PowerFactory What's New 2020

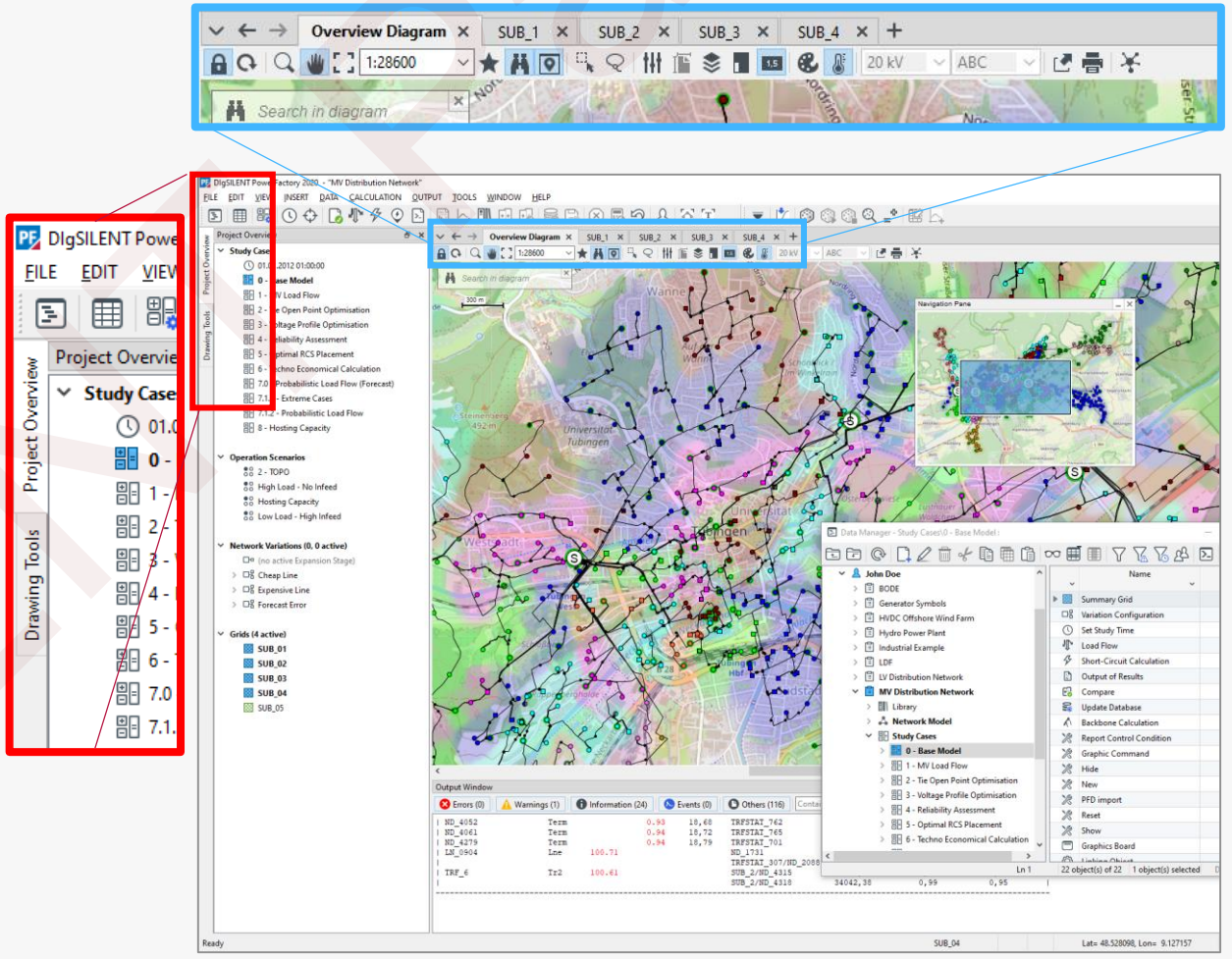
DIgSILENT GmbH, Germany

POWER SYSTEM SOLUTIONS
MADE IN GERMANY

User Interface

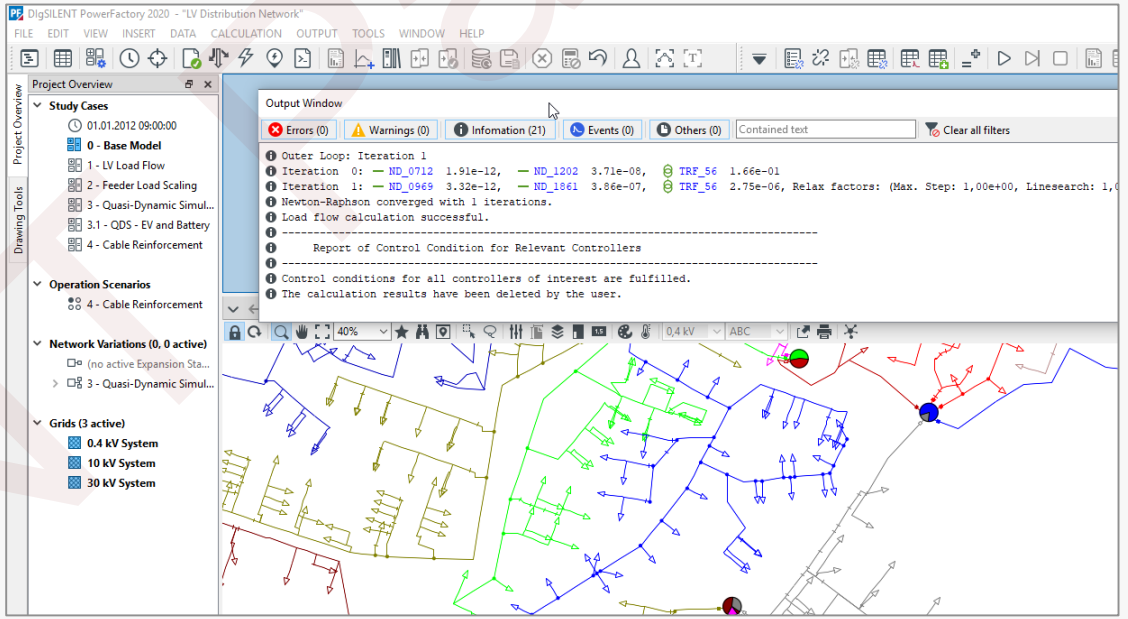
User Interface – Windows, Toolbars and Icons

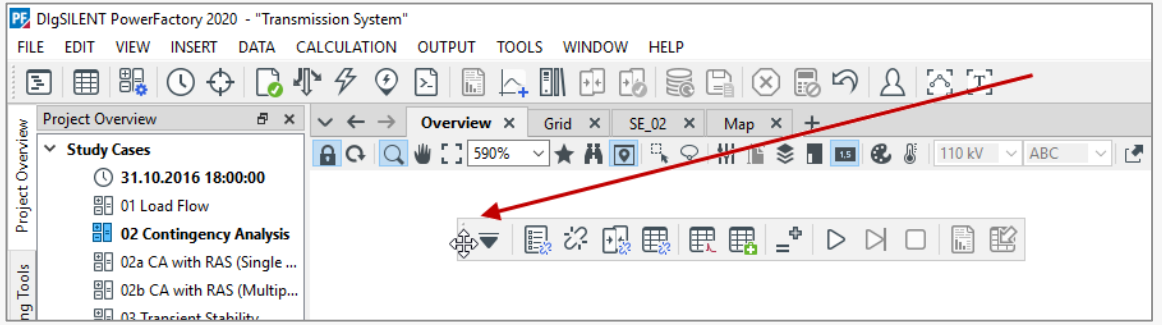
- **Default Windows Layout** modified for more ergonomic working
- Tabbed Windows (left side)
  - **Project Overview** and
  - **Drawing Tools**
- Tabbed Windows for **Graphics Board**
  - Tabs arranged in upper part
  - Easy browser-like navigation
  - Support of paging via mouse-wheel
  - Optionally use icons to easily distinguish
    - Diagrams
    - Substation diagrams
    - Block diagrams
    - Plots
    - …



User Interface – Windows, Toolbars and Icons

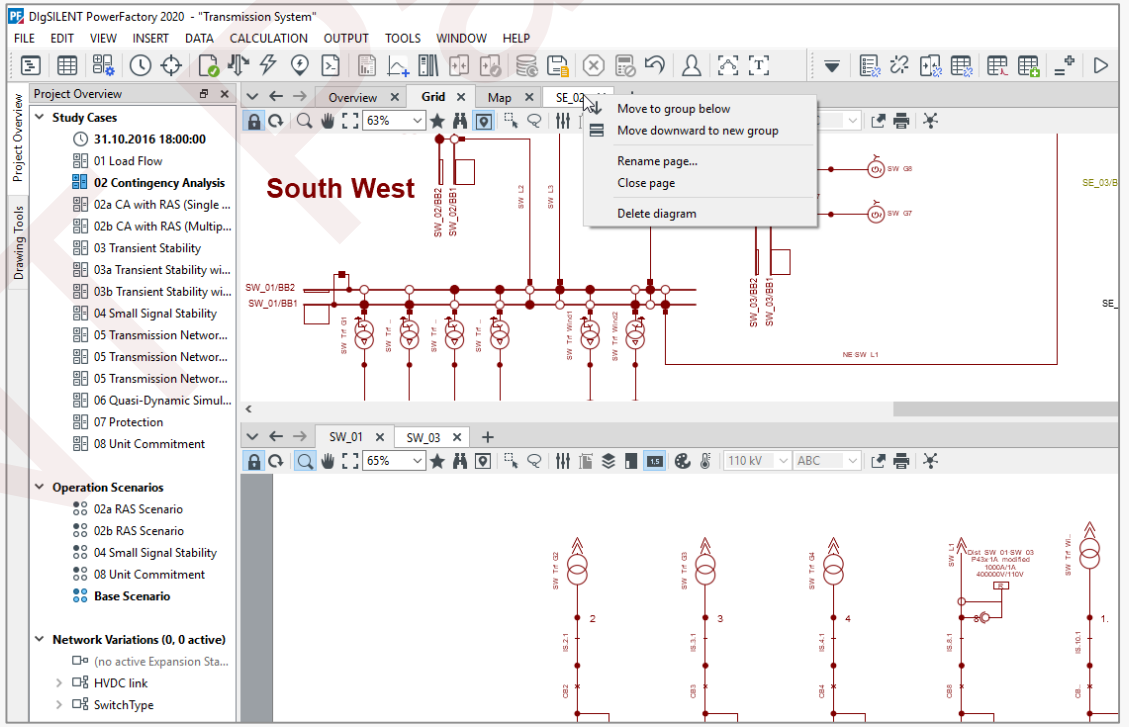
- All Toolbars and Tool Windows and are Dockable using Drag & Drop functionality
- Enabling easy customised window arranging
- Icons within the Data Manager and Network Model Manager have been harmonised
- Tool windows can be stacked (Project Overview and Drawing Toolbar)
- Application is now DPI aware

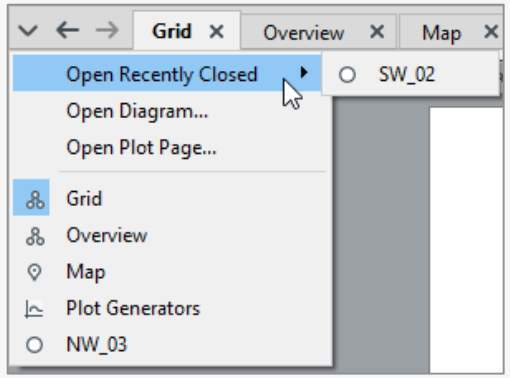




User Interface – Split View

- Graphics Board supporting Split View
  - Horizontal
  - Vertical
- Enabling parallel view of:
  - Network graphics (Single Line, Geographic and Substation)
  - DSL Model Block Definitions
  - Scripts (DPL and Python)
  - Plots
- Easy and intuitive tab handling of diagrams and plots
  (plots are now also closable)

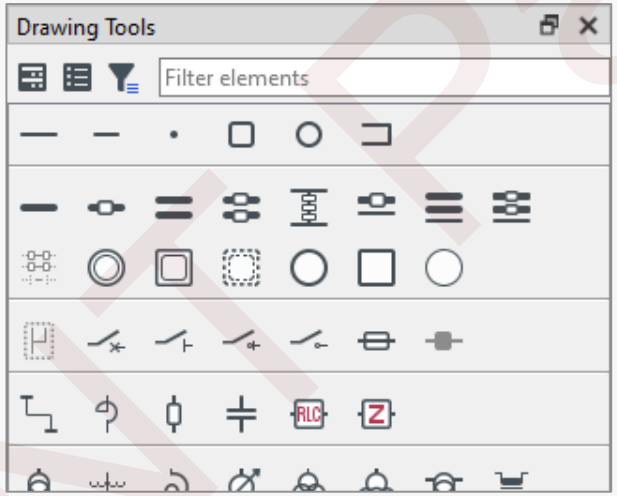


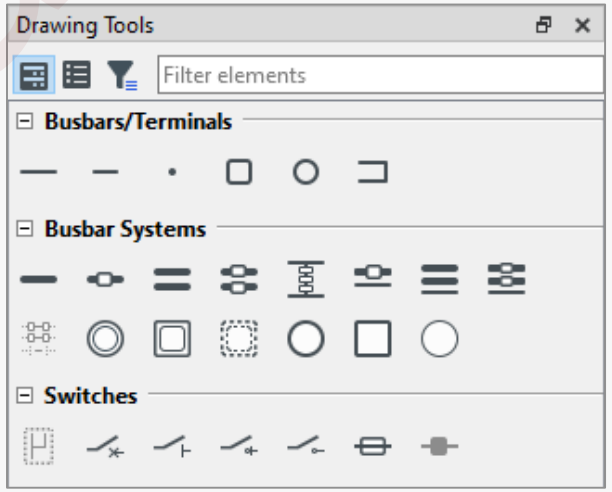


Network Diagrams and Graphic Features

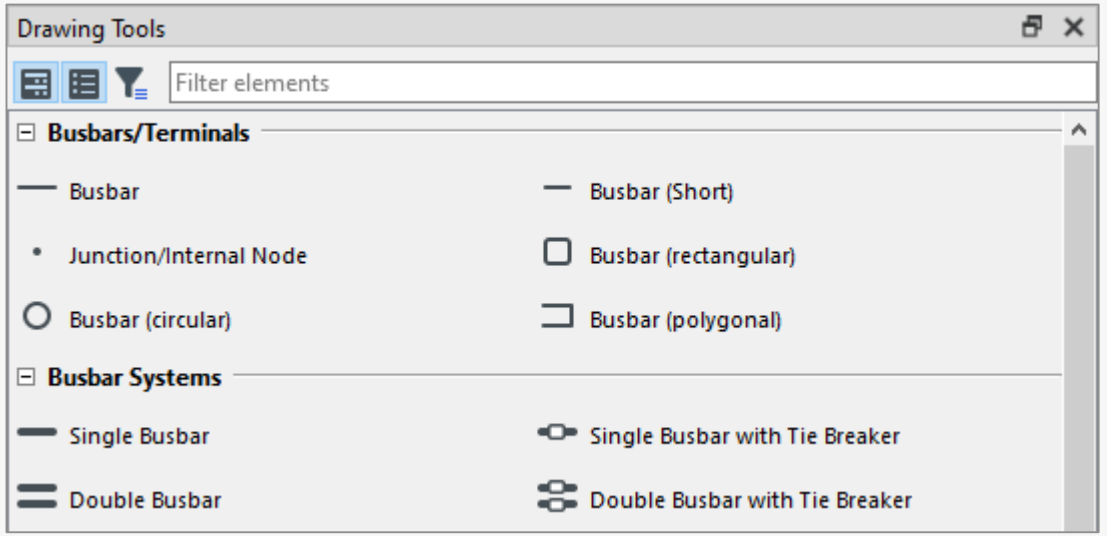
Redesign of the Drawing Toolbar

- Searching and Filter options
  - Search option for the drawing toolbar
  - Filtering based on categories allowing a faster overview about the available options



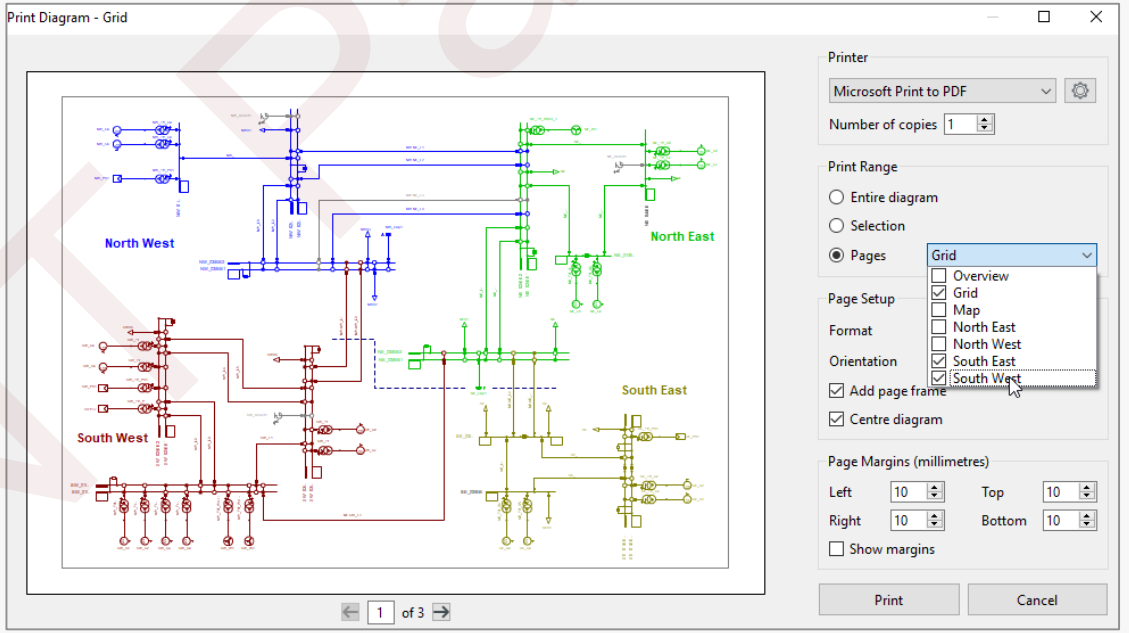


- Grouping and Sizing
  - Elements are newly grouped with enlarge or hide options for the individual groups
  - Names of the individual drawing options can be shown or hidden – making it easy to find what you are searching for
  - The drawing toolbar as an undocked floating window leads to a better usage of the space



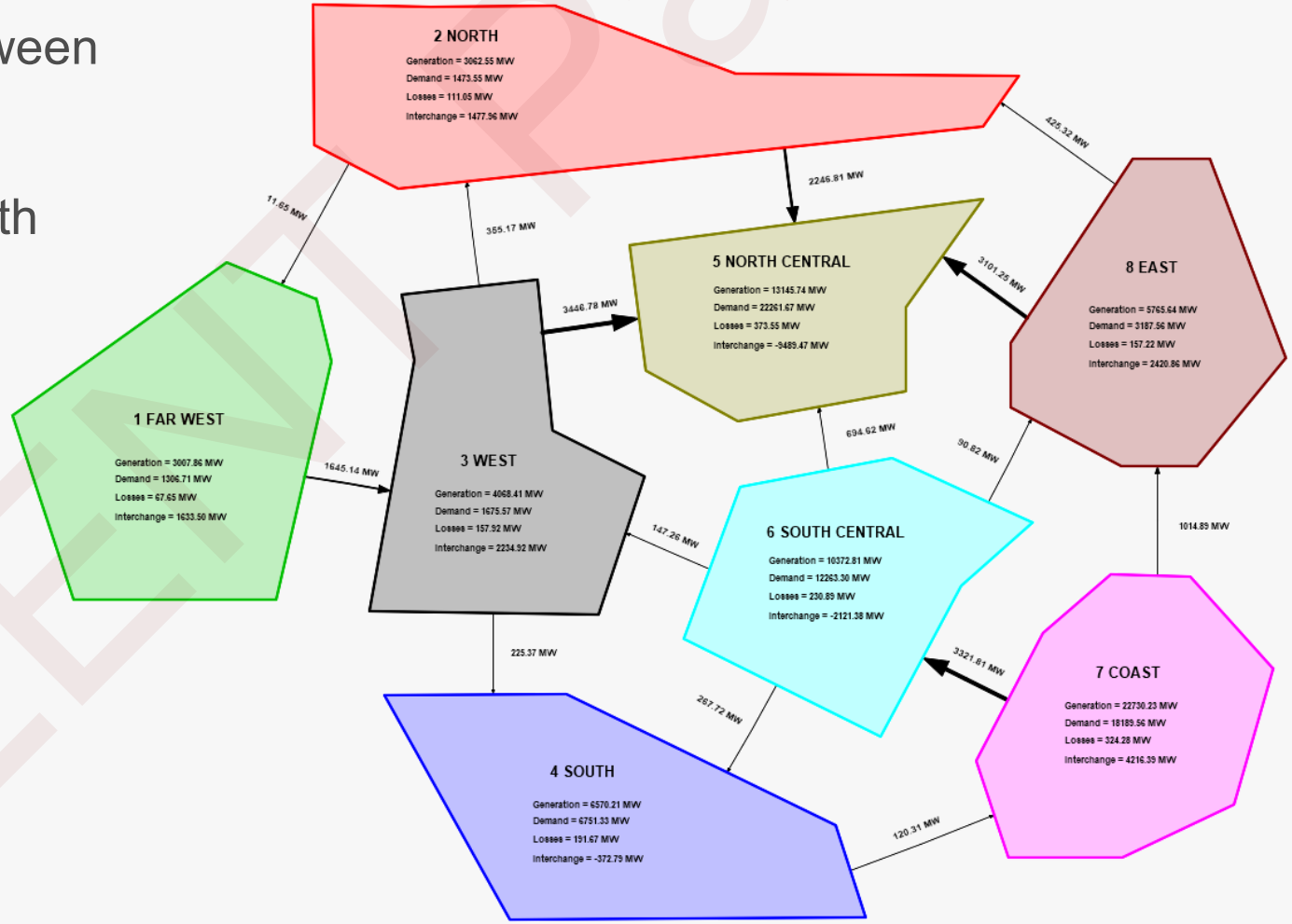
Updated Printing Concept

- Enhanced Printing Concept
  - Enhanced printing concept
  - Allowing multi-page pdf creation of multiple diagrams
  - Option to select the diagrams to be exported
  - Page preview supporting multiple pages



Area Interchange Diagrams

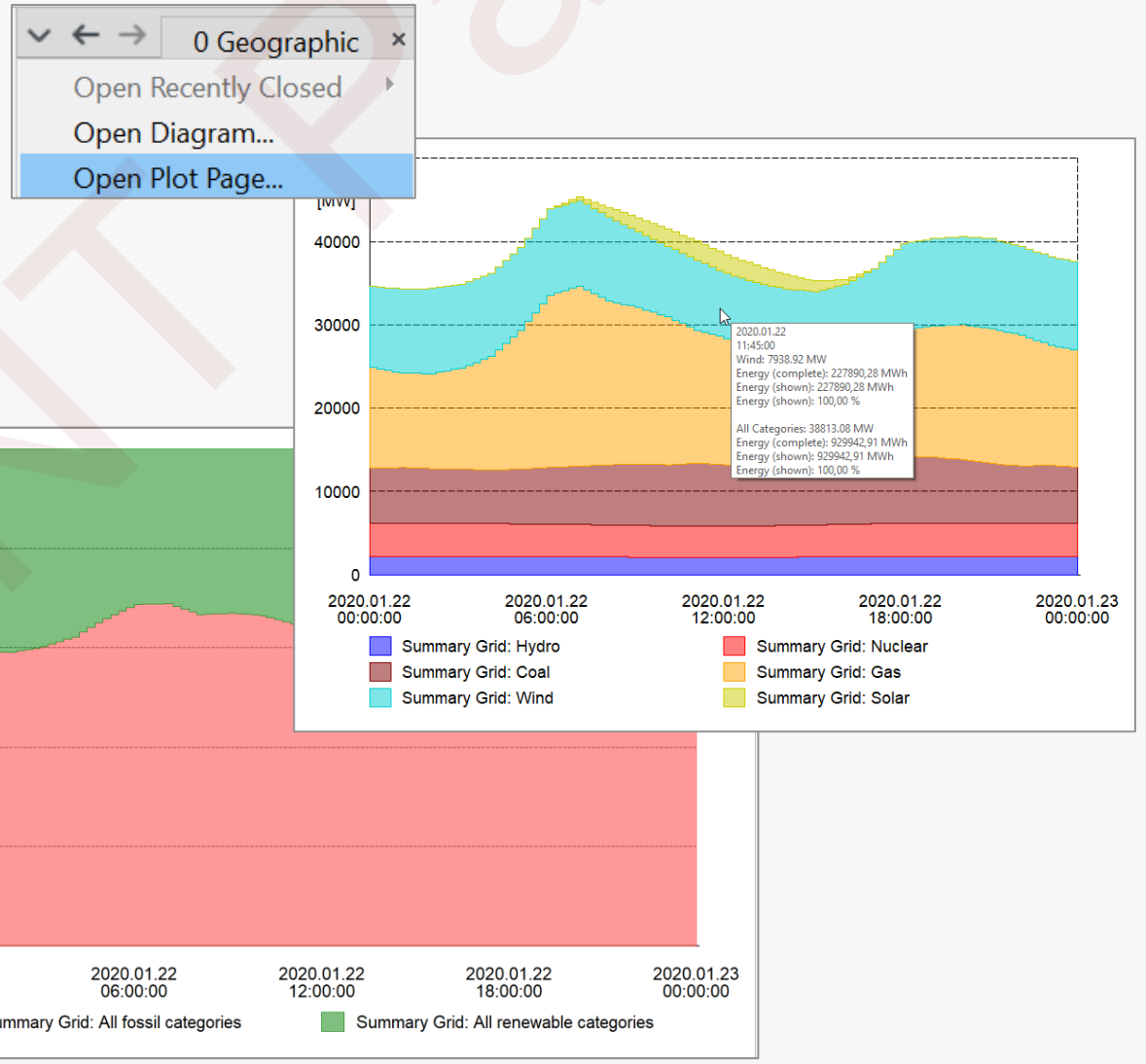
- Visualisation of the interchange between grids, zones and areas
- Automatic adaption of the arrow width based on load flow results
- Flexible and user definable design



Permanent Plots

- Permanent Plots
  - Allowing pre-defined plots to be closed and reopened
  - Opening is possible using the new drop-down menu

- New Plot designs
  - Energy Plots
  - Pots according to primary resource

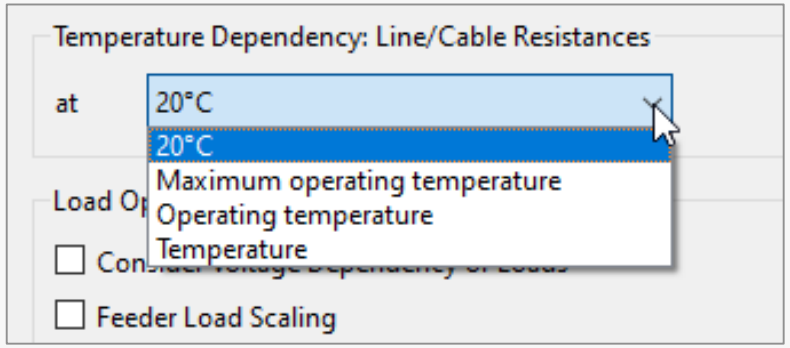


Analysis Functions

Load Flow Analysis – Operating Tap Limits and Temperature

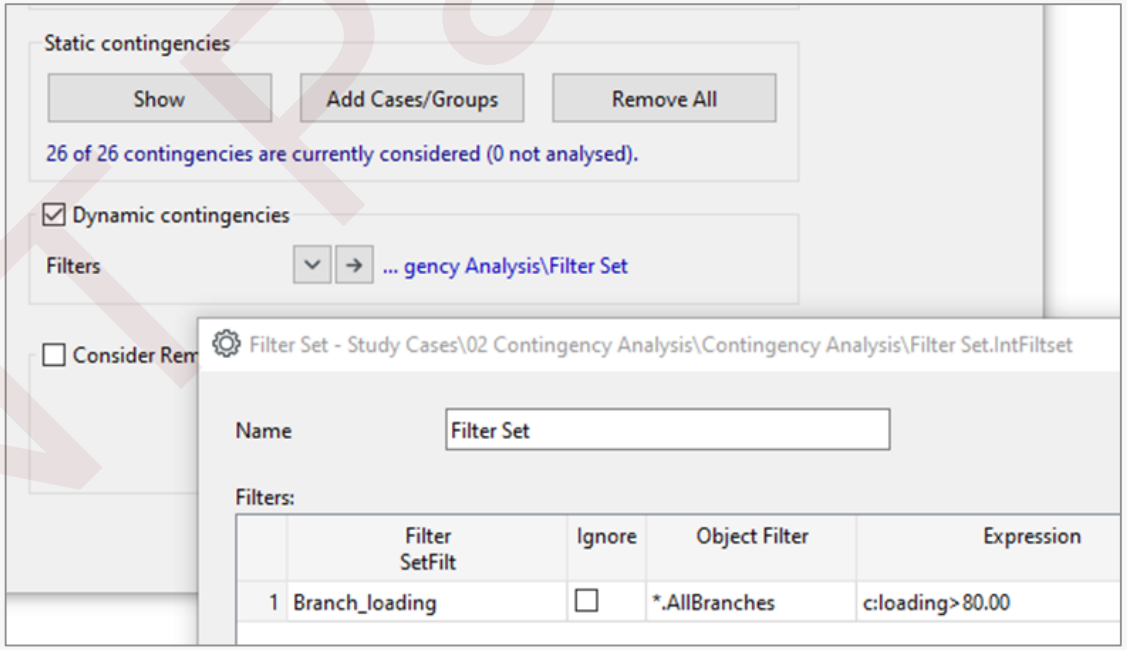
- Operating Tap Limits of Transformers
  - Allowing tapping margins for transformers based on operational guidelines
  - Consideration of margins for emergency situations

- Temperature Dependency
  - Load Flows can now be run, considering:
    - User-defined temperatures
    - The individual maximum operating temperature of each line



Contingency Analysis – Contingency Definition

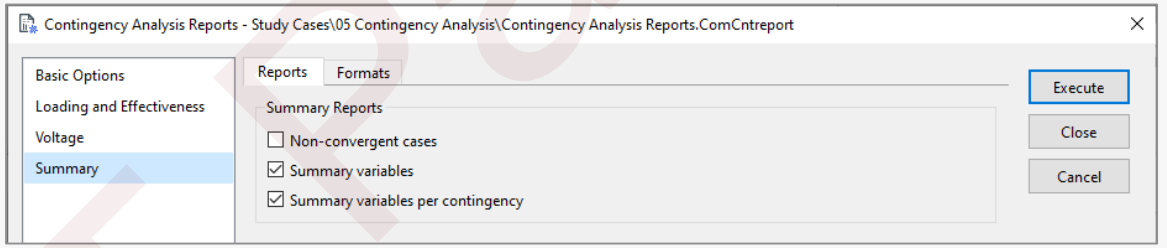
- Dynamic Contingency Definition
  - Automatic detection of relevant equipment based on pre-fault load flow conditions (e.g. loading or voltage)
  - Triggered by user-defined criteria
  - Can be combined with static contingency definitions
  - Beneficial for time sweep contingency analysis to restrict on critical time instants



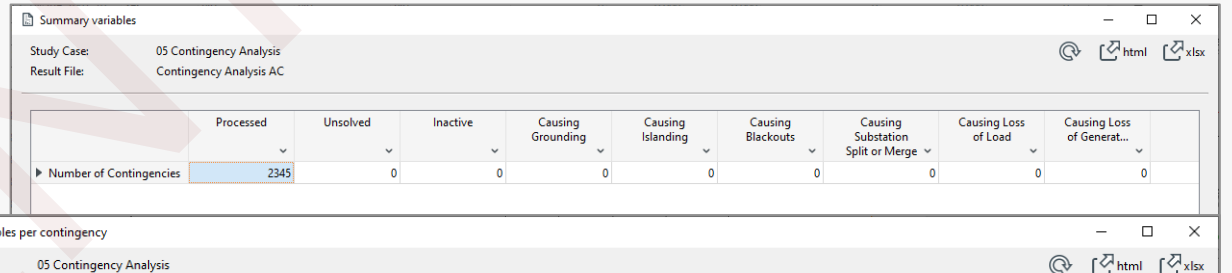
- Dispatch Events as Post-Fault Actions
  - Support of absolute power changes
  - Support for Ward-Equivalents

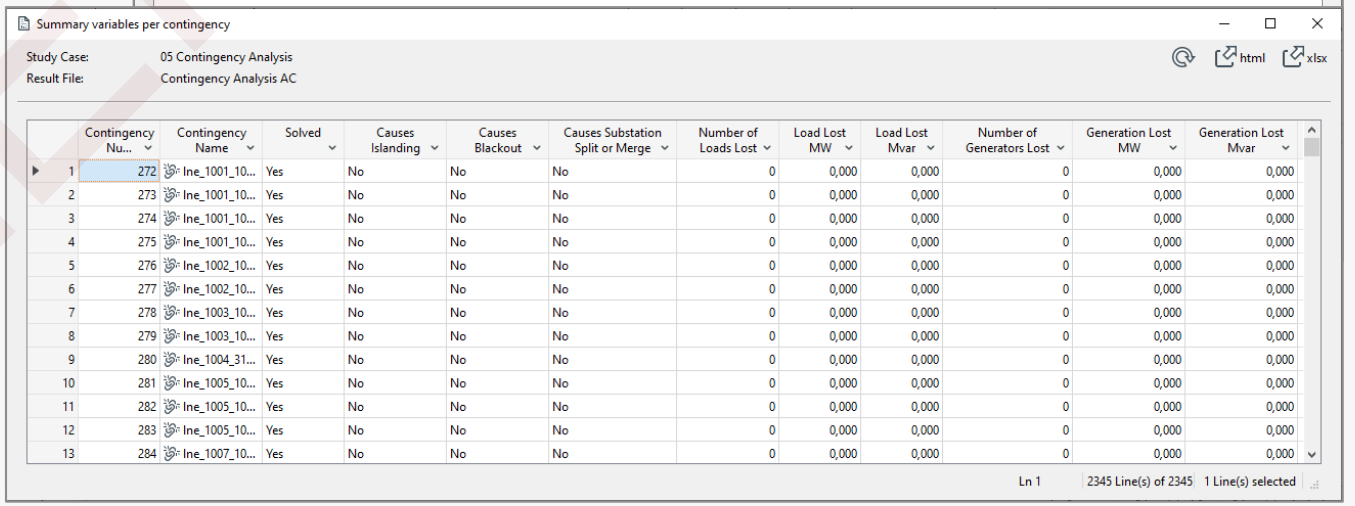
Contingency Analysis – Contingency Reporting

- Contingency Reporting Dialog
  - Redesign of the report selection dialog



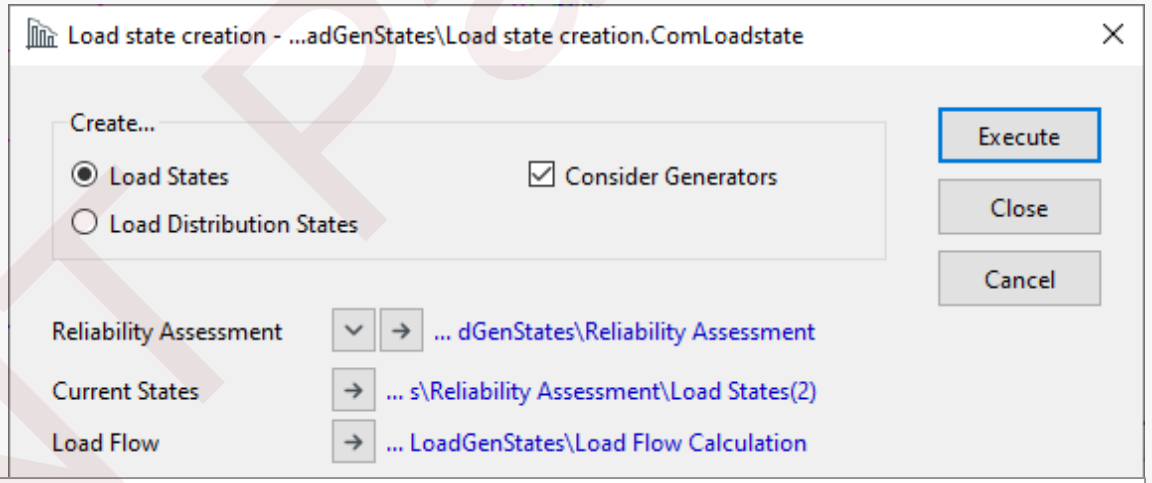
- Contingency summary reporting
  - Summary results over all contingencies
  - Getting the grid impact at a glance:
    - Solved
    - Caused Islanding
    - Caused Blackout
    - Caused Substation Split/Merge
    - Number of Loads Lost
    - Load Lost [MW/Mvar]
    - Number of Generators lost
    - Generation Lost [MW/Mvar]

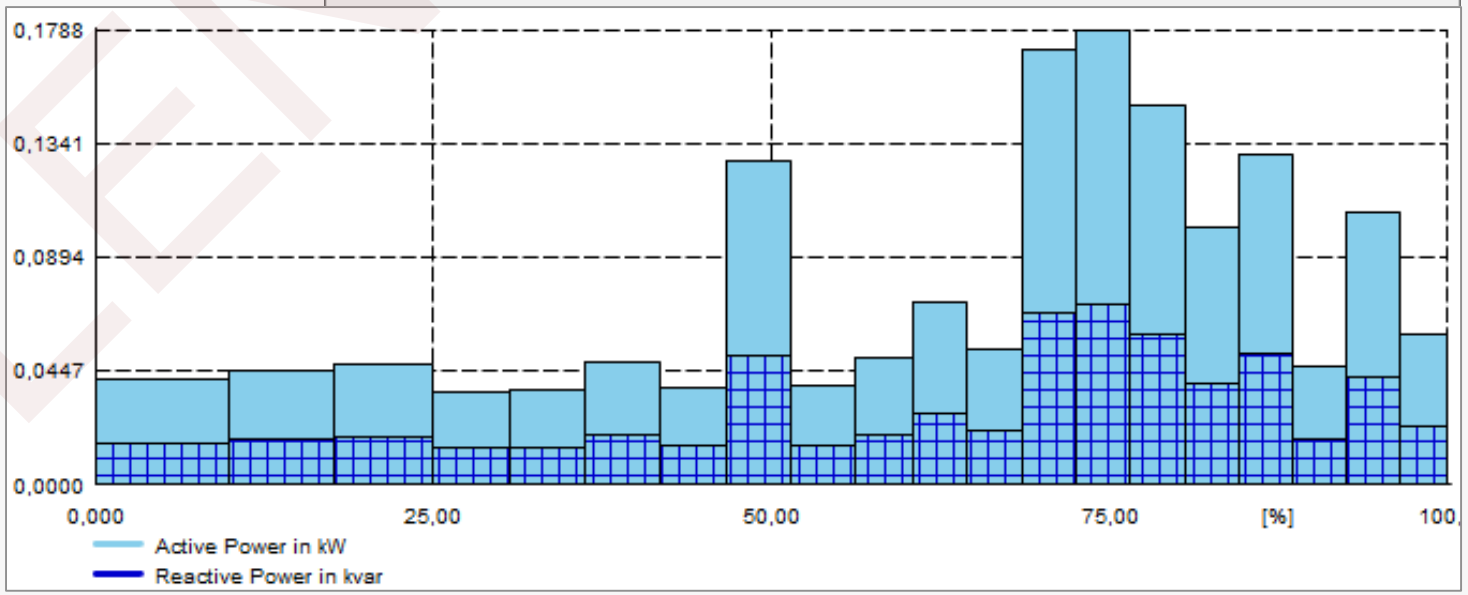




Reliability Analysis – Dispatch Profiles

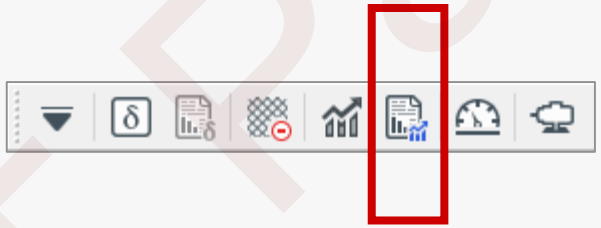
- Reliability assessment accounts now for Dispatch Profiles of generating units
- Counterpart to Load States was introduced
  → Generation States

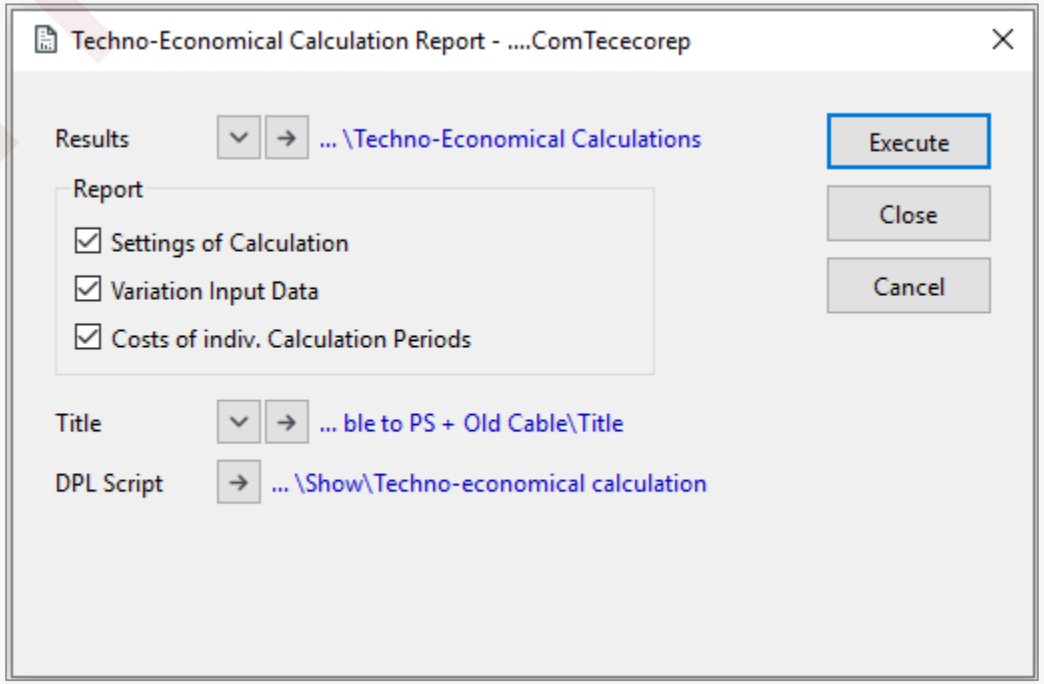




Techno-Economical Calculation – New Reporting of Results

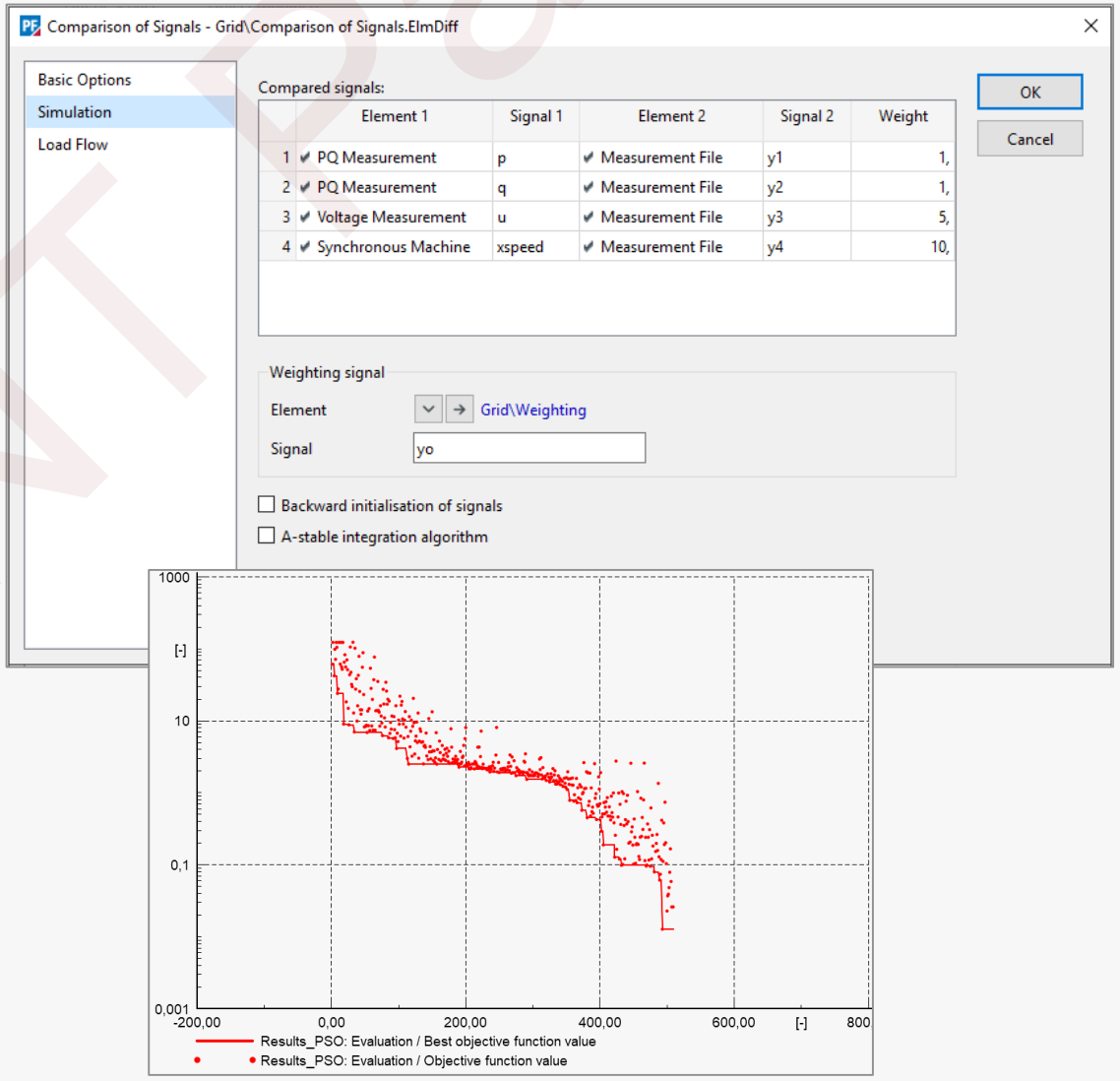
- Results analysis as report was revised
- Report can be assessed separately
- Dedicated icon in toolbox has been introduced
- No need for repeating whole Techno-Economical Calculation





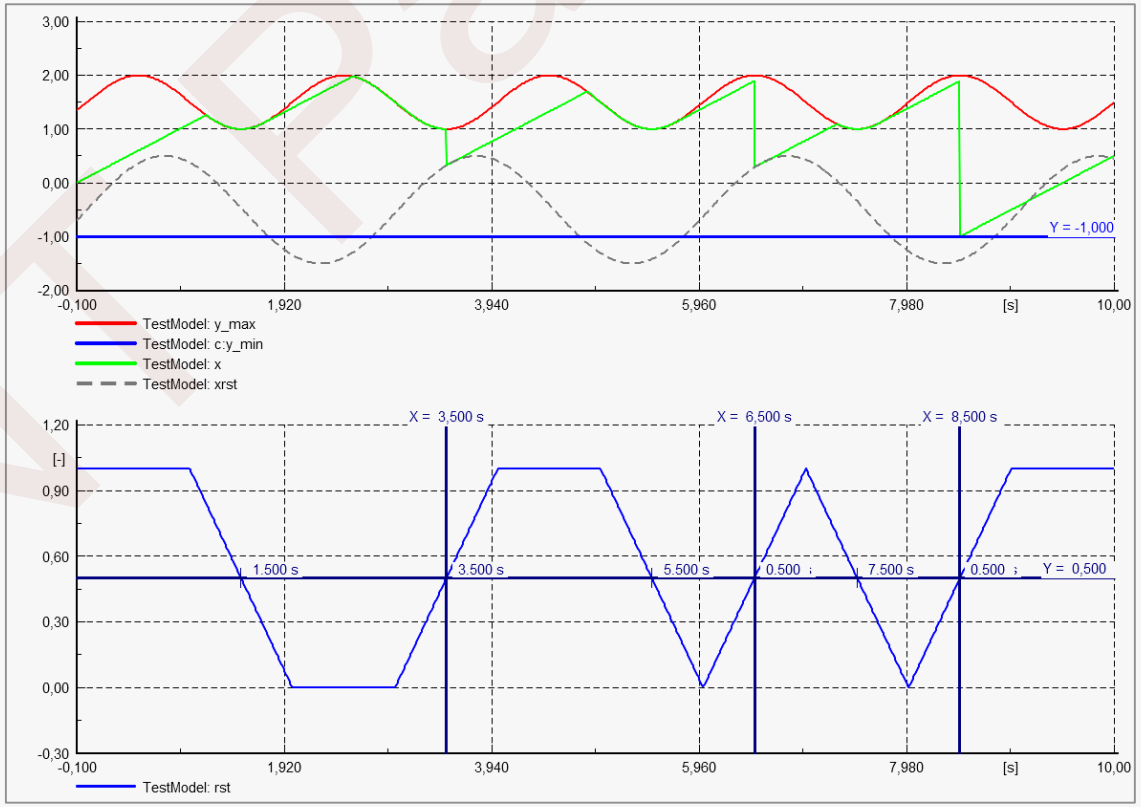
Parameter Identification – Redesign of the Parameter Identification

- New optimisation methodologies
  - Swarm intelligence algorithm
  - Pattern search methods
  - Global optimisers
  - Gradient based optimisers
- Smart stop criterion for faster calculation
- Improved definition of reference curves
- Full support for bounded and unbounded optimisation problems
- Result recording applied after each iteration



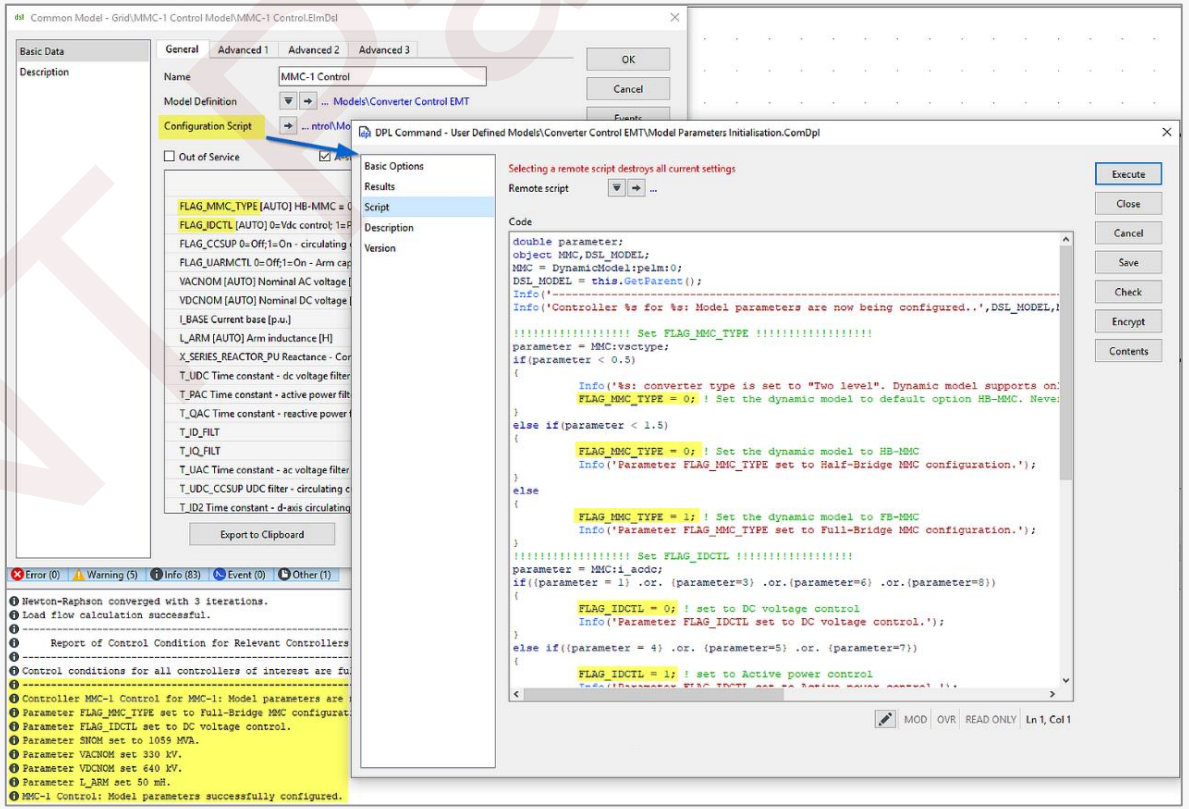
DSL – “reset” procedure

- Resets a variable upon the rising edge crossing of a variable
- Used to change DSL **state and internal variables**
- Similar with the DSL **event()** procedure
- Can be used in **DSL macros**



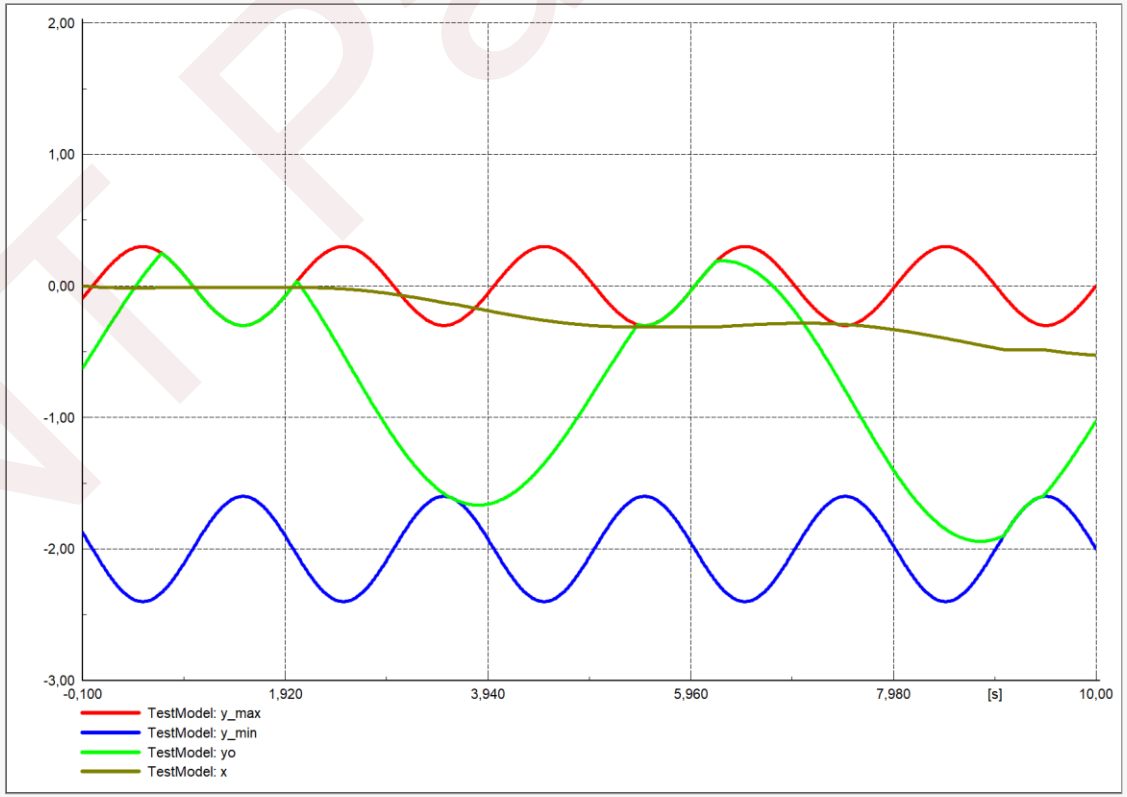
DSL – script based initialisation

- **Configuration Script** based on DPL
- DSL Model **parameters can be configured**
- Any **load flow results and data model information** can be used for configuration
- Among others, **execution of commands is forbidden**
- Generation of user defined **output window messages**



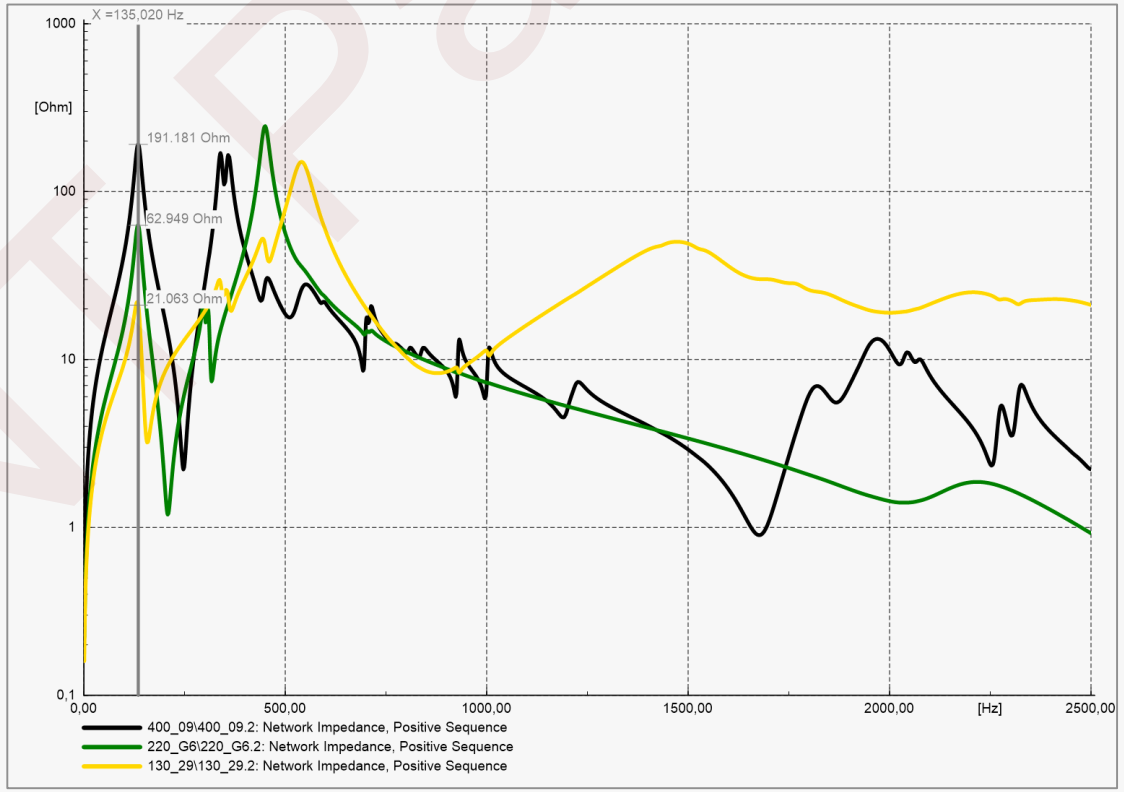
DSL – PI regulator with variable non-windup limits

- DSL function **picontrol()**
- PI controller based on IEEE 421.5
- With **variable limits**
- Extends functionality of already existing **picontrol_const()** - which has constant limits



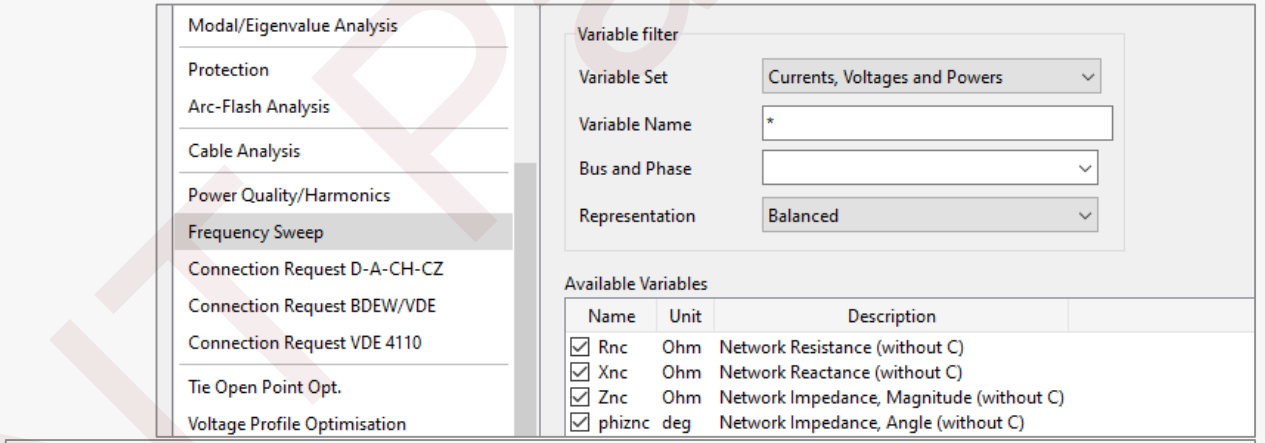
Frequency Sweep – no Load Flow initialisation

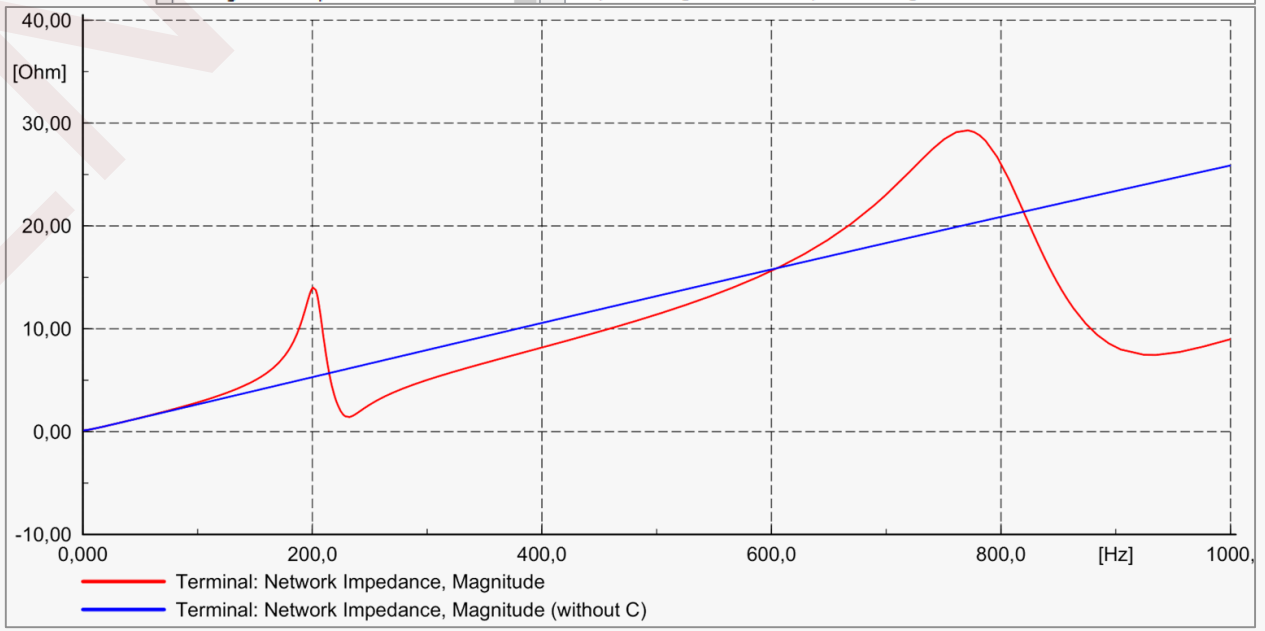
- Additional option for network impedance frequency sweep
- Load flow initialisation of the network not required
- Significant performance improvement for large networks, especially for contingency analysis



Frequency Sweep – New result variables

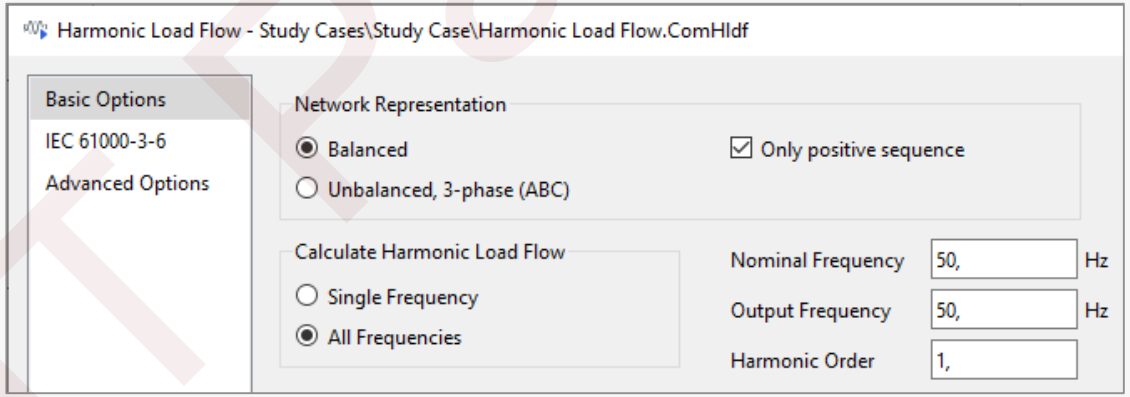
- Network impedance calculation without network capacitances
- Evaluation of impact of capacitive components on network impedance
- Additional calculation triggered when corresponding result variables are selected





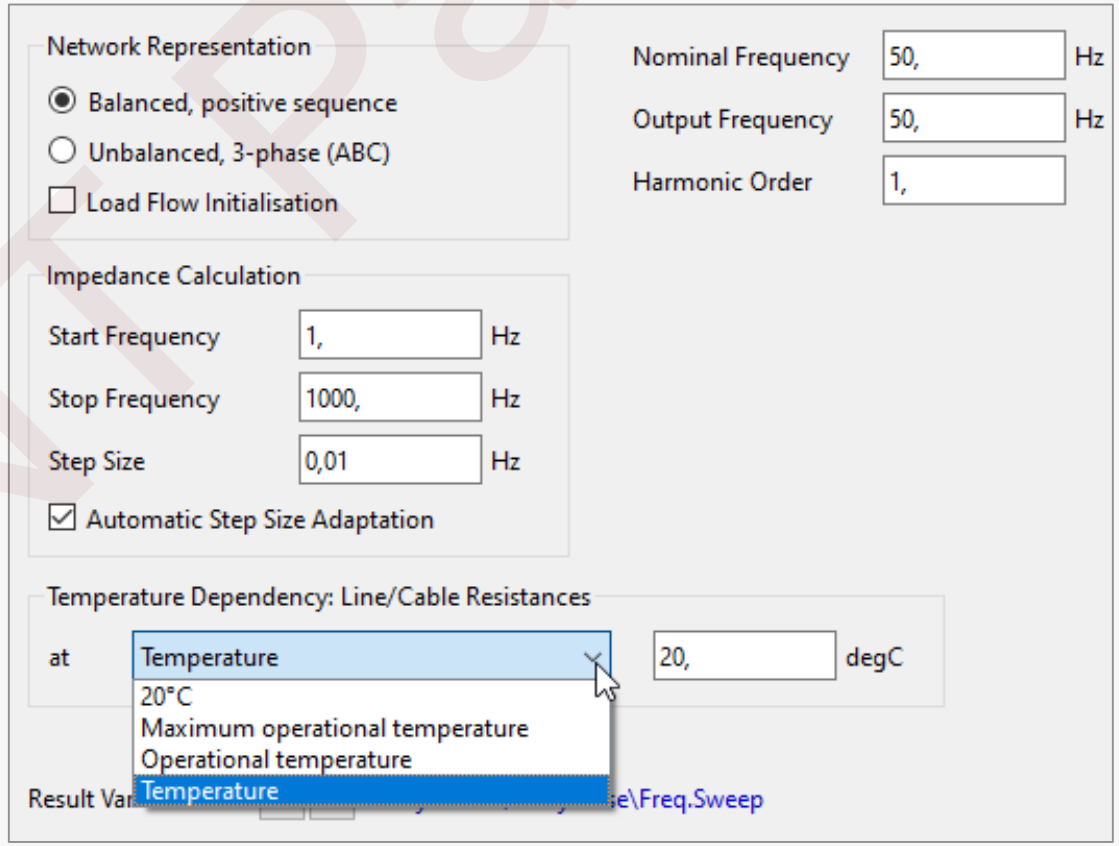
Harmonic Load Flow – Positive sequence option

- Enhancement of Harmonic Load Flow calculation for Balanced Network Representation
- Harmonic orders, which naturally appear in the negative sequence are treated as being in the positive sequence



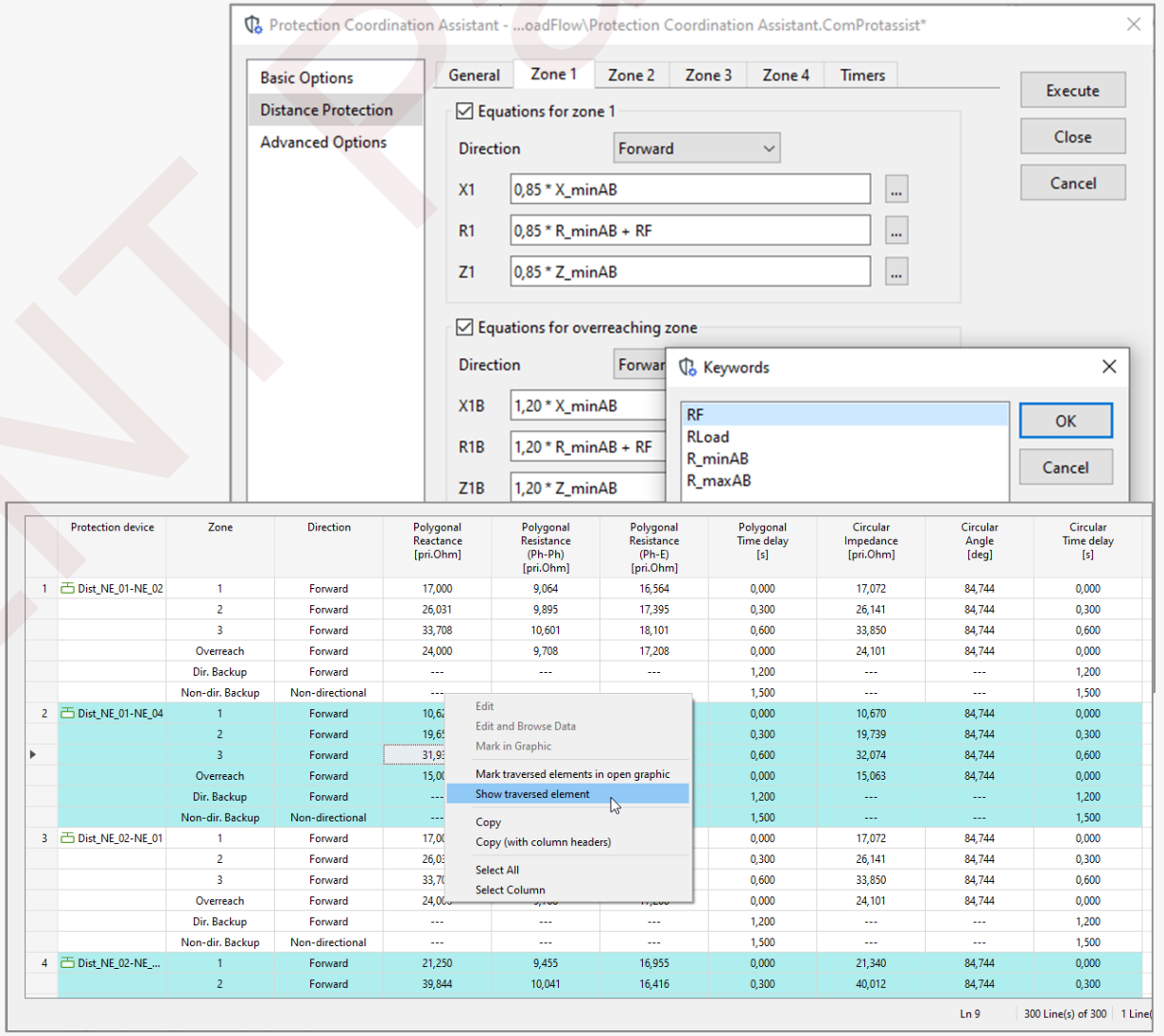
Harmonics LDF and Frequency Sweep – Temperature dependency

- Harmonic Load Flow and Frequency Sweep consider temperature setting from assigned Load Flow Initialisation
- Frequency Sweep without initialisation allows user defined temperature setting (same options available as in the Load Flow)



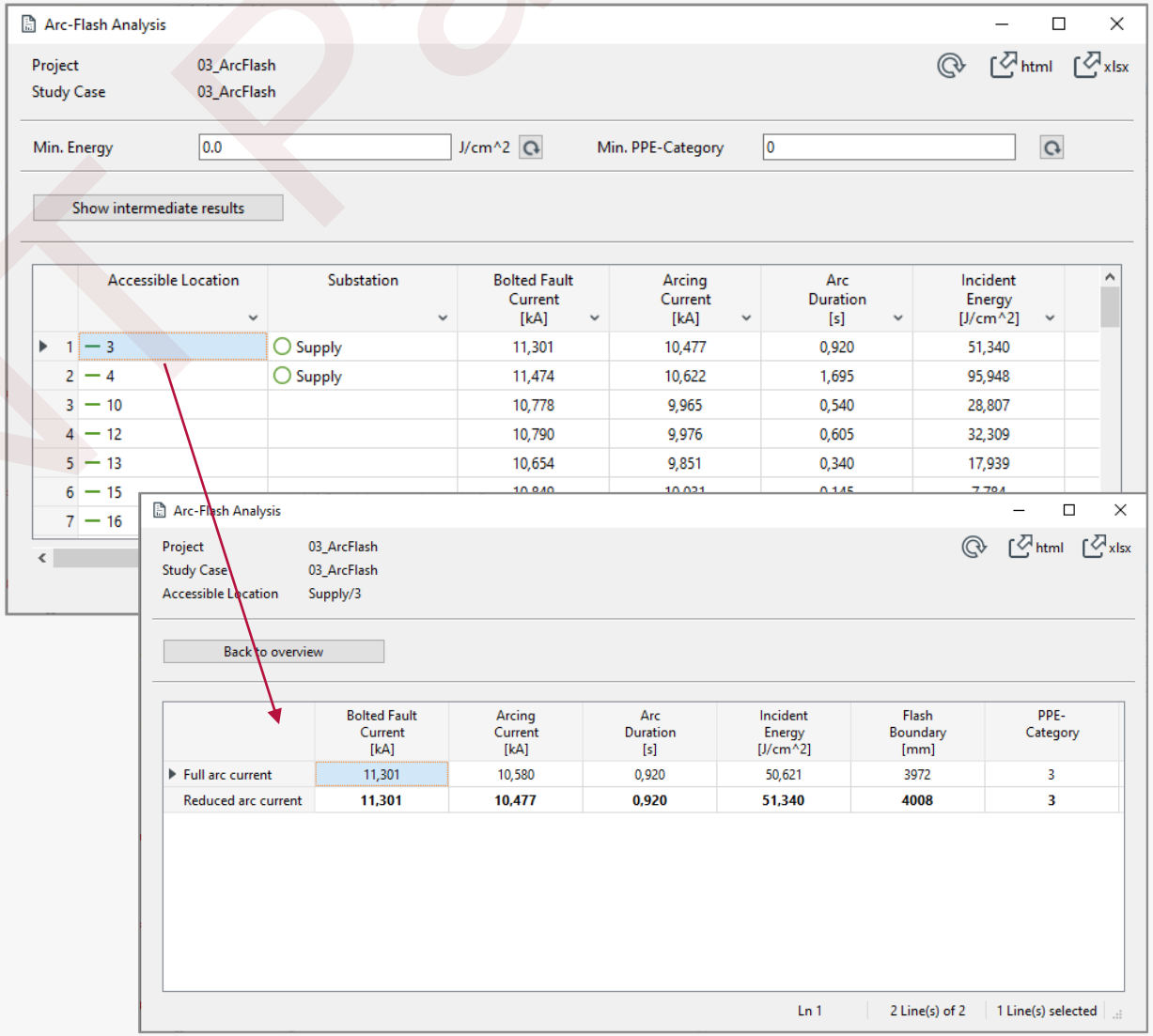
Protection Coordination Assistant

- User defined settings rules:
  - Individual keyword-based rules
  - Full flexibility using equations
  - Option to calculate angles for circular characteristics based on:
    - Zone 1 impedance angle
    - Angle based on the summation of line impedances for the individual zones
- Coordination Assistant Reporting:
  - Enhanced tabular report
  - Detailed result view
  - Option to write back results to the relays



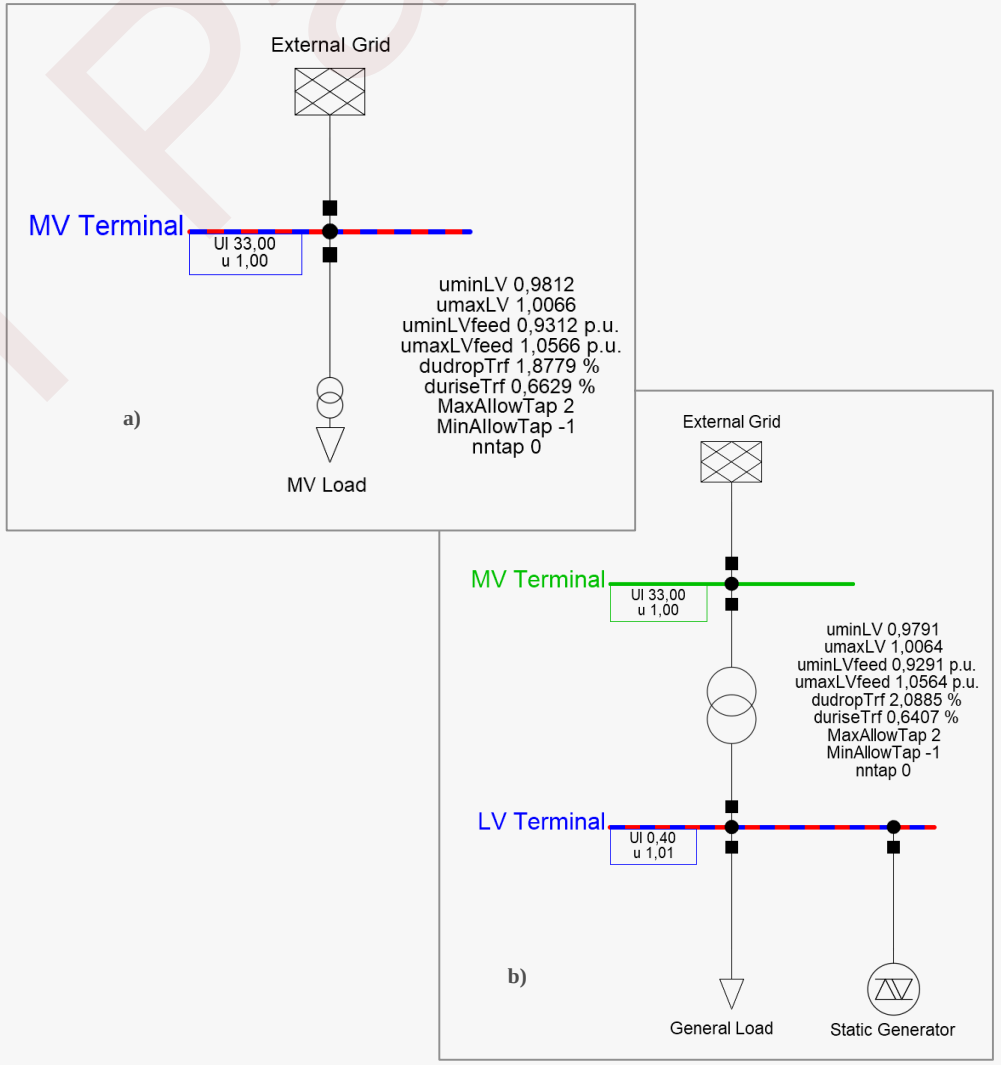
Arc Flash Hazard Analysis

- Supporting new Standards:
  - Support of new IEEE 1584-2018 standard
- Advanced reporting:
  - Overview results for all calculated components
  - Intermediate results table per relevant element



Voltage Profile Optimisation – Supported Models

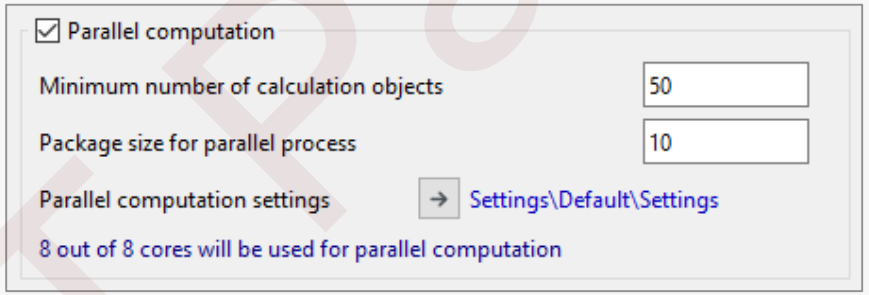
- Possible Configurations for the Voltage Profile Optimisation:
  - **a) Medium Voltage Load**
    - With built-in distribution transformer in type
    - Load share and generation specified in MV load
    - Max. voltage drop/rise in LV network
  - **b) Distribution Transformer + Loads / Generators**
    - LV network modelled
    - One aggregated load containing max. voltage drop/rise in LV network
    - Whole LV network modelled in detail (voltage drop/rise considered based on load flow)
    - All load and generation models in PowerFactory are supported (except MV load)

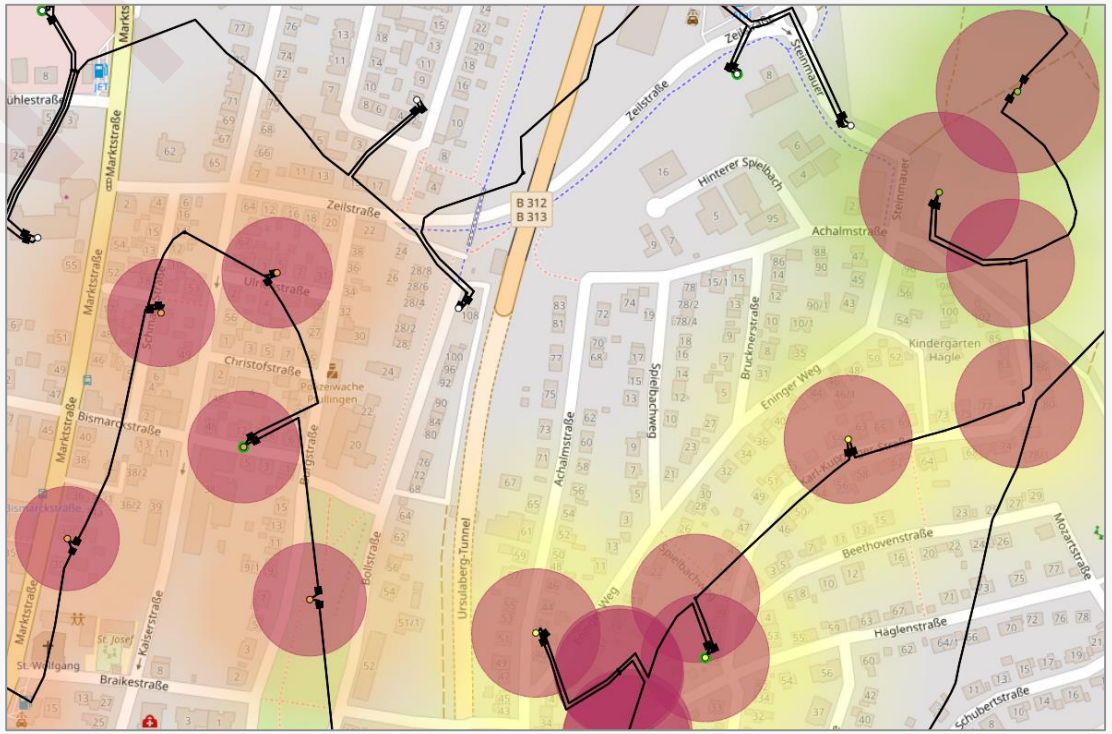


Hosting Capacity

- Parallel Computation
  - Several cores can be used for the calculation
  - Leads to a significant reduction in the calculation time

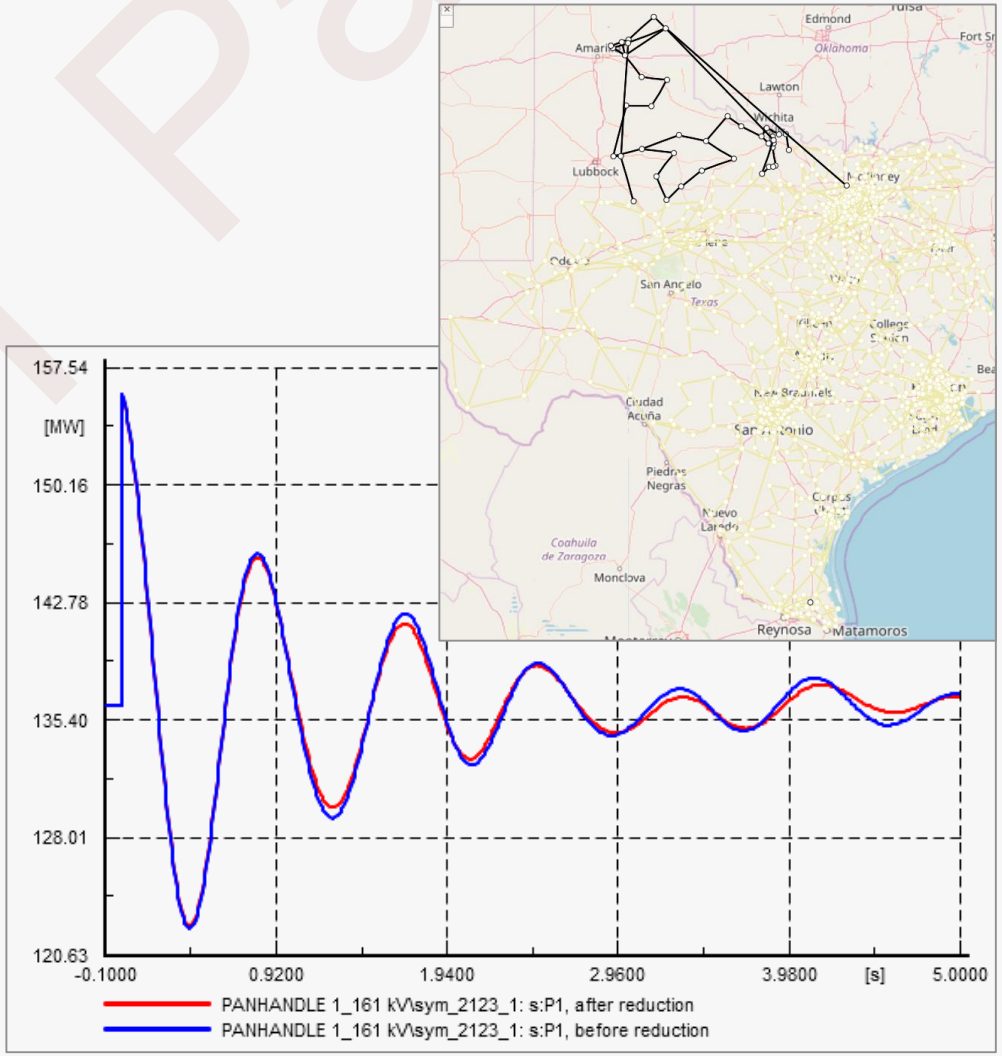
- Presentation of results in geographic diagrams
  - Circles can be displayed around sites, substations, secondary substations and nodes
  - Size of circles represents the connectable amount of power





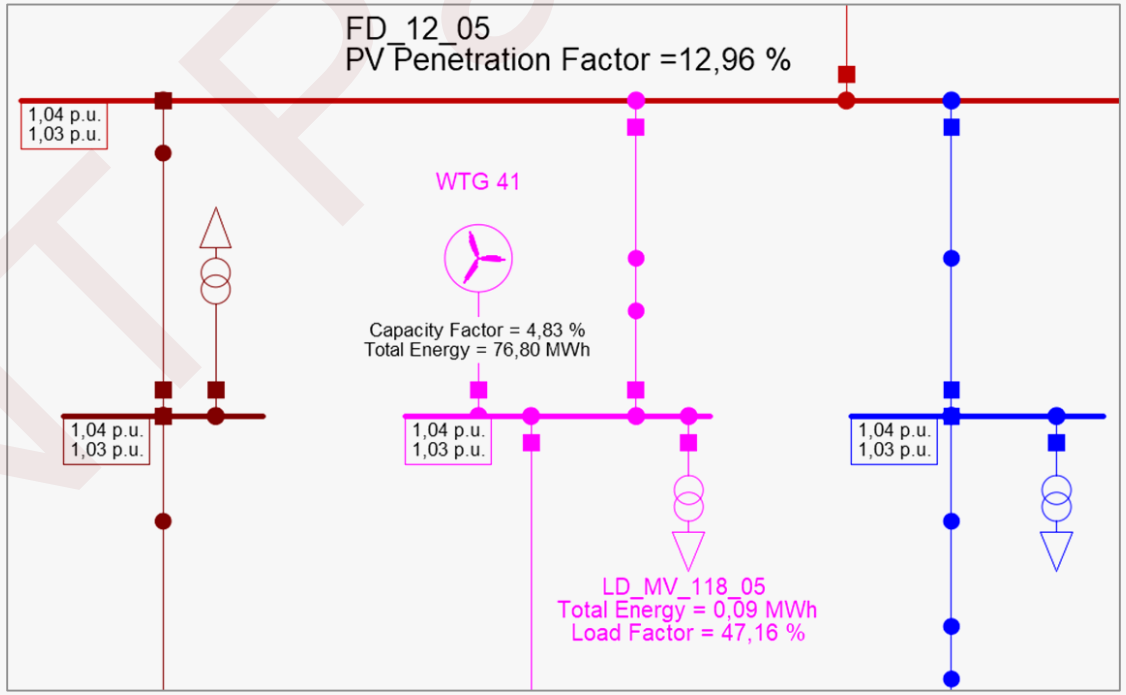
Dynamic Network Reduction

- Reduction of a large scale network to a small region while retaining the dynamic behaviour of the whole system.
- Parameter identification internally used
- Performance and handling improvements
- Confidential network parts and models can be reduced for data exchange



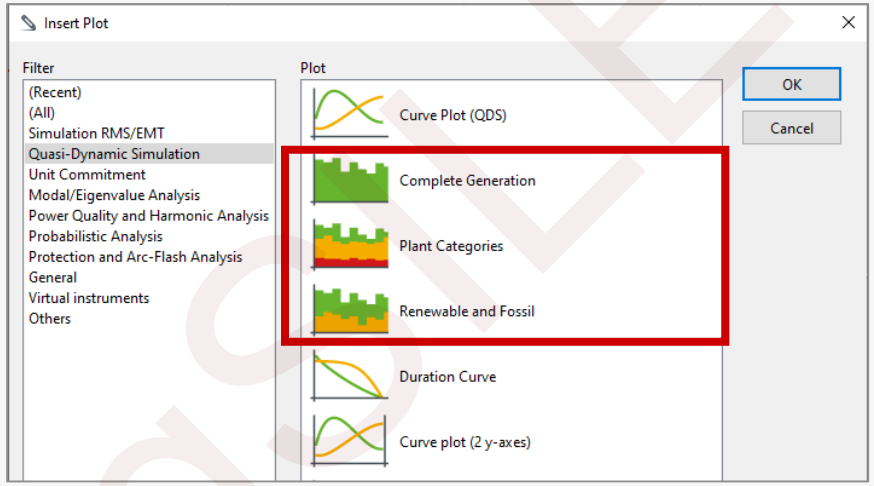
Quasi-Dynamic Simulation – Enhanced calculation quantities

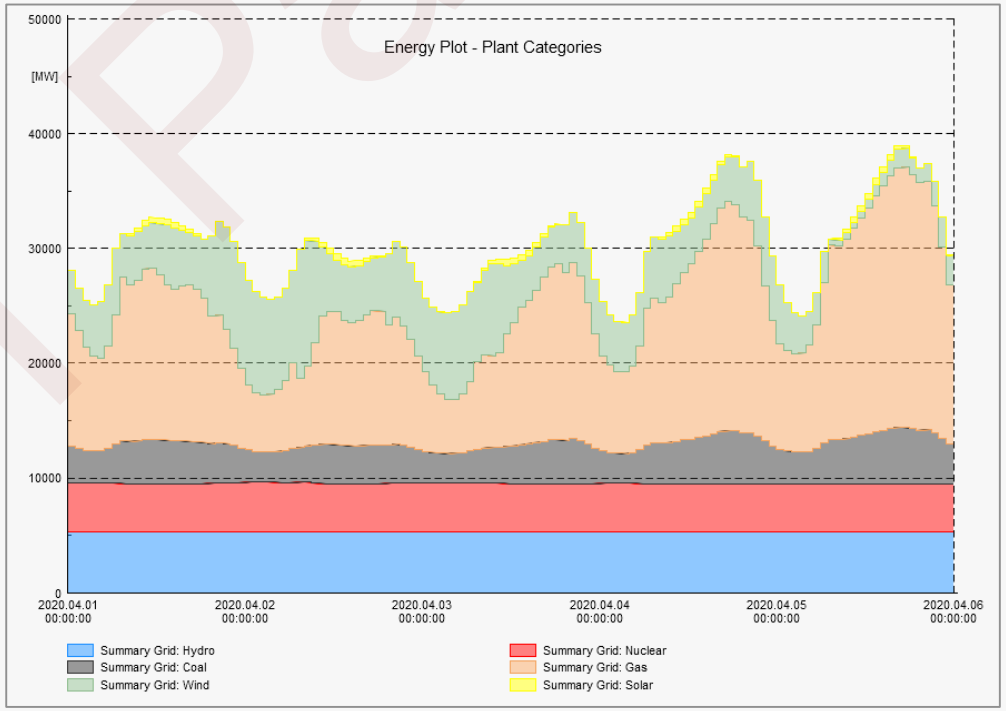
- New result variables:
  - **Capacity Factor:** Ratio of the actual to the maximum possible electrical energy of a generator
  - **Load Factor:** Average load divided by the peak
  - **PV Penetration Factor:** Ratio of the total peak PV power to the peak load apparent power of a feeder
  - **Maximum Reverse Power:** Quantifies the maximum power export of a feeder

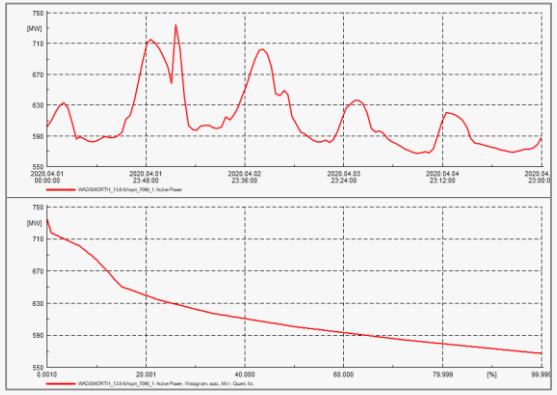


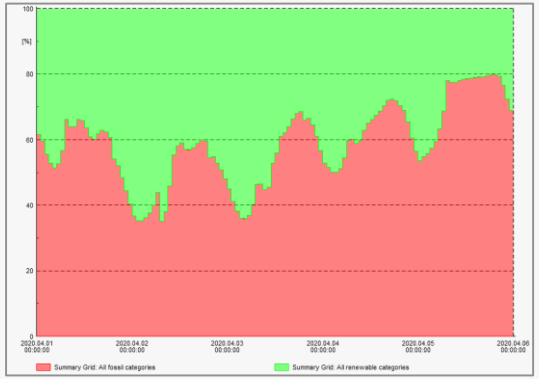
Quasi-Dynamic Simulation – New Visualisation Options

- Energy Plots are available for:
  - Complete Generation
  - Plant Categories
  - Renewable vs Fossil Generation
- Energy plots can be displayed in absolute values or relative in percent
- Annual duration curves



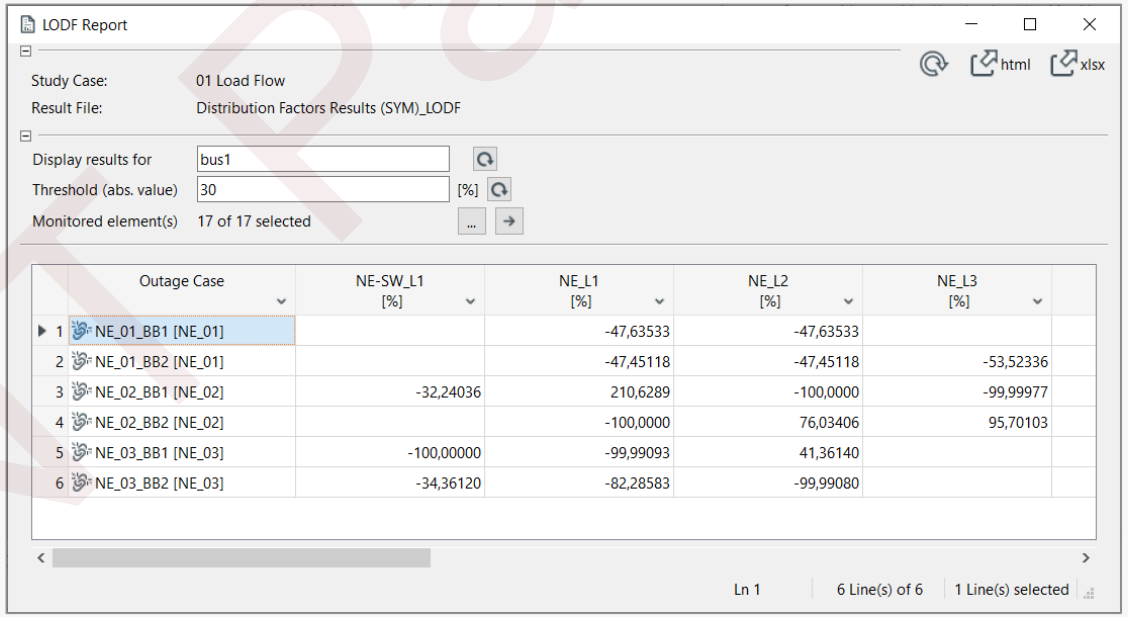






Sensitivity Analysis – New distribution factory

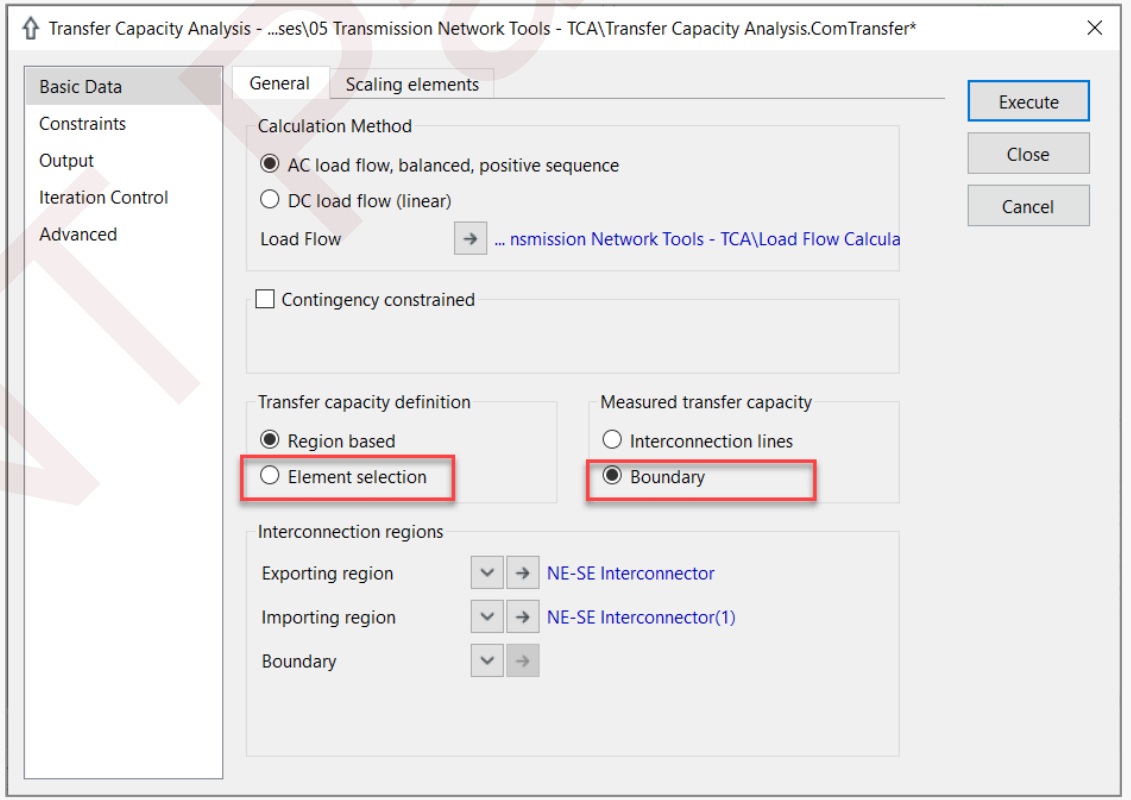
- New Quantities:
  - PTDF (Power Transfer Distribution Factor)
  - LODF (Line Outage Distribution Factor)
  - OTDF (Outage Transfer Distribution Factor)
  - PSDF (Phase Shift Distribution Factor) or TCDF (Tap Change Distribution Factor)
- Calculation for multiple elements:
  - Multi-selection of analysed elements saving time in processing the individual quantities
  - Sensitivities with different contingencies
- Reporting:
  - Tabular report with user-defined filter and thresholds



	Outage Case	NE-SW_L1 [%]	NE_L1 [%]	NE_L2 [%]	NE_L3 [%]
1	NE_01_BB1 [NE_01]		-47,63533	-47,63533	
2	NE_01_BB2 [NE_01]		-47,45118	-47,45118	-53,52336
3	NE_02_BB1 [NE_02]	-32,24036	210,6289	-100,0000	-99,99977
4	NE_02_BB2 [NE_02]		-100,0000	76,03406	95,70103
5	NE_03_BB1 [NE_03]	-100,00000	-99,99093	41,36140	
6	NE_03_BB2 [NE_03]	-34,36120	-82,28583	-99,99080	

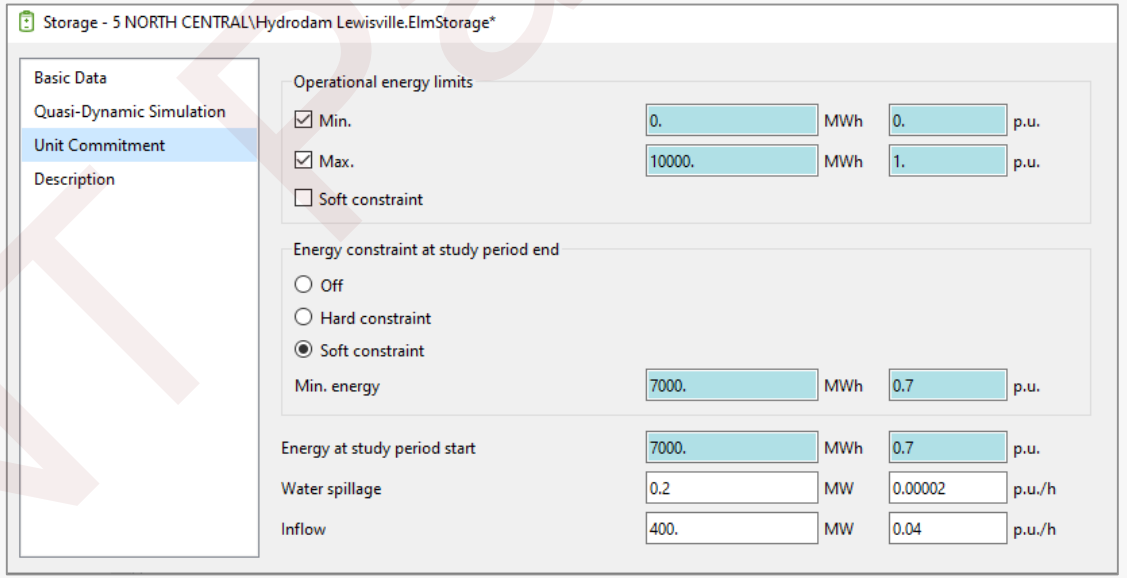
Transfer Capacity – New Options

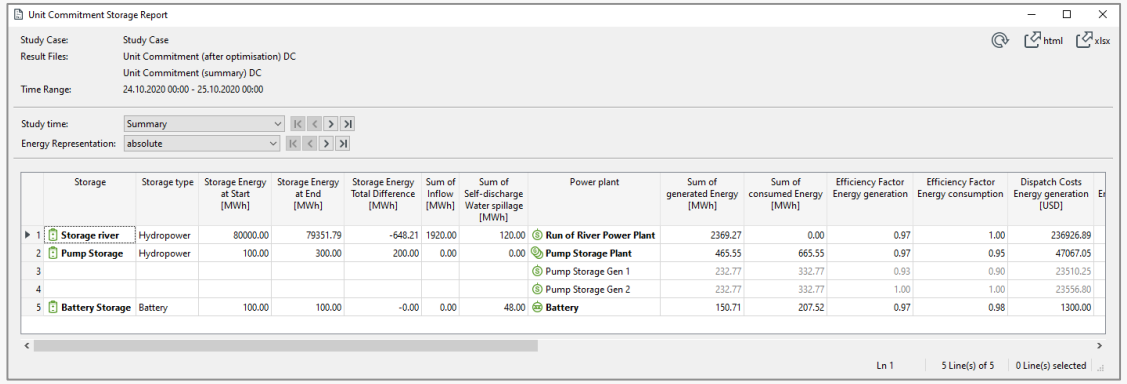
- Importing and exporting regions:
  - User definable importing and exporting regions using boundaries
  - Allowing full flexibility in the analysis
- Definition of scaled elements:
  - User definable definition of scaled elements
  - Including generators and loads



Unit Commitment and Dispatch Optimisation – Storage Models

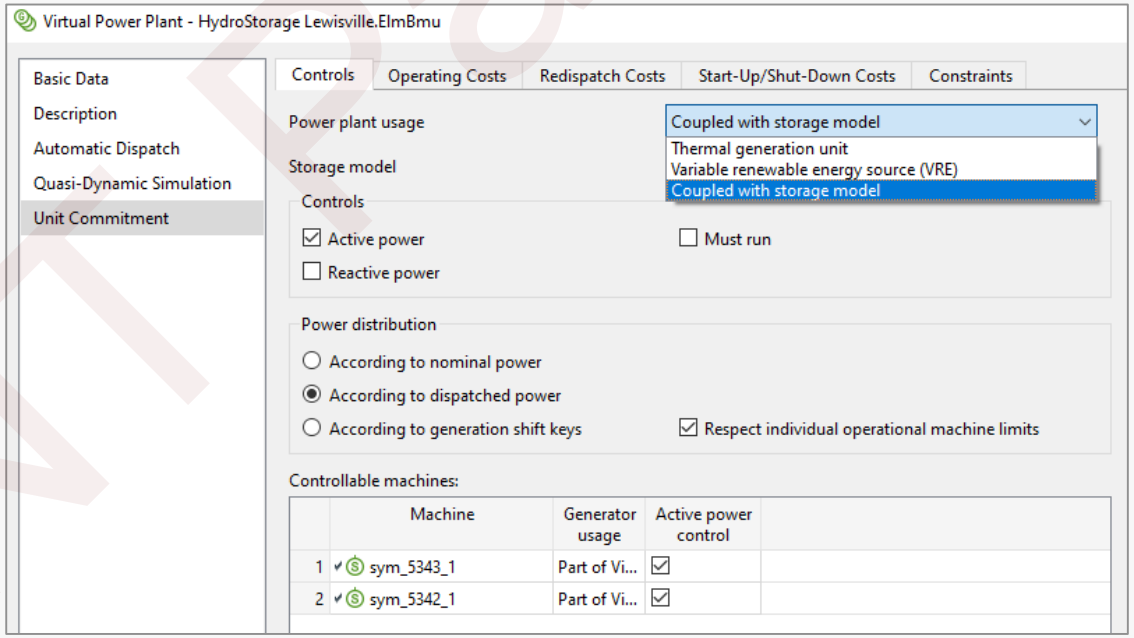
- The storage model can be used as:
  - Hydro Units
  - Batteries
  - General storages
- Consumption and generation mode
- Linked to the generator via efficiency curves
- Several generators can be linked to one storage via a Virtual Power Plant





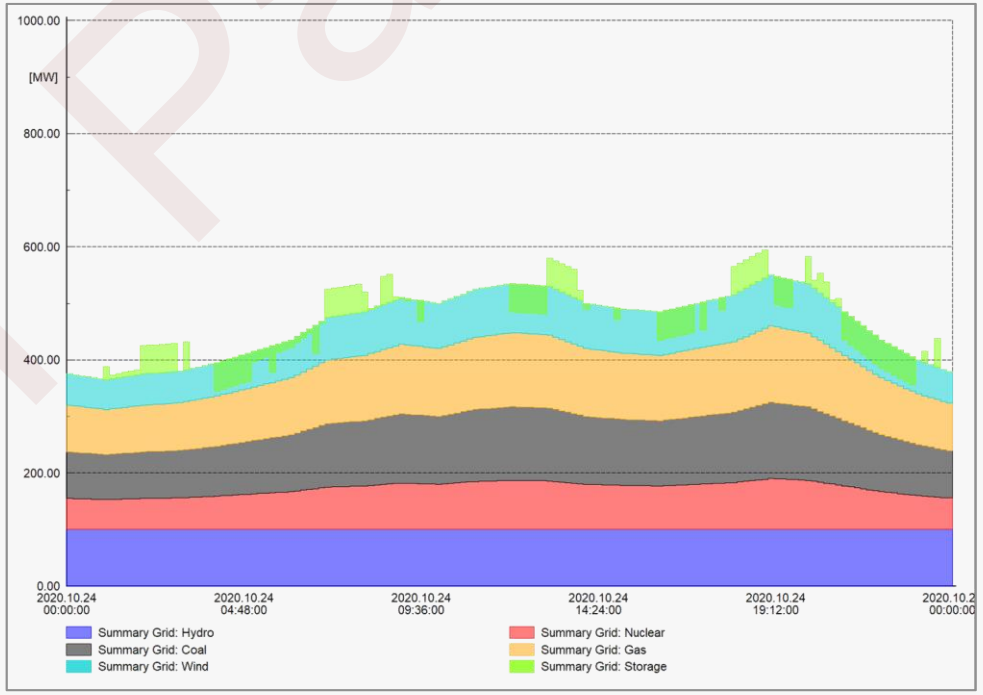
Unit Commitment and Dispatch Optimisation – Virtual Power Plant

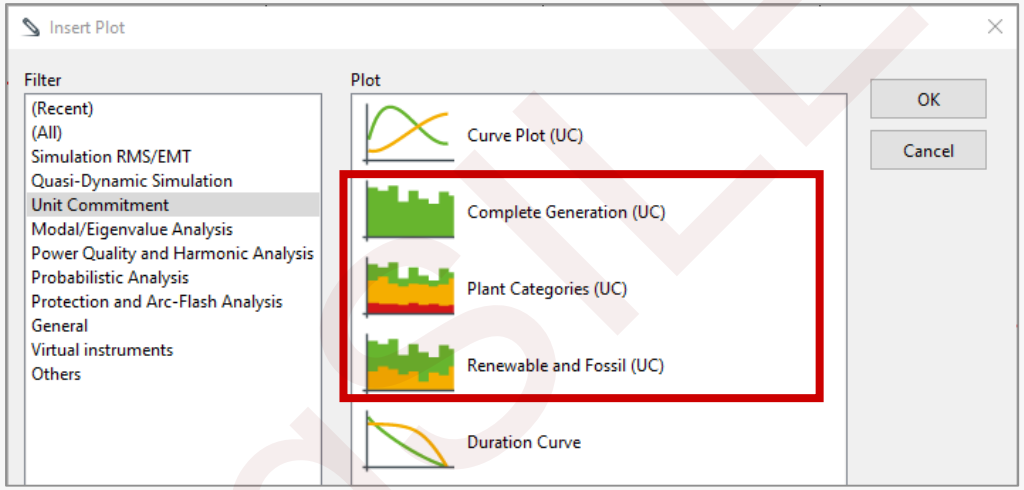
- Combination of several generation units for the optimisation
- Use cases:
  - Several generators can be represented as one power plant in market simulations.
  - Aggregate single wind turbines to a wind park.
  - Linking several machines to one storage.

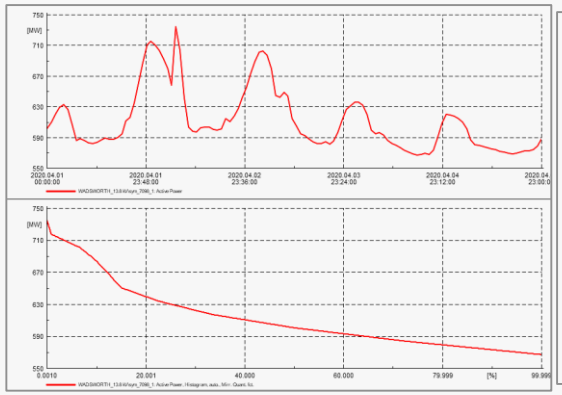


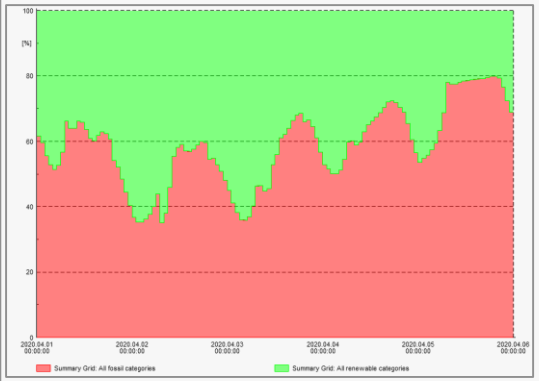
Unit Commitment and Dispatch Optimisation – New Plots

- Energy Plots are available for:
  - Complete Generation
  - Plant Categories
  - Renewable vs Fossil Generation
- Energy plots can be displayed in absolute values or relative in percent
- Annual duration curves



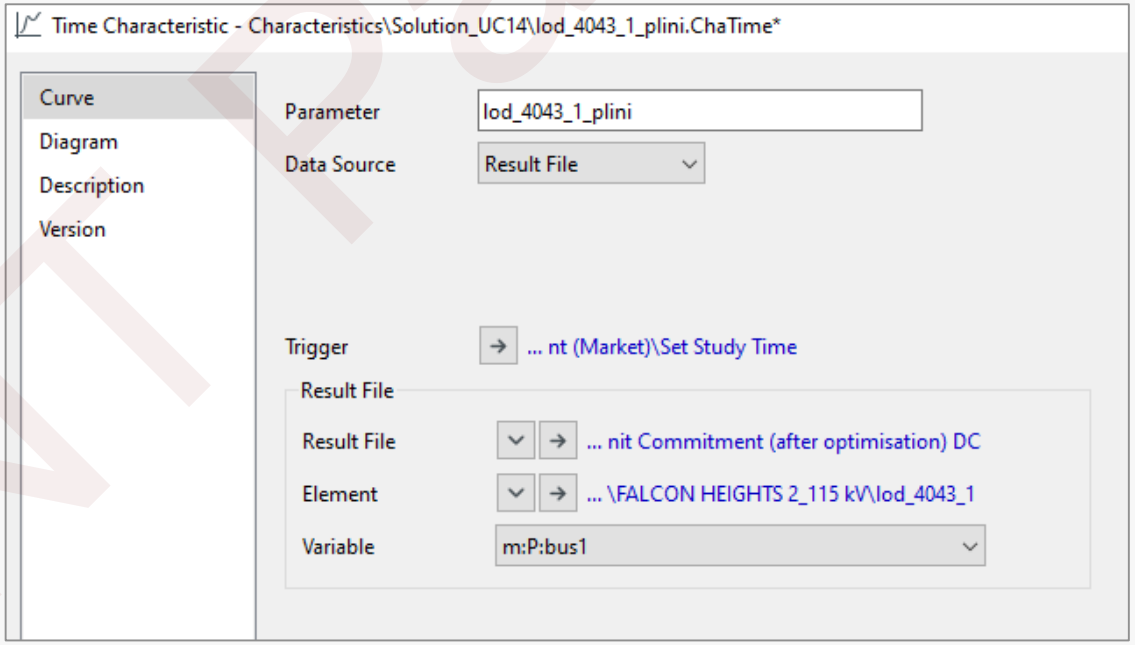






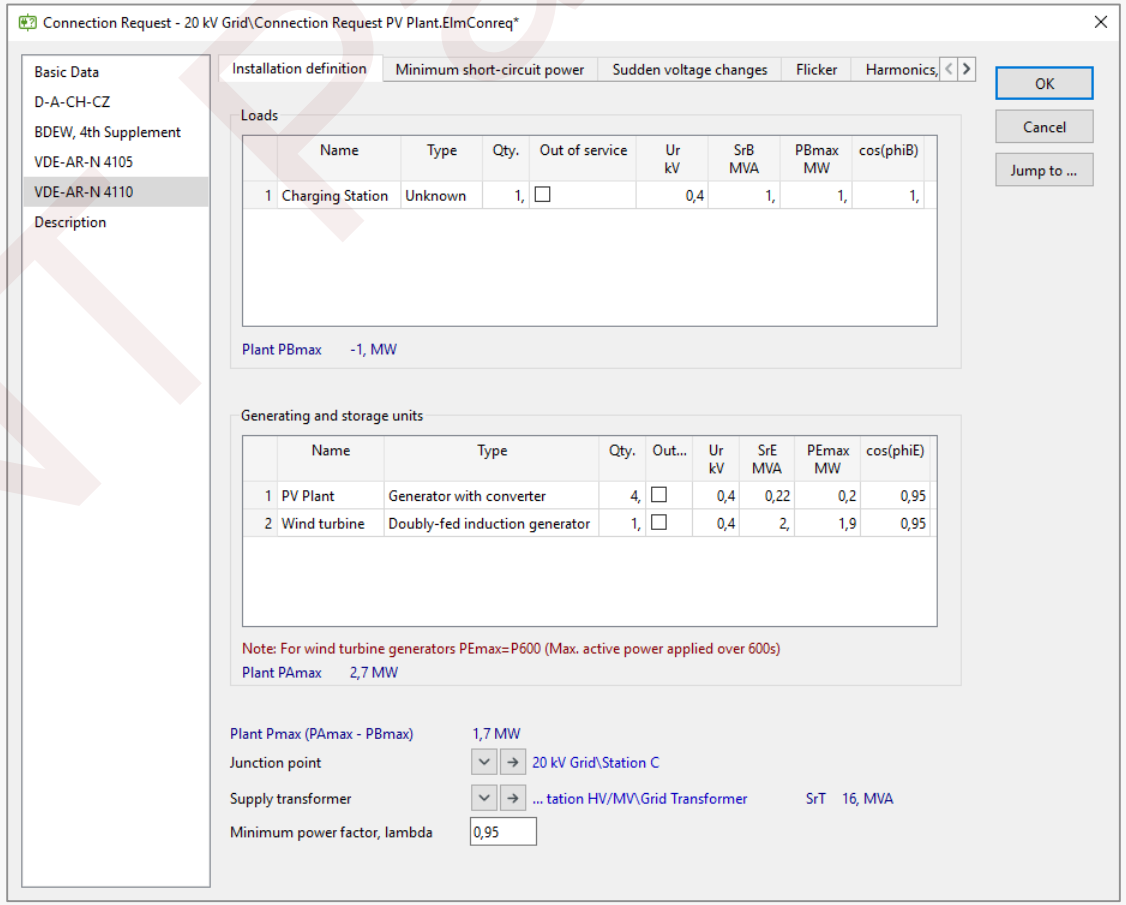
Unit Commitment and Dispatch Optimisation – Loading of Results

- Loading a single point in time from the result file to the network model.
  - Allows as detailed investigation in the network model for certain areas
- Load the complete results from the optimisation to characteristics.
  - Allows the execution of other calculation on the optimised network.
  - Enables to execute a market simulation without constraints first and then executing a re-dispatch calculation based on the market results.



Connection Request Assessment – Support of New Standards

- **VDE-AR-N 4105:2018**
  - For low voltage networks
  - Update from version 2011 to 2018
  - Applicable for generators
- **VDE-AR-N 4110:2018**
  - For medium voltage networks
  - New guideline replacing the BDEW
  - Applicable for customer plants (generator, loads, storage units, mixing plants and charging equipment for electric vehicles)

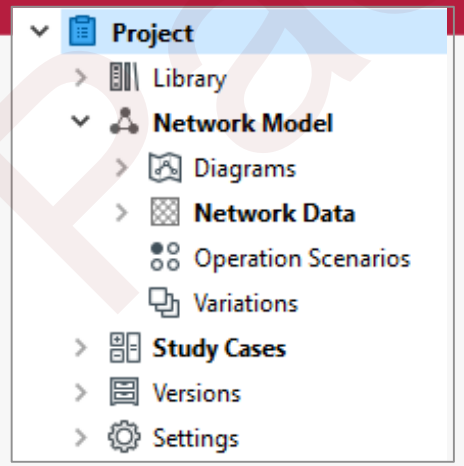


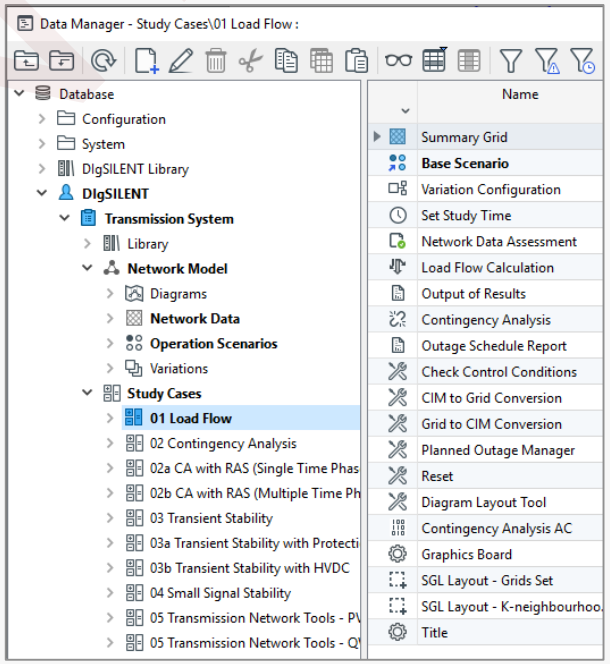
Handling and Data Management

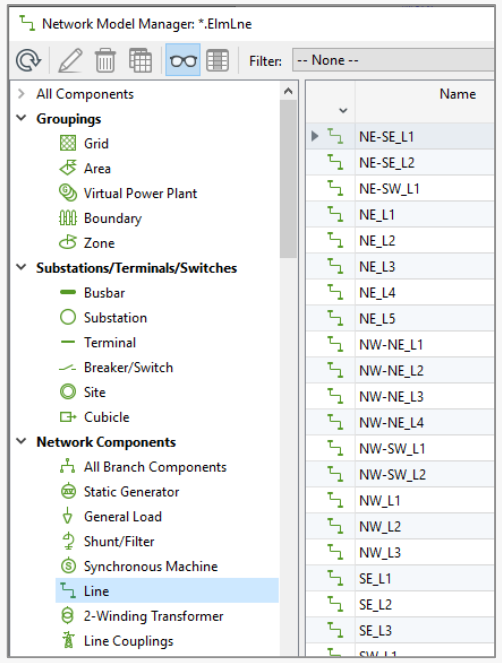
Improved Project Structure

- Default **Project structure** has been tidied-up:
  - **Operation Scenarios** are now located in Network Model folder
  - **Variations** are now located within the Network Model folder
  - Variation recording logic remains unchanged (i.e. recording of Network Data changes)

- Data Manager & Network Model Manager:
  - Redesign of all icons
  - Alignment with icons of main toolbars

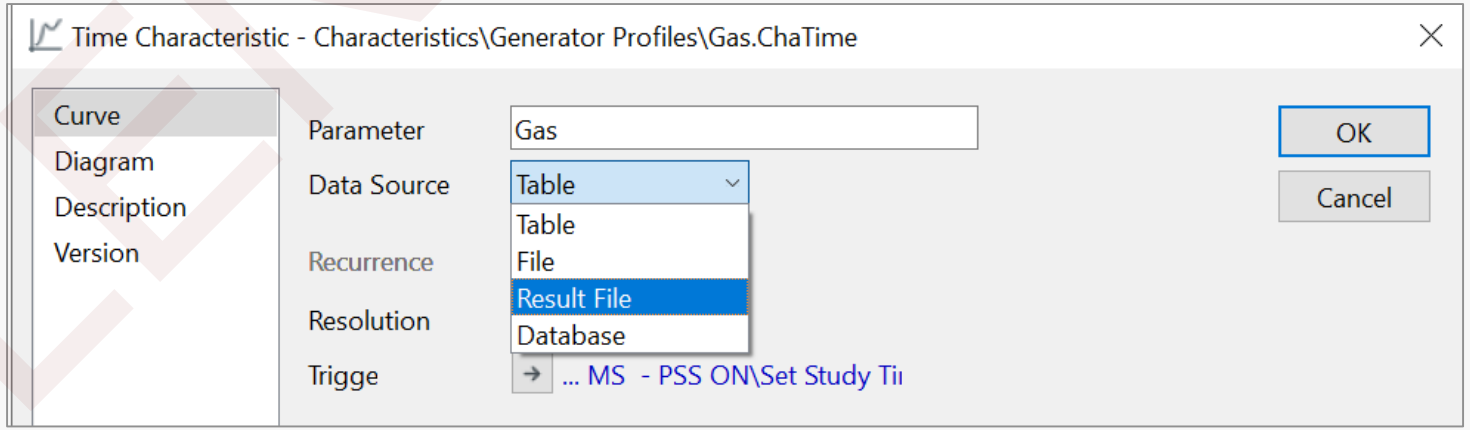






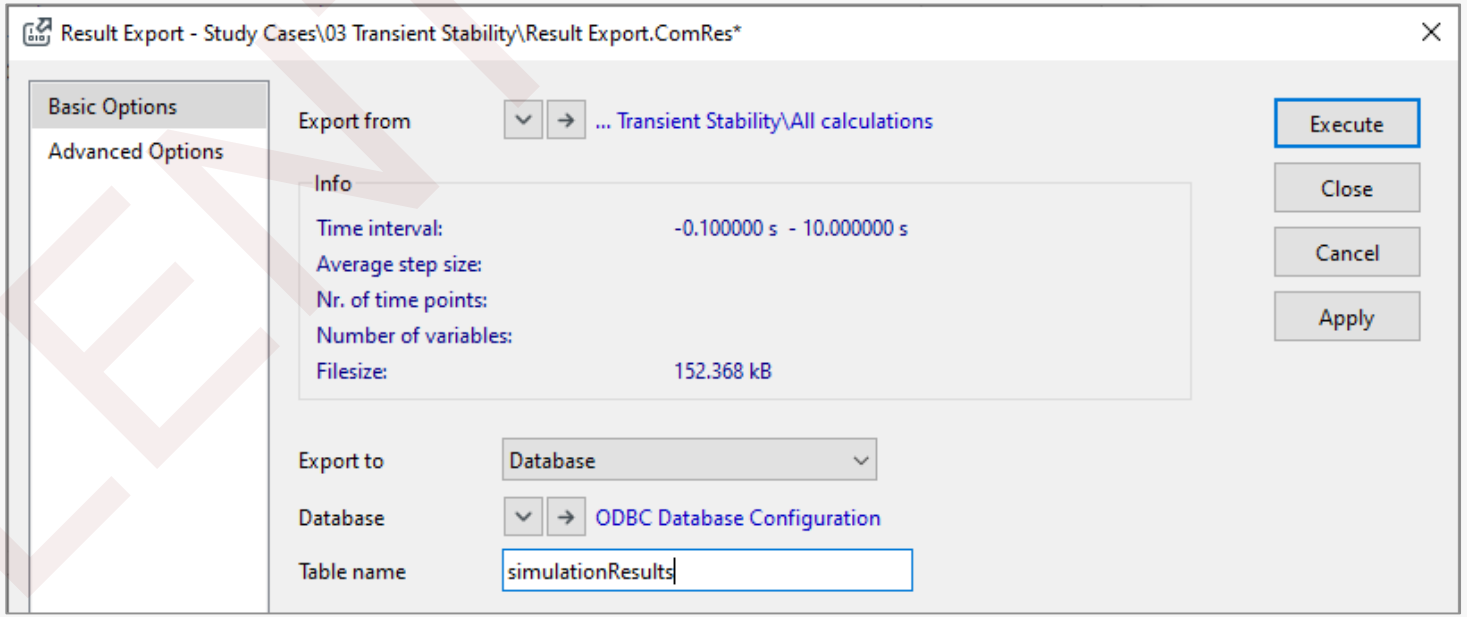
Characteristics – Support of new data sources

- Support of new sources for characteristics
  - From database: direct access to common databases (Oracle, PostgreSQL, MS SQL Server) to take time series data
  - From result files: using old results e.g. from the Unit Commitment and reuse these data as input



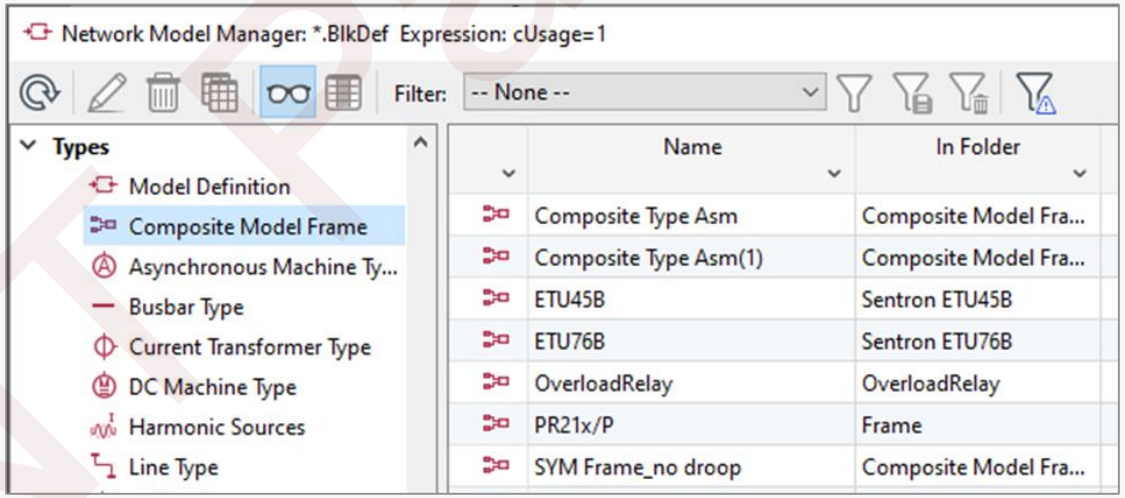
Result Files – Support of External Databases

- Exporting result files to databases
  - Support of the direct database export
  - Supported databases via ODBC:
    - Oracle
    - PostgreSQL
    - MS SQL Server



Dynamic Models – New Filter options

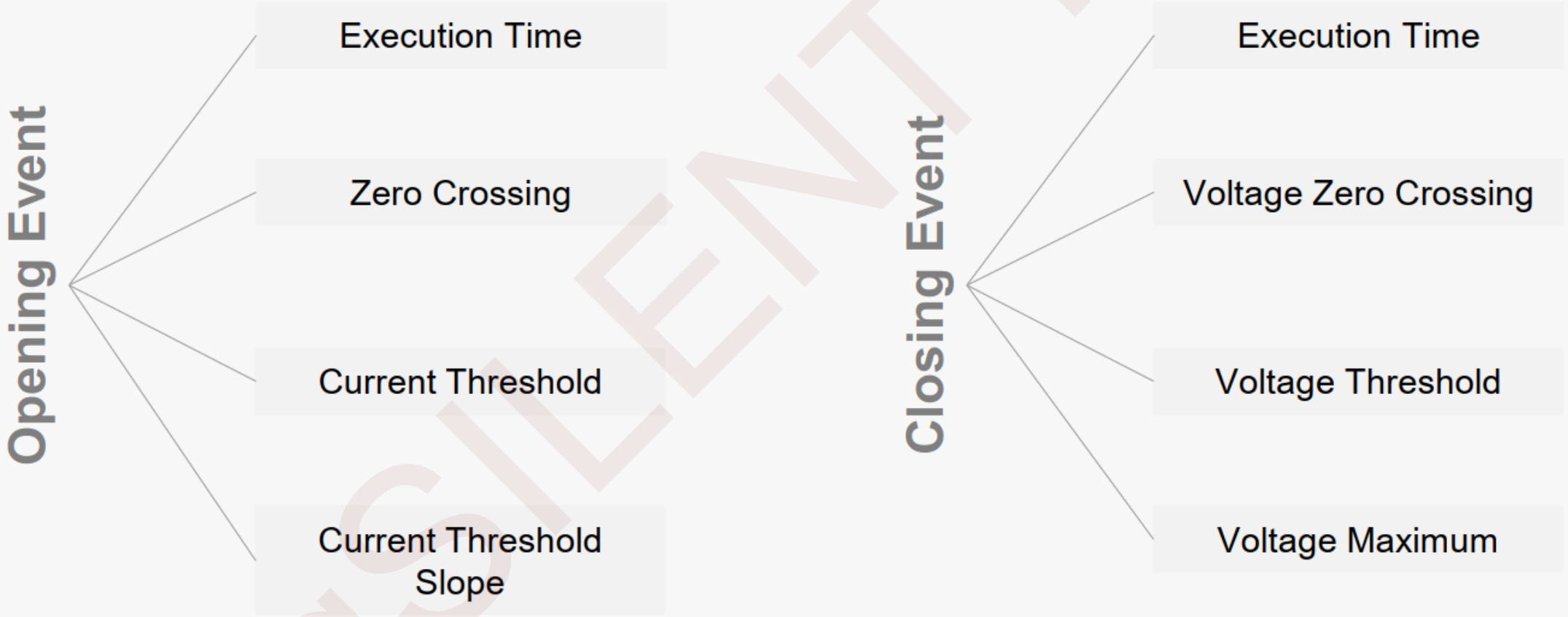
- Filtering between different kinds of models
  - Allowing to separate models such as
    - Model Definition
    - Composite Model (Frames)
  - Split within the network model manager by default
  - Giving a quick overview what the BlkDef is doing



Power Equipment Models

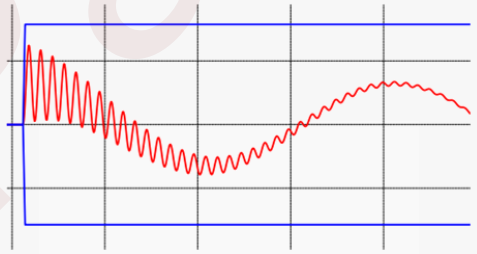
Power Equipment Models – Circuit Breaker and Switches I

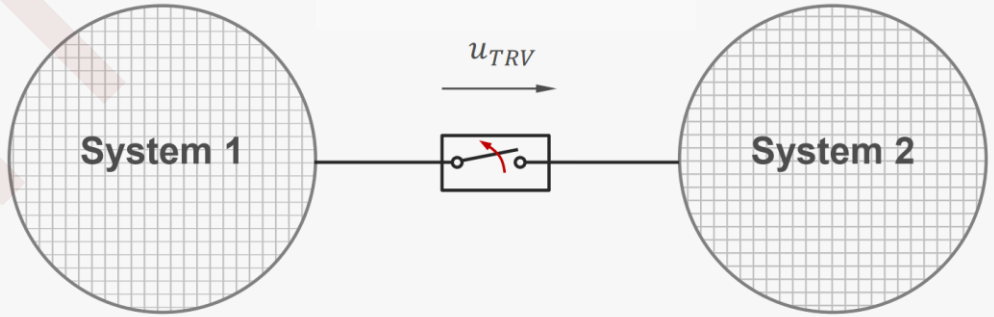
- Additional options for opening and closing events in time domain simulations

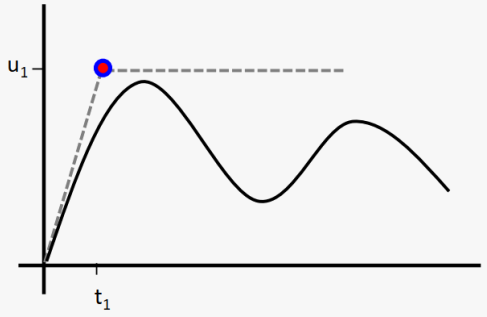


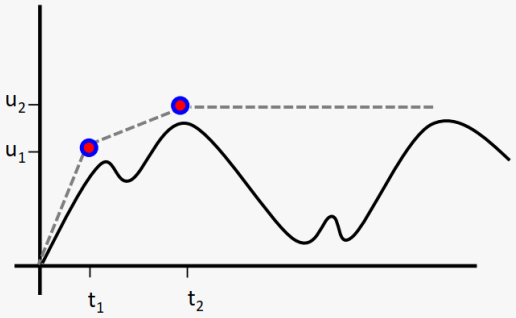
Power Equipment Models – Circuit Breaker and Switches II

- Circuit Breaker Envelope Curve
  - Circuit Breaker envelope curve representing the dielectric strength during transient recovery voltage (TRV)
  - Envelope curve can now be defined in the circuit breaker type
- IEC 62271-100
  - Both 2-parameter and 4-parameter curve for the dielectric strength of the circuit breaker available



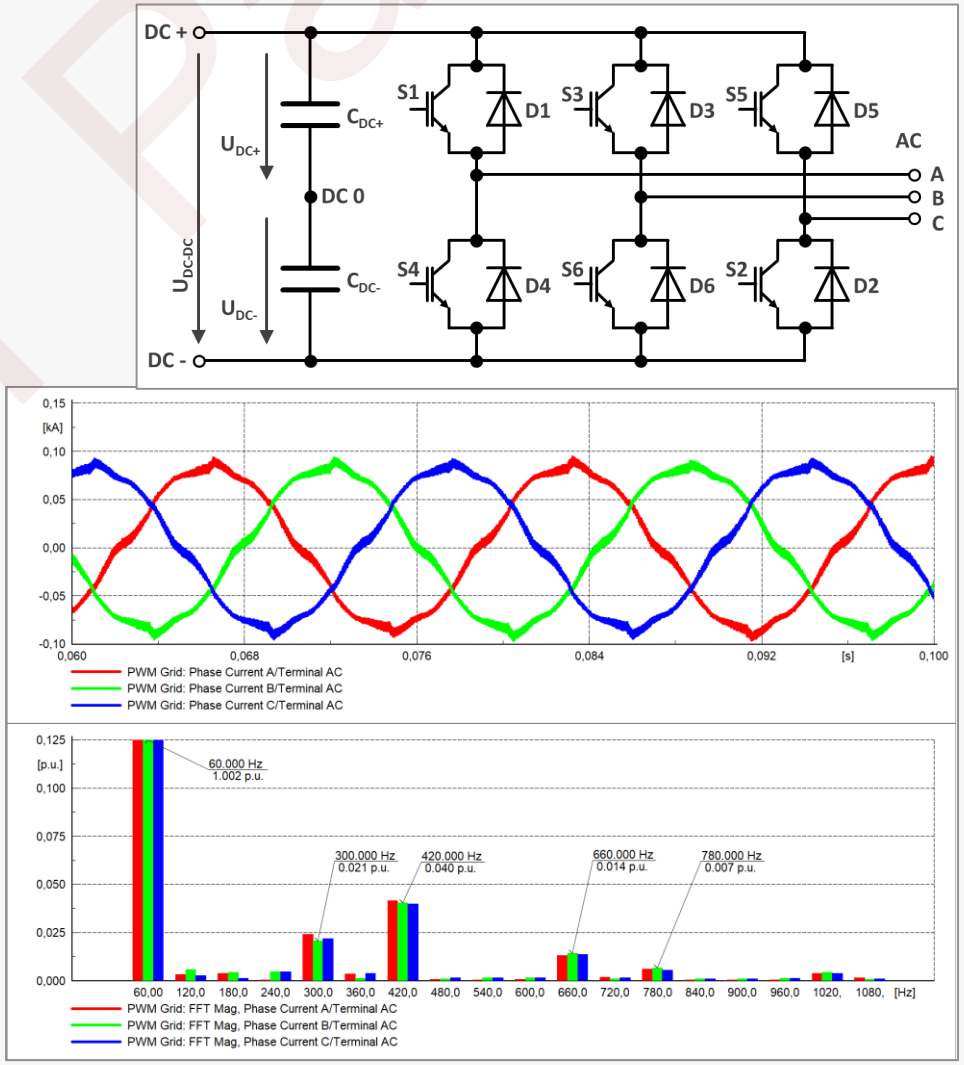






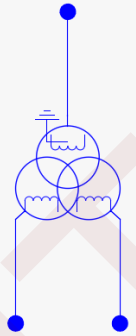
Power Equipment Models – Two-Level PWM Converters

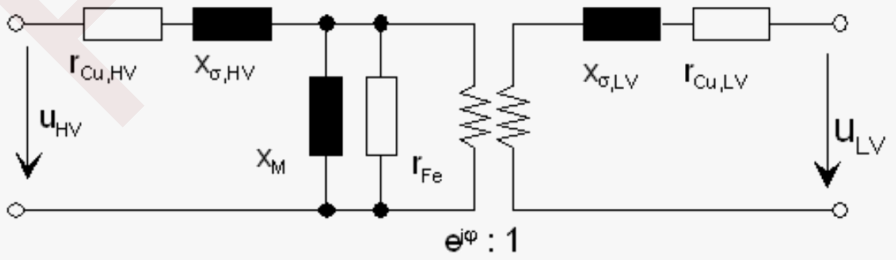
- **Support of dead-time:** switching in/out of same leg transistors occurs with an OFF state delay (both transistors of same leg are OFF)
- For **EMT simulation** only**, detailed model** only
- Dead-time generates considerable **low level harmonics** (5^{th},7^{th} , 11^{th}, 13^{th},..)
- Two configuration options:
  - Dead-time parameter in build-in model, or
  - Individual transistor gate signals (6 signals)

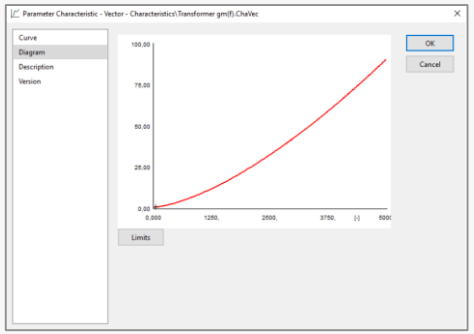


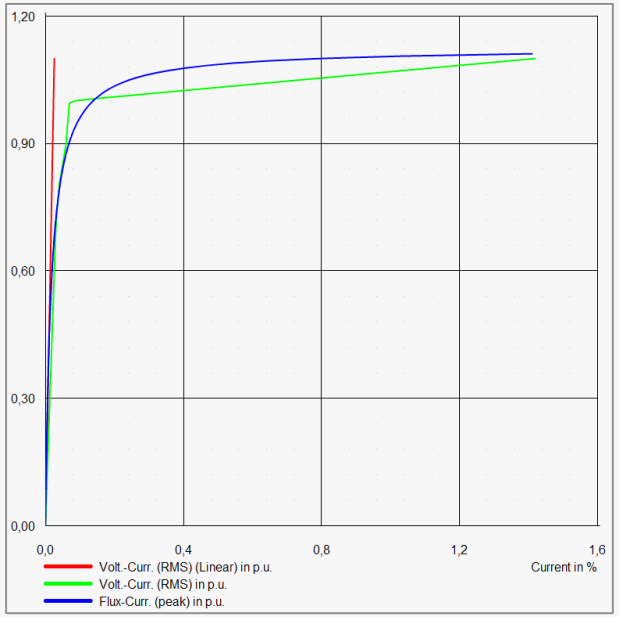
Power Equipment Models - Transformers

- Single phase three winding transformer
  - Railway systems but also for special transformers in three phase system
- Frequency-dependent magnetising impedance
  - L(f) and G(f) for harmonic load flow calculation and frequency sweep
- Frolich equations for saturation models
  - Improved modelling of magnetising curve for EMT simulations such as transformer energisation and resonance studies









Power Equipment Models – Further Enhancements

- Synchronous Machines
  - Single phase synchronous machines model (e.g. for railway systems)
  - Support of negative sequence torque for the *"Standard"* synchronous machine model

- Shunts
  - Support of continuously controlled shunts
  - Used for theoretic results
  - Modelling PE-controlled shunts

Documentation material

Documentation material

- Documentation
  - Updated User Manual
  - Updated Technical References
  - Updated Scripting References
  - New „Welcome to PF“ intro
- Application Examples
  - Redesign of Application Examples dialogue
  - Revision of Application Examples
    - Lightning Transients
    - Switching Transients
  - New Application Examples:
    - Texas Grid
    - Resonance Studies
- Tutorial
  - Revision of introductory tutorial

Interfaces, Converters & Compatibility

Interfaces, Converters & Compatibility

- Python Interface
  - Support of Python 3.8
- PSS/E Converter
  - Support of PSS/E version 34 for import
  - Support of PSS/E version 33 for export
- Compatibility
  - Support of Windows Server 2019
  - Support of Oracle database clients 18c and 19c

Thank you!

And enjoy PowerFactory 2020