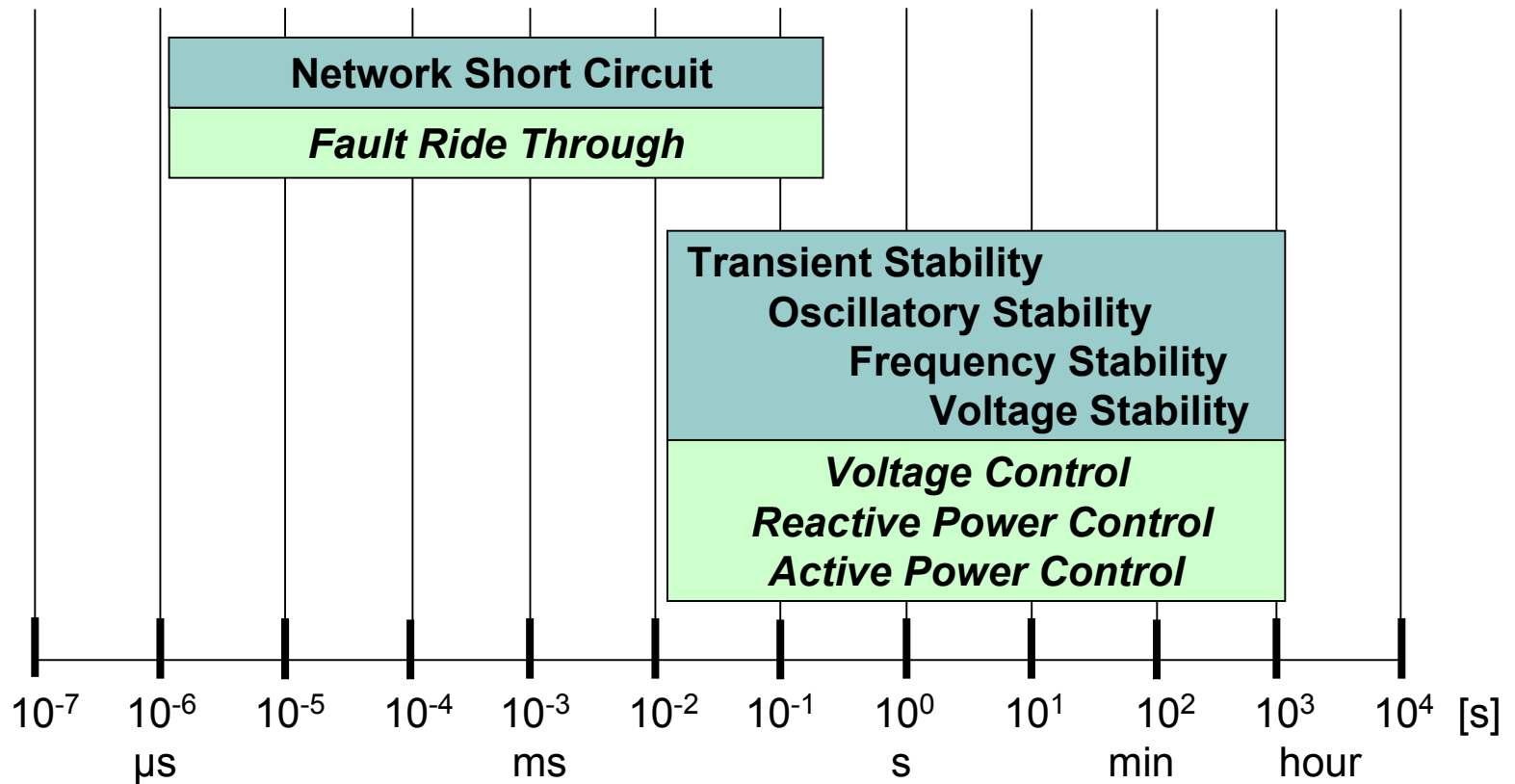


Outline

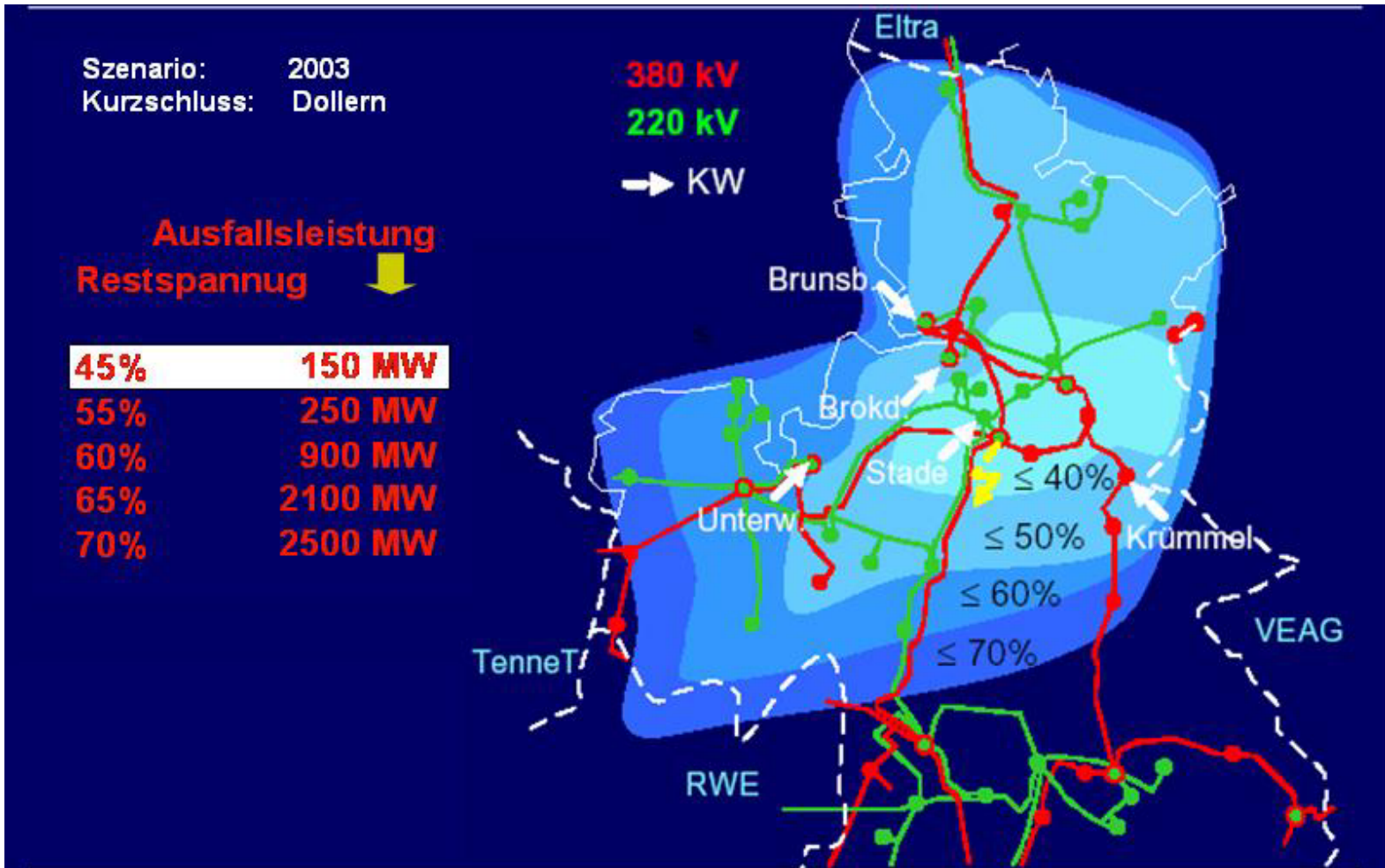
- Overview about power system dynamic issues
- Eon-requirements
- Wind turbine dynamic capabilities
- Simulation results for a selected wind park
- Conclusions



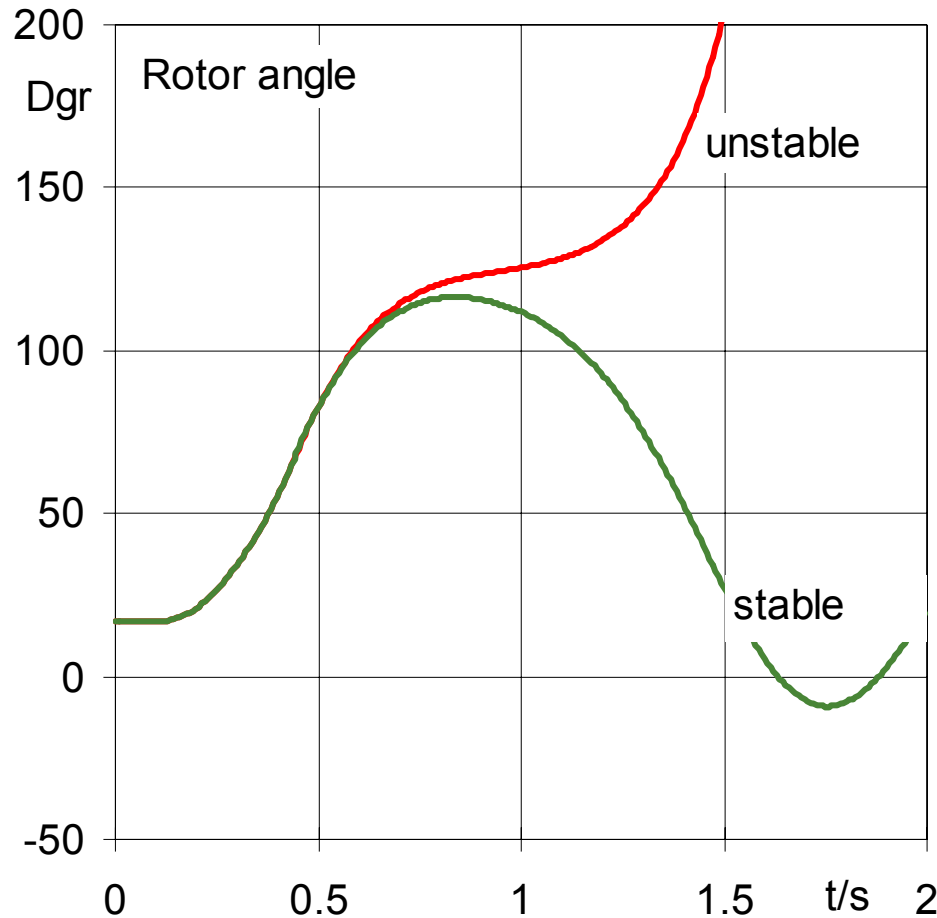
Power System Dynamic Concerns



Voltage Profile During Network Faults



Transient Stability



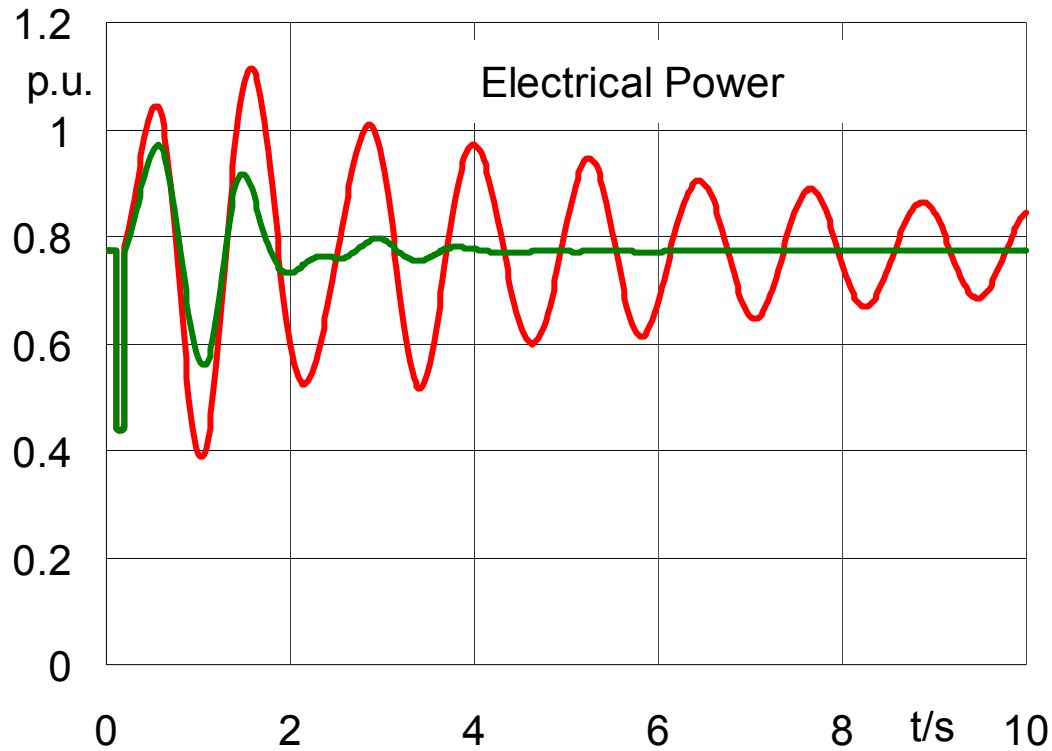
Impact of increasing wind power generation on

- critical fault clearing time

?



Oscillatory Stability



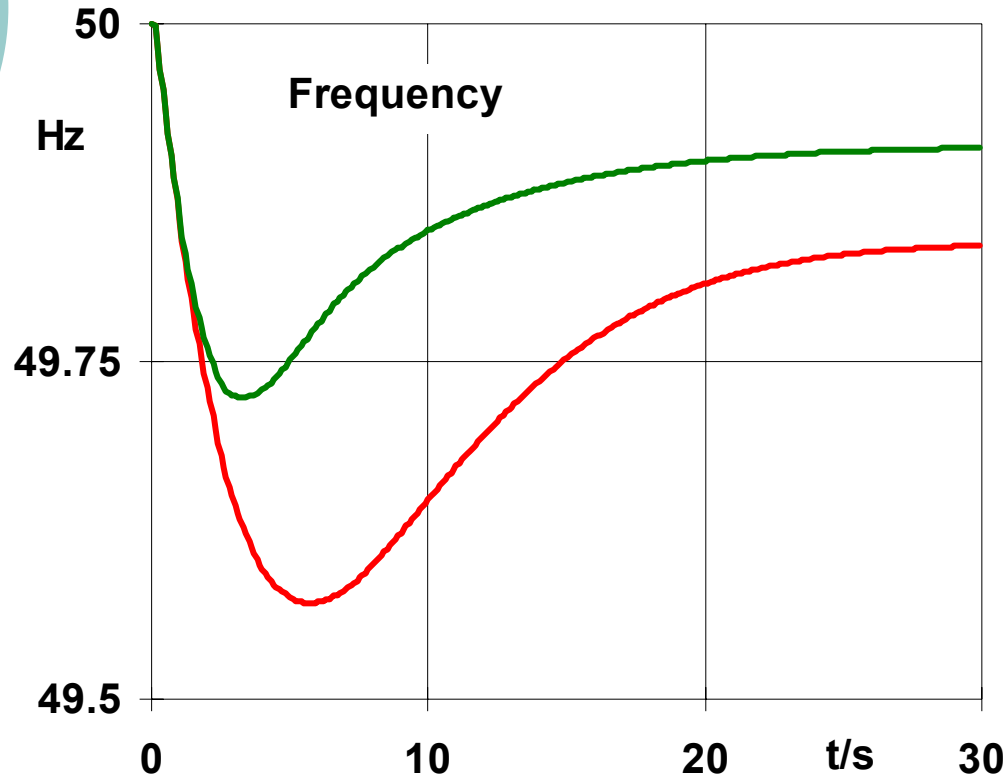
Impact of increasing wind power generation on

- **Frequency**
- **Damping**

?



Frequency Stability



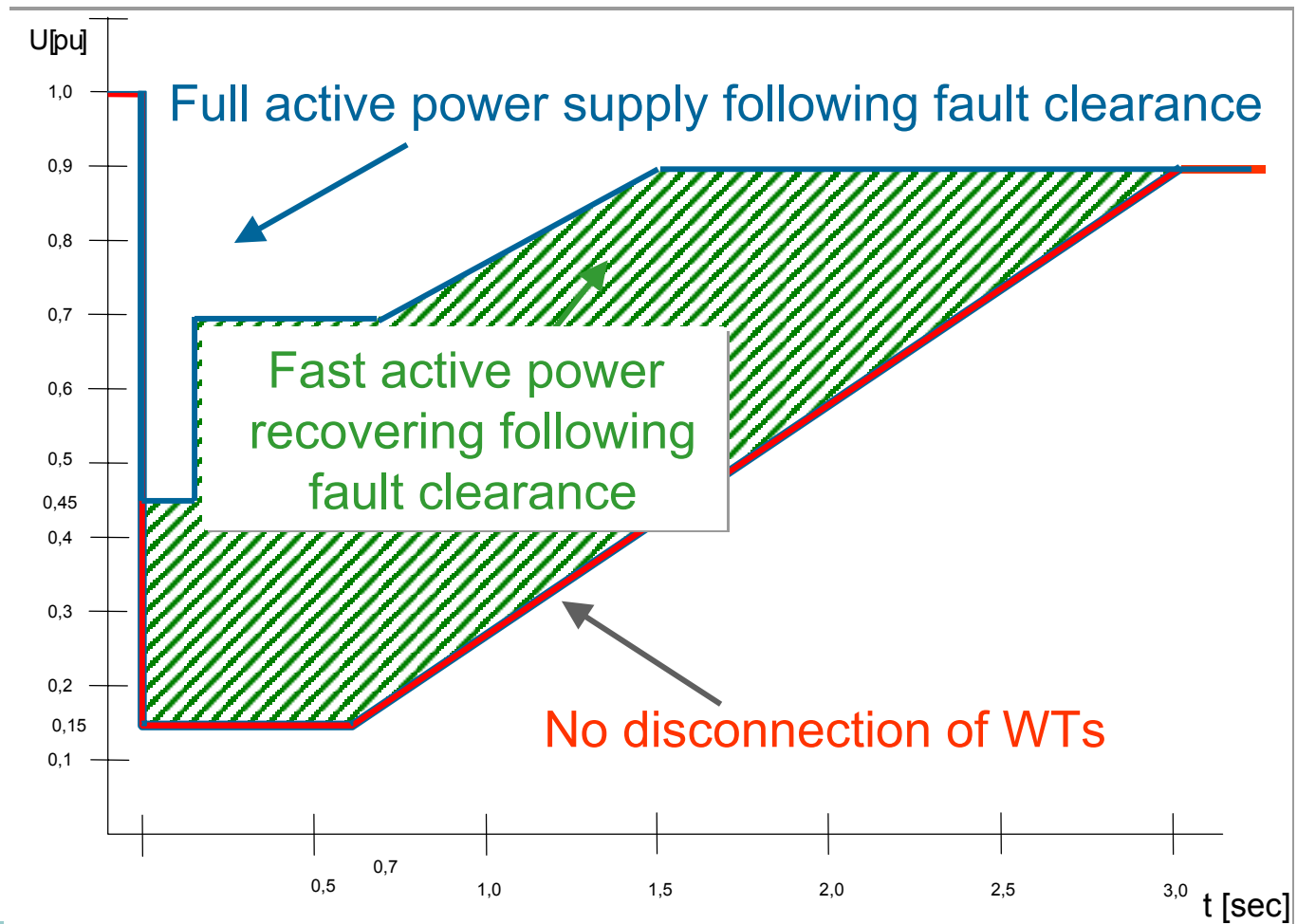
Impact of increasing wind power generation on

- f_{\min}
- t_{\min}

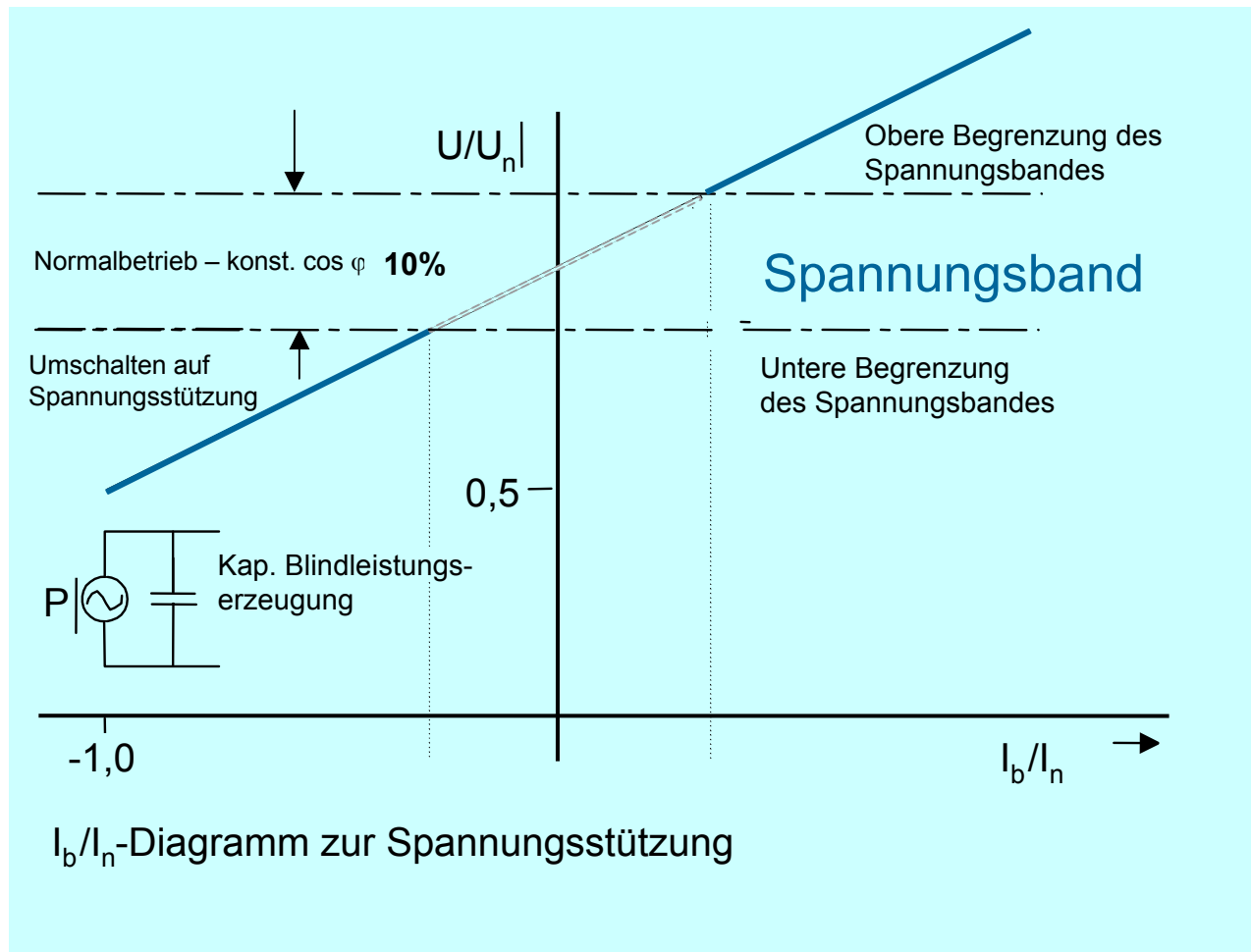
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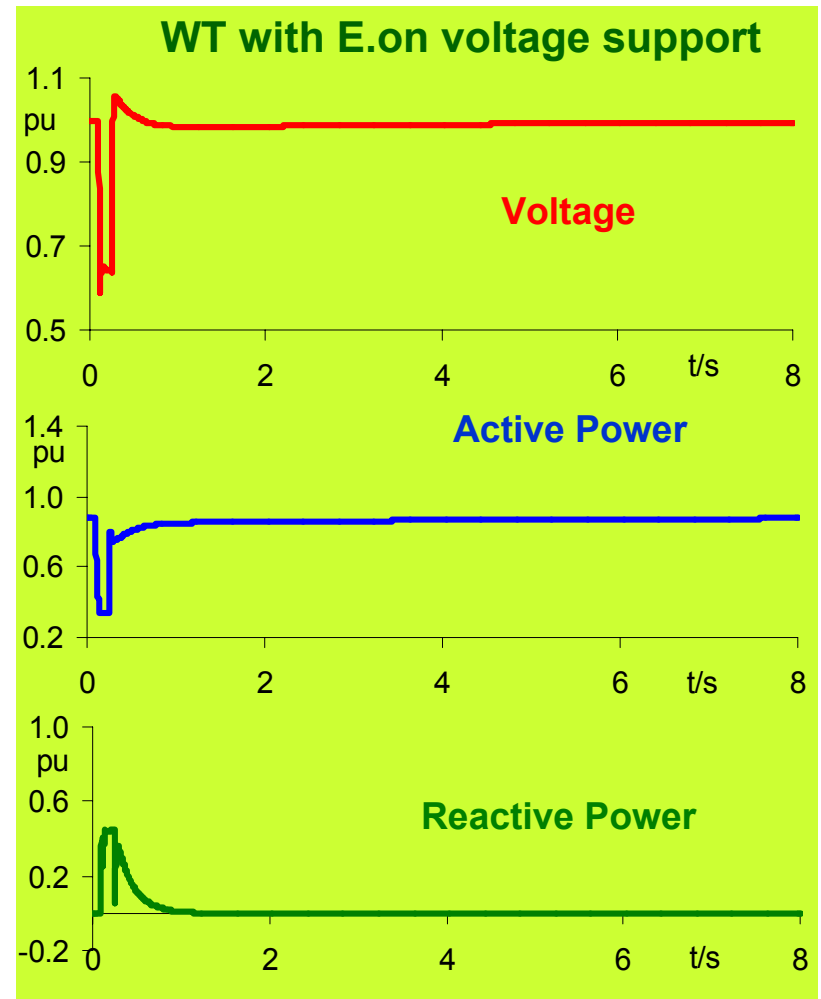
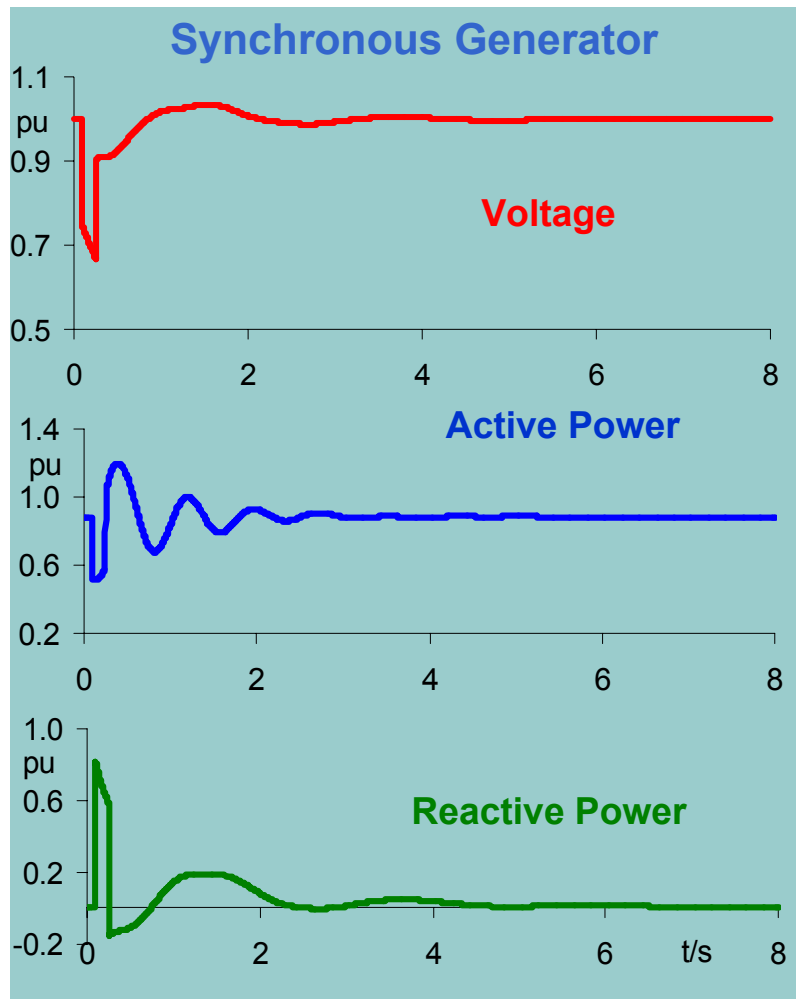
Riding Through Fault Capability



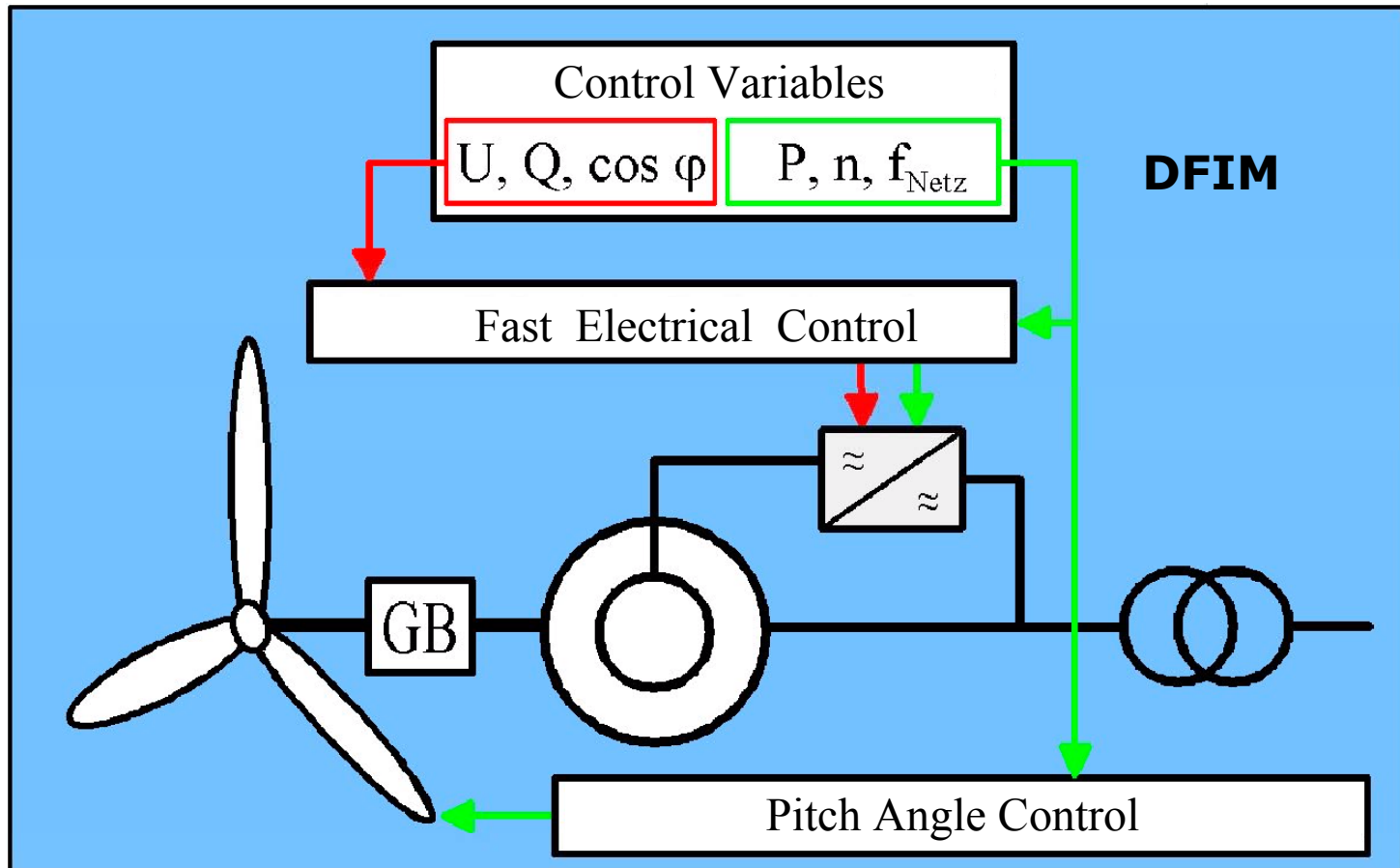
Back-Up Voltage Operation



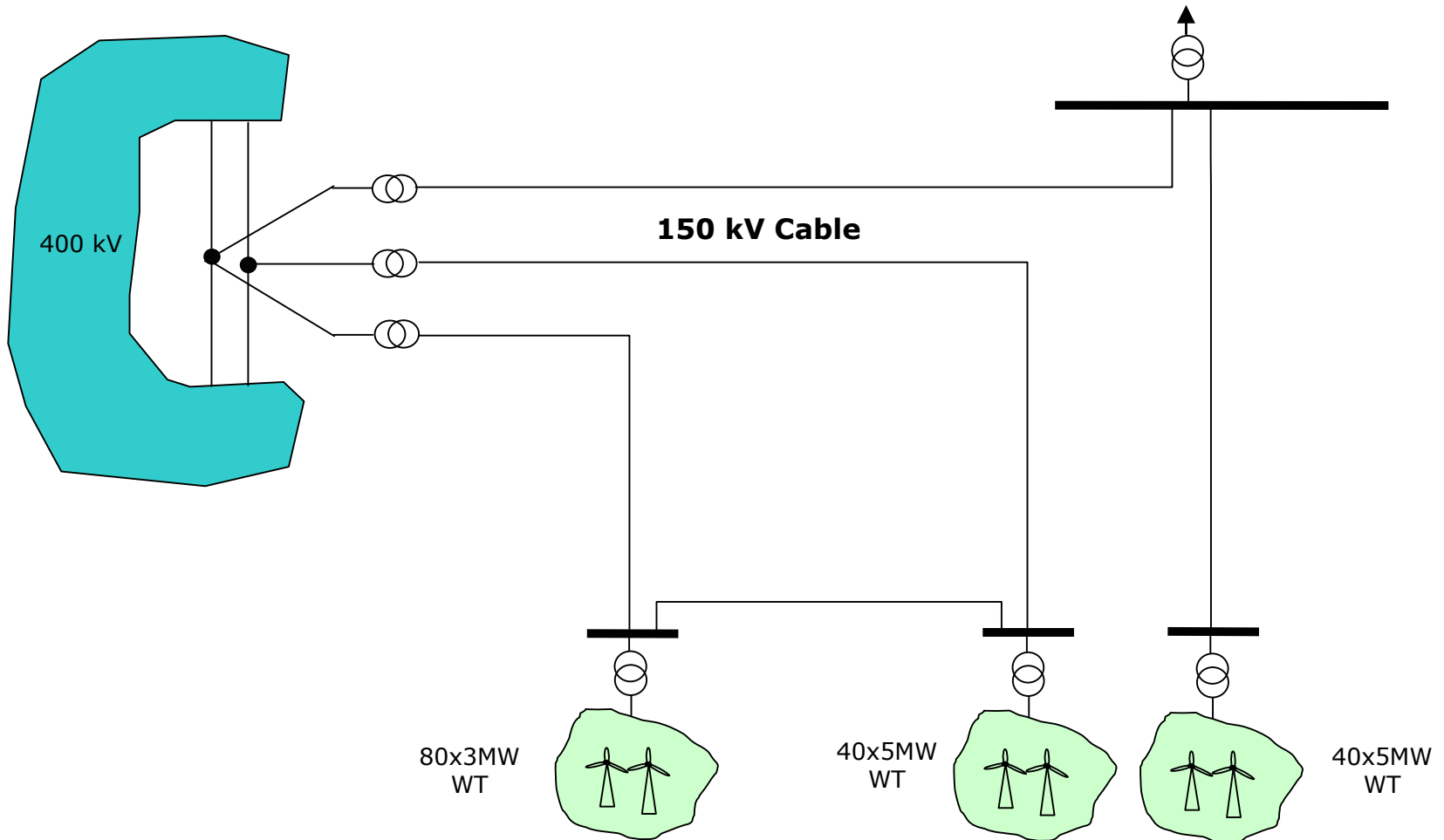
Comparison of SG and WT



Control of Wind Turbines

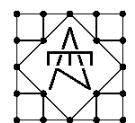
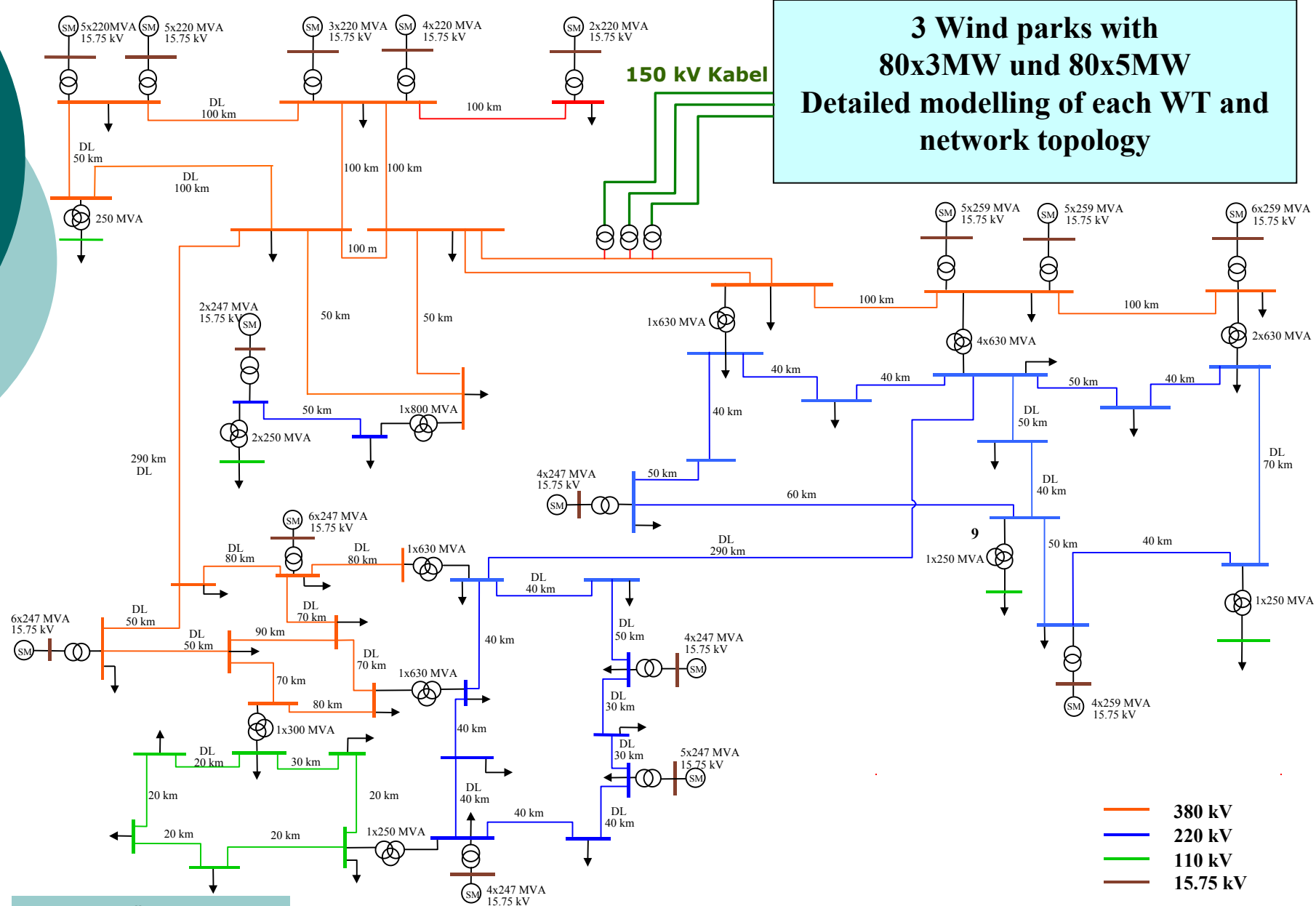


Investigated Power System

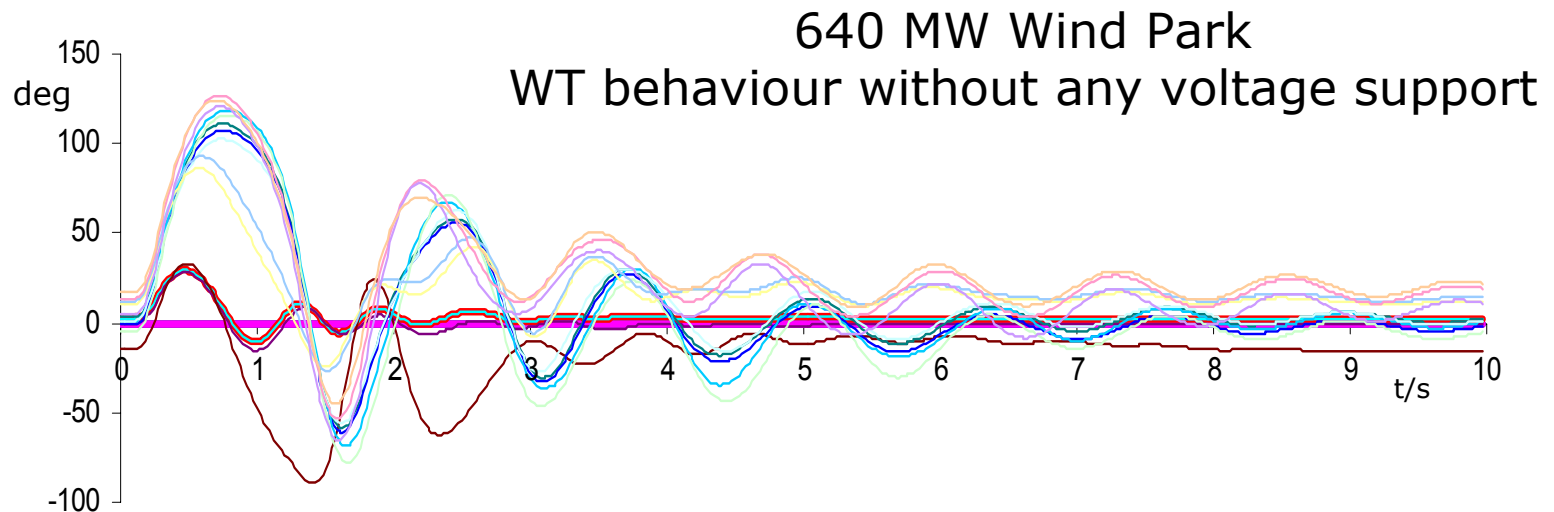
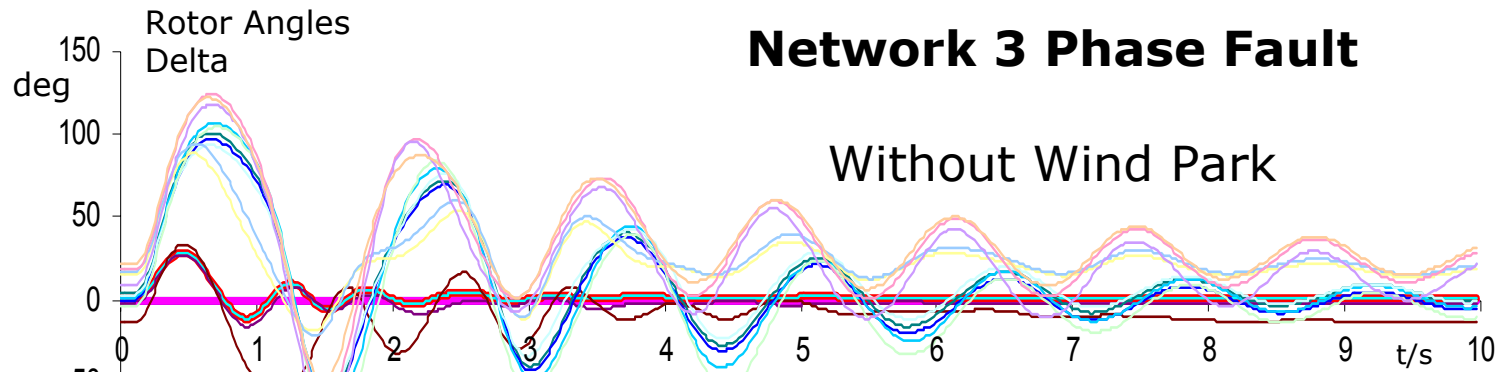


3 Wind parks with 80x3MW und 80x5MW

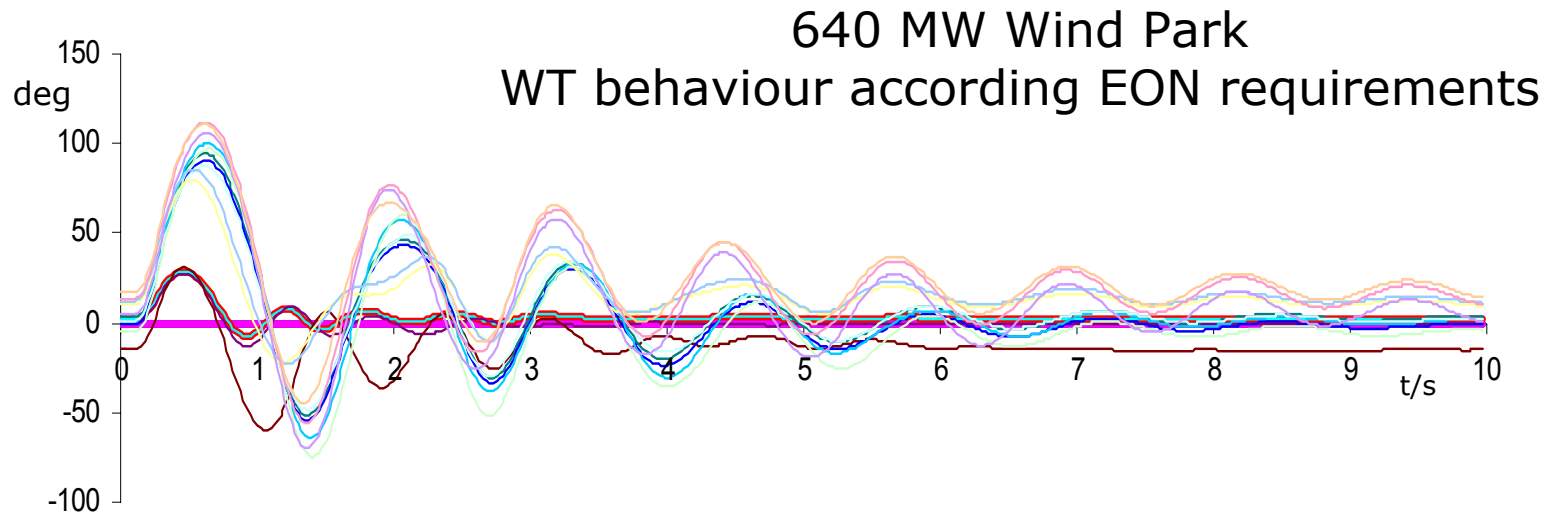
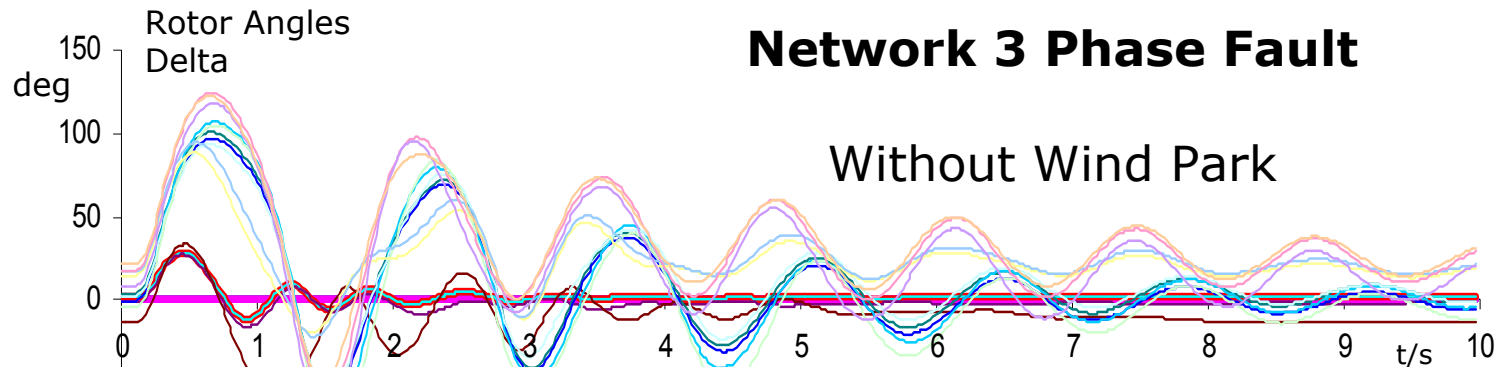
Detailed modelling of each WT and network topology



Comparison of System Behaviour (1)

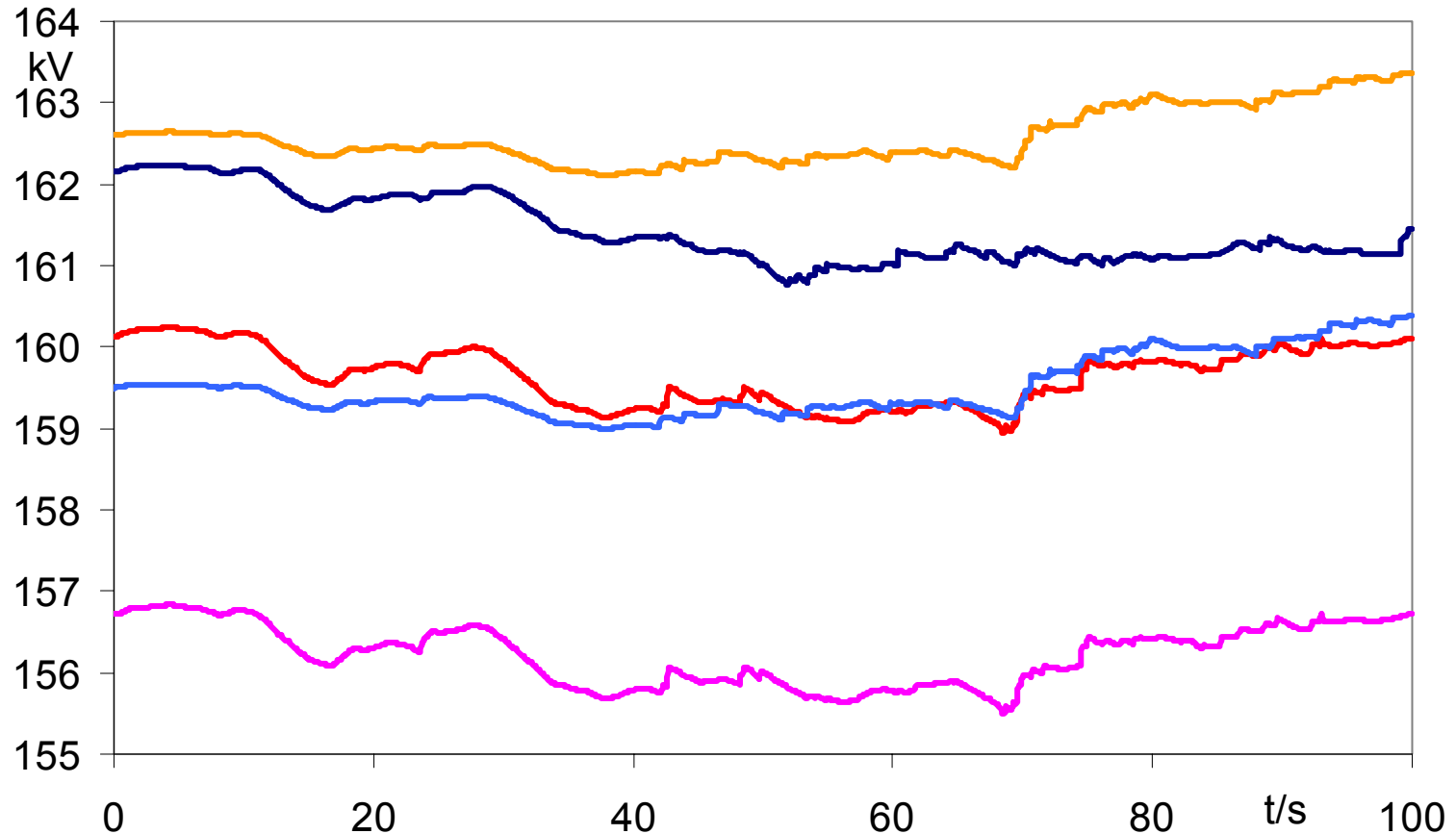


Comparison of System Behaviour (2)



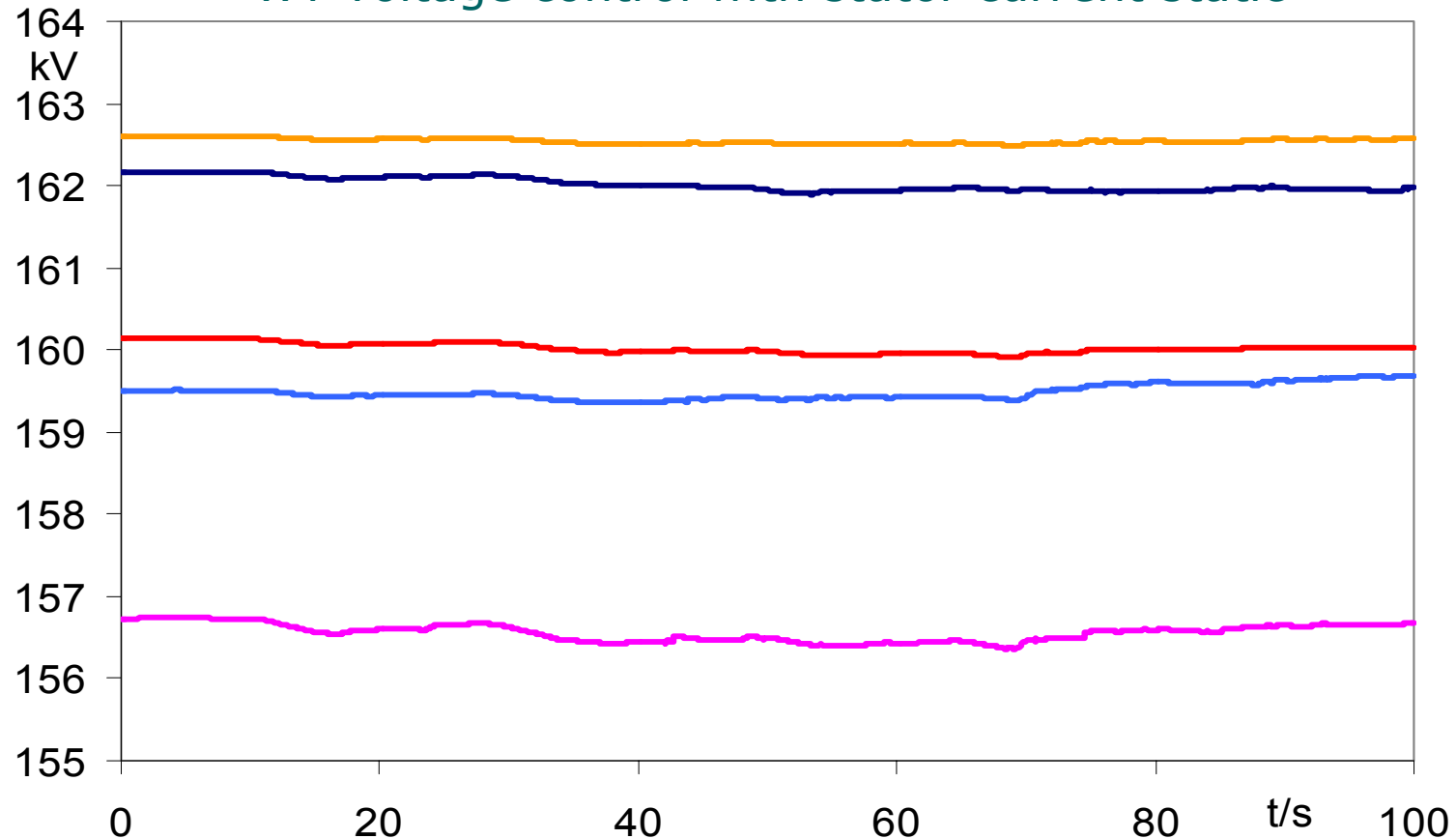
Fluctuating Wind Power Supply (1)

Voltages at 150-kV-Nodes
WT supplying constant reactive power



Fluctuating Wind Power Supply (2)

Voltages at 150-kV-Nodes
WT voltage control with stator current static



Conclusions

- **Without voltage support (voltage control) system behaviour tends to be worse**
 - **Impact on system stability depends on the particular system configuration: *location and control of wind farms, location, type and control of replaced conventional generators***
- Connection of large wind farms requires detailed investigations concerning their impact on power system dynamics!**





Thank you for
your attention!