POWERFACTORY

PowerFactory 2021

What’s New

PF2021

POWER SYSTEM SOLUTIONS
MADE IN GERMANY

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***Welcome to PowerFactory 2021*!**

As we near the end of this challenging year, we are pleased to introduce the latest version of *PowerFactory*. Despite the necessary restrictions and new ways of working, we have been able to continue uninterrupted in the process of delivering the developments to *PowerFactory* as planned, and providing the new features and improvements which we wanted to make available to you in this version.

With renewable generation now a mainstay of power supply in many networks, increasingly sophisticated tools are required to analyse system security, taking into account the complexities associated with wind and solar generation in particular. Features such as probabilistic analysis and the interaction with economic considerations are becoming essential. In *PowerFactory 2021* we have introduced a new module called *Economic Analysis Tools*. This incorporates the existing *Techno-Economical Calculation* function with a new *Power Park Energy Analysis* tool, which offers flexible options for analysis according to your requirements. Take a look at Section 1.2 to read more.

Users interested in the analysis of distribution networks will see that we have reorganised the toolboxes in order to accommodate the growing number of available functions. New in *PowerFactory 2021* is an *Optimal Equipment Placement* tool (Section 1.7.2), which focuses on the placement of voltage regulators and storage models.

Network operators in general may be interested in a new Network Reduction method based on regional aggregation (see Section 1.6) and developments to the Unit Commitment and Dispatch Optimisation module (see Section 1.9), and transmission operators in particular will note that CGMES 3.0 is now supported (see Section 6.2.1).

Users will also notice that we have reworked the Plots framework, providing a much more intuitive user experience. This includes new layout and styling options, as well as new automation for intelligent axis labelling. See Section 2.3 for more details.

From the network model management aspect, we also offer some significant developments. In Section 3 you will find descriptions of two new tools: the *Operation Scenario Manager* and the *Variation Manager*. The *Operation Scenario Manager* allows ready comparison between data in different scenarios and possibilities for easy copying of data values between one scenario and another. The *Variation Manager* provides a valuable visualisation of network Variations and Expansion Stages in a customisable Gantt-chart style view.

Renewable generation and the growing use of power electronics continue to be themes of increasing importance. In Section 4 (Power Equipment Models), you can find out about the newly introduced models and enhancements to existing models that are now available, in particular relating to EMT simulations.

These are just a few highlights of course. Please read on and see what else is new! You might also want to watch the *What's New* video on our YouTube channel

We wish you success with *PowerFactory 2021* and we look forward to your comments and feedback.

Your DIgSILENT team

Contents

1 Analysis Functions

1.1 Economic Analysis Tools *NEW MODULE*

In *PowerFactory 2021*, a new module *Economic Analysis Tools* is introduced. This module comprises the newly developed *Power Park Energy Analysis* function, and the existing *Techno-Economical Calculation* function, which is moved from the *Additional Functions* to *Economic Analysis Tools*.

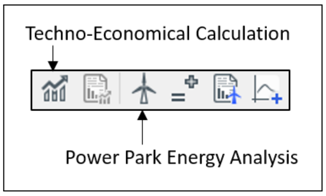


Figure 1.1: *Economic Analysis Tools* toolbox

1.2 Power Park Energy Analysis *NEW FUNCTION*

The new function *Power Park Energy Analysis* provides an evaluation of profitability of power parks based on load flow calculations.

In the early planning stage of power plant development, the economic efficiency is a critical factor for subsequent project realisation. Key figures such as energy feed-in, full load hours, profit and loss are often considered to substantiate cost-effectiveness. In order to quantify these important indicators, certain information about the power park is needed. For renewable generation in particular, this includes location-dependent factors such as the wind speed distribution at the site of a wind turbine or the solar irradiation of a PV system.

Network calculations are essential when it comes to determining the network losses of a power park, based on the possibly volatile infeed of the generating units, and the topology as well as the mode of operation of the power plant internal network. The *Power Park Energy Analysis* tool combines the powerful network calculation functions of *PowerFactory* with an economical evaluation. With this tool, the user can conveniently determine important quantities such as energies, profit and loss for a power plant, derived from network calculation results.

The new *Power Park Energy Analysis* function can be found in the *Economic Analysis Tools* toolbox. The command dialog for *Power Park Energy Analysis* is shown here:

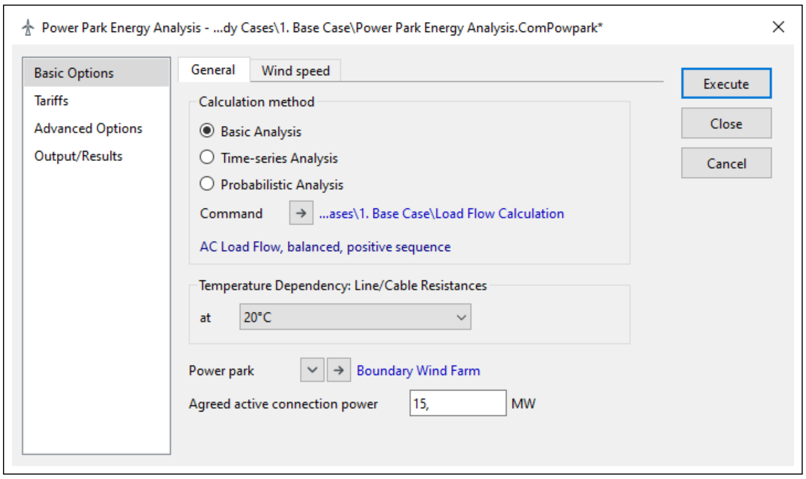


Figure 1.2: Command window for *Power Park Energy Analysis*

There are three calculation methods available:

- Basic analysis
- Time-series analysis
- Probabilistic analysis

1.2.1 Basic analysis

The *Basic analysis* is designed for power parks consisting of wind generators. The wind speed distribution will be modelled using a single Weibull distribution. In order to consider the power feed-in of the generating units configured with the plant category *Wind*, there is the new model "Wind speed input" available, as described in 4.2.1, in conjunction with a wind power curve. Over the range of wind speed, the energies and losses within the power park are calculated stepwise based on load flow calculations. Taking into account the probability of each wind speed from the given Weibull distribution, the yearly losses as well as energies and economic figures of the power park are determined. The *Basic analysis* features easy handling and a detailed report output.

1.2.2 Time-series analysis

The *Time-series analysis* provides the option to perform an energy yield analysis of power parks, combined with an economical evaluation over a user-defined period of time. This method is based on the Quasi-Dynamic Simulation and has therefore a very similar handling when setting up the simulation. This includes the possibility of specifying time-based characteristics for network equipment, for example the active power output of generating units such as photovoltaic installations. In addition, simulation events can be entered for a certain period, and QDSL models can be used, e.g. for battery energy storage systems. The time-series analysis calculation method is particularly characterised by its flexibility in data input.

1.2.3 Probabilistic analysis

The *Probabilistic analysis* method offers the opportunity to carry out the energy analysis taking probability distributions of various quantities into account. For example with regard to wind farms, for each turbine an individual Weibull distribution for the probability of wind speeds can be specified. Furthermore, copula elements can be defined, which can establish the correlations between the individual distributions. Using the probabilistic analysis, either the Monte Carlo or Quasi Monte Carlo method are available. In addition to the energy analysis, this calculation method provides a range of further statistical evaluation possibilities.

1.2.4 Results reporting and visualisation

The creation of reports and the visualisation of results in plots are core elements of this new tool. In the *Power Park Energy Analysis Report* command, the user can select the sections of the report to be displayed in the output window. For the Basic analysis, the following report categories are available:

- Power park data
- Average powers
- Energy data
- Average electrical losses
- Electrical energy losses

- Operating hours
- Profits and costs
- Maximum loadings

In Figure 1.3, an extract from an example results report based on the *Basic analysis* method is shown.

```
|--------------------------------------------------------------------------------------------------------------|
|                                                                                                              |
|                                      P O W E R   P A R K   D A T A                                           |
|                                                                                                              |
|--------------------------------------------------------------------------------------------------------------|
| Wind farm name                 :  ↦ Wind Farm                                                                |
| Nominal power of the power park :  15,00 MW                                                                  |
|--------------------------------------------------------------------------------------------------------------|
|     Low voltage level   (LV)        |     Medium voltage level  (MV)       |     High voltage level   (HV)     |
|--------------------------------------------------------------------------------------------------------------|
|          Un <= 1,0 kV               |        1,0 kV < Un < 66,0 kV         |          Un >= 66,0 kV           |
|--------------------------------------------------------------------------------------------------------------|
|                    Wind speed                   (Weibull distribution)                                       |
|--------------------------------------------------------------------------------------------------------------|
| Average wind speed vw_avg                   :      8,862 m/s                                                 |
| Scale factor A                              :     10,000 m/s                                                 |
| Shape factor k                              :      2,000                                                     |
|--------------------------------------------------------------------------------------------------------------|
| Conductor temperature of lines/cables       :      20°C                                                      |
|--------------------------------------------------------------------------------------------------------------|
|--------------------------------------------------------------------------------------------------------------|
|                                                                                                              |
|                                  R E S U L T S   O F   A N A L Y S I S                                       |
|                                                                                                              |
|--------------------------------------------------------------------------------------------------------------|
|--------------------------------------------------------------------------------------------------------------|
|                                          Average powers                                                      |
|--------------------------------------------------------------------------------------------------------------|
| Average net power output at PoC over a year   | Average power of wind turbines over a year                   |
|--------------------------------------------------------------------------------------------------------------|
|                  5,988 MW                     |                        6,168 MW                              |
|--------------------------------------------------------------------------------------------------------------|
| Average feed-in power at PoC                  | Average consumed power at PoC                                |
|----------+------------------------------------+----------+---------------------------------------------------|
| Per year  | over feed-in operation time       | Per year  | over consumption operation time                   |
|----------+------------------------------------+----------+---------------------------------------------------|
| 5,994  MW |            6,572  MW              | 0,006  MW |          0,066  MW                                |
|--------------------------------------------------------------------------------------------------------------|
|--------------------------------------------------------------------------------------------------------------|
|                                          Energy data per year                                                |
|--------------------------------------------------------------------------------------------------------------|
|    Total annual net        |   Total annual generated    |   Total annual feed-in    |   Total annual consumed  |
|    energy output at PoC    |   energy of the wind farm   |                           |     energy at PoC        |
|----------------------------+-----------------------------+---------------------------+--------------------------|
|      52458,21 MWh          |        54032,02 MWh         |       52509,14 MWh        |       50,93 MWh          |
|--------------------------------------------------------------------------------------------------------------|
|--------------------------------------------------------------------------------------------------------------|
|                                          Operating hours                                                     |
|--------------------------------------------------------------------------------------------------------------|
| Number of hours of wind farm full load operation based on the total annual net energy output at PoC :  3497,21   h/a |
| Number of hours of wind turbine full load operation                                                 :  3602,13   h/a |
| Number of hours of feed-in operation at PoC                                                         :  7989,95   h/a |
| Number of hours of consumption operation at PoC                                                     :  769,97    h/a |
| Downtime hours of the wind farm                                                                     :  769,97    h/a |
| Number of hours when equipment is overloaded                                                        :  0,00      h/a |
|                                                                                                              |
```

Figure 1.3: Extract from an example results report of the *Power Park Energy Analysis*

With regard to the graphical representation of the calculation results, the user has access to numerous result variables that can be plotted. For the different calculation methods of the energy analysis function, predefined plots are available, for example the generation and losses curves for the basic analysis and the load duration curve for the probabilistic analysis. The variables to be shown are already pre-selected in these plots. An example of several diagrams, created using the results of the *Basic analysis* calculation method, is shown below in Figure 1.4.

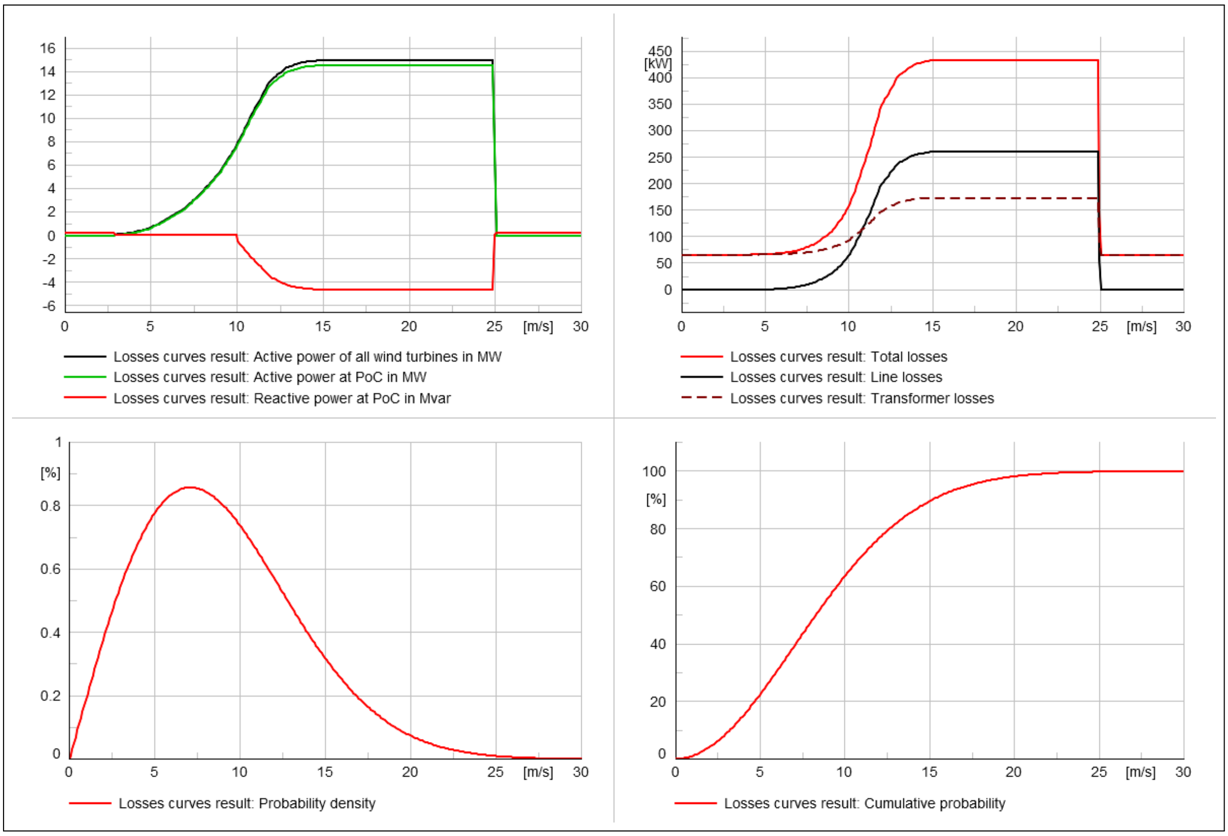


Figure 1.4: Sample plots from *Power Park Energy Analysis*

1.3 Short-Circuit Calculation

1.3.1 Complete method: Support of G74 Issue 2

The Complete Short-Circuit method offered within *PowerFactory* was implemented according to the UK Engineering Recommendation G74. In 2020, Issue 2 of G74 was published, affecting in particular the treatment of converter-based generation, and so the Complete method has been extended accordingly.

There are some related changes to generator attributes. The *Short-Circuit Model* attribute for the Complete method will remain separate from the *Power station unit type* (i.e. it is still possible to have two different short-circuit models for IEC60909 and Complete calculations). The currently available short-circuit models for the Complete method (“Equivalent synchronous machine” and “Dynamic voltage support”) are supplemented by two converter-based short-circuit models: “Doubly fed induction generator” and “Full size converter”.

The modes “Dynamic Voltage Support”, “Doubly fed induction generator” and “Full size converter” will be treated as converter-based generation according to the G74. The former two will be converter-based in the transient calculation only, and the latter in both sub-transient and transient.

This means that the “Dynamic voltage support” is in essence a “Doubly fed induction generator” but with a different input for the sub-transient contribution. In order to harmonise this in the future, the “Dynamic voltage support” option will eventually be removed. But in the interim it is retained for reasons of compatibility and to allow plenty of time for users to decide how to configure their machine models.

Details of the element attributes will be found in the relevant Technical Reference documents.

1.3.2 Simulation of source isolated earth faults, broken conductors

A new event has been added for the analysis of power line faults. The event allows the modelling of different outcomes on either side of the point of failure. It is easy to configure whether the line conductor is interrupted partly or entirely, as well as which sides and phases have experienced the fault.

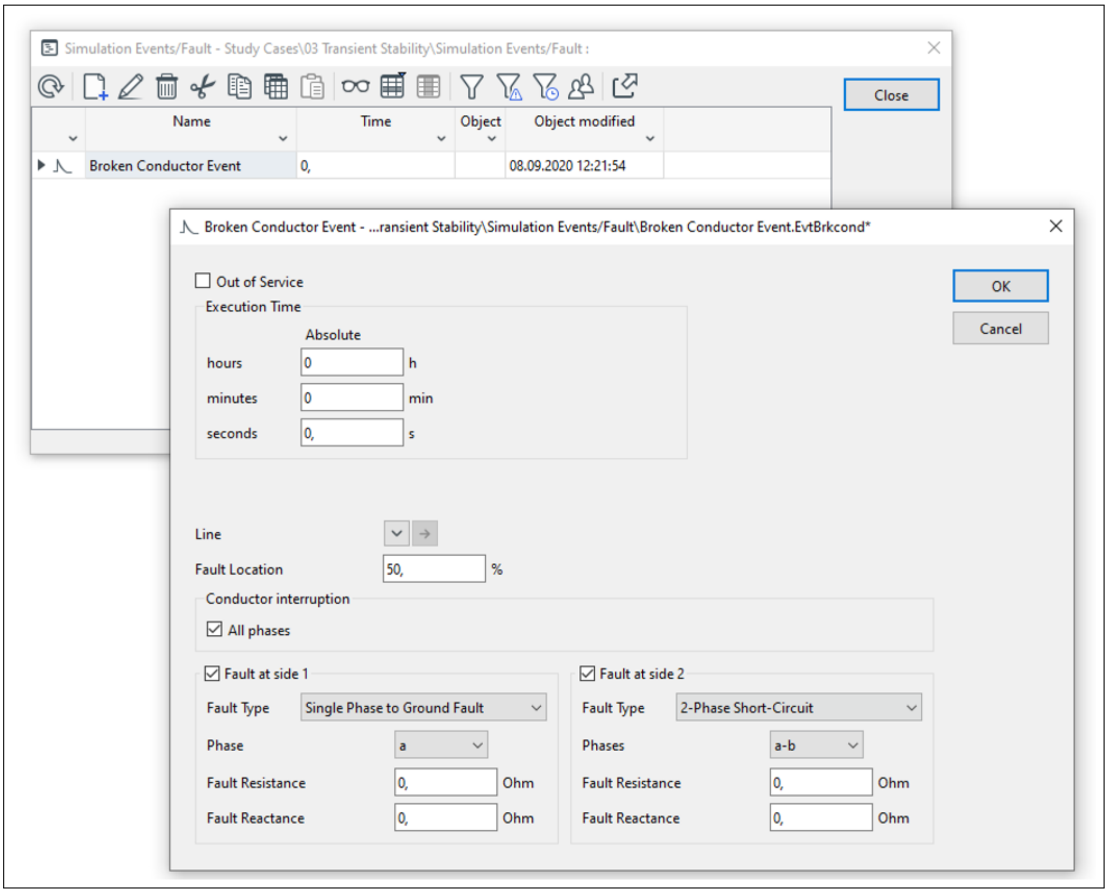


Figure 1.5: Configuration options of the broken conductor event.

1.3.3 New input options for the fault impedance

The handling of the short-circuit event object *(EvtShc)* has been enhanced so that it is now possible to specify the associated fault impedance in four alternative forms:

- Resistance and reactance.
- Impedance magnitude and impedance angle.
- Impedance magnitude and X/R ratio.
- Impedance magnitude and R/X ratio.

1.3.4 Enhancement of schematic Single Line Diagrams (SLD) for time-overcurrent plots

In *PowerFactory 2021*, the schematic single line diagrams for time overcurrent plots have been improved, in order to provide the user with full flexibility for the definition of the path as well as creation of plots. The changes are:

- Now users can directly display the corresponding SLD in a time-overcurrent plot without defining the path explicitly. The path can be created automatically by just selecting first and last elements in the graphic; optionally, additional elements can be selected in order to constrain the route.
- In order to investigate the short-circuit faults at different locations and to evaluate the coordination between different protection devices of the path, the user can execute the calculation directly from the SLD. The protection devices can also be directly accessed and edited if required.
- In addition, if the path includes busbars or terminals with no protection devices defined, then these connected elements will be displayed as a branch in the form of a dotted line. This can reduce the area required by the SLD and enable the user to concentrate only on the protection devices.
- Also, now there is a possibility to create a SLD consisting of multiple end terminals with their corresponding time-overcurrent plots.

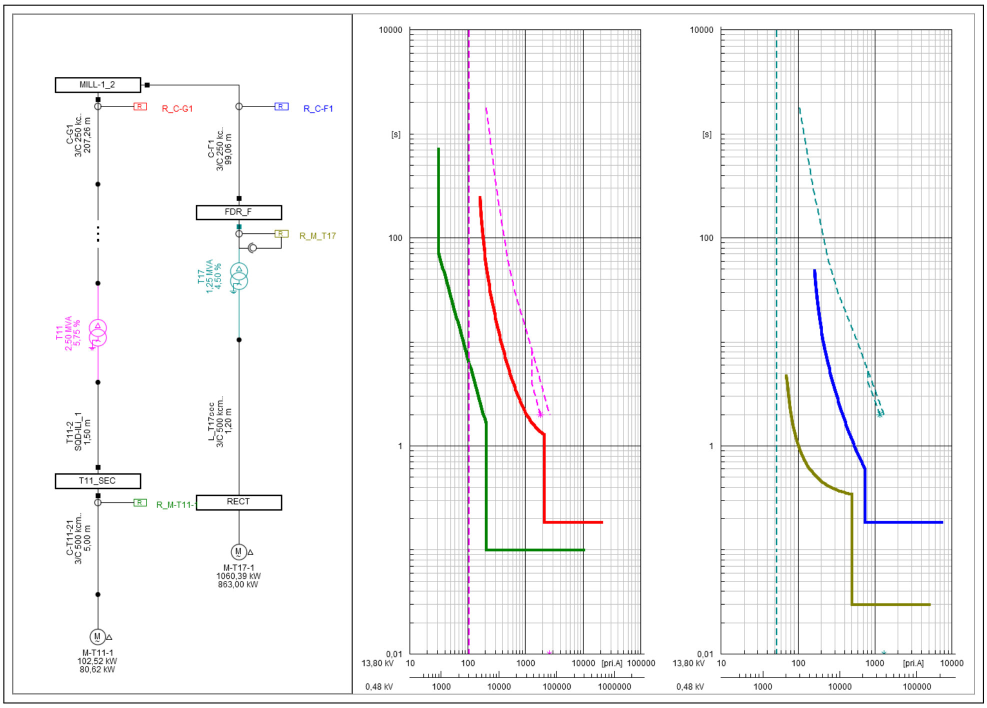


Figure 1.6: SLD for multiple path selection

- For scripting purposes, a new command (*ComCreateplot*) has been introduced for the creation of the time-overcurrent and time-distance plots.

1.4 Arc-Flash Analysis

1.4.1 Update to AC part of DGUV 203-077 calculations

The September 2020 update to DGUV 203-077 arc-flash guidance has resulted in some changes to the AC part of the corresponding calculation in *PowerFactory*. The default PPE Energy ratings have been altered to correspond with the updated guidance and a new minimum arc energy parameter has been made available. This parameter specifies a level above which personal protective equipment is required in order to protect against the thermal effects of arc flash.

1.5 Small Signal Stability

1.5.1 Unbalanced Modal Analysis (RMS-RST)

In *PowerFactory 2021*, the Modal- / Eigenvalue analysis module has been expanded to allow the calculation of unbalanced and unsymmetrical networks, in addition to the balanced network representation (positive sequence) that was previously supported.

Small Signal Stability studies can therefore now be carried out for the following network types:

- Unbalanced networks
- Mixed 1-, 2- and 3-phase networks
- Networks with Distributed Energy Resources (DER)
- Micro Grids
- AC Railway supply systems
- Networks with power electronics components in which, in addition to the positive sequence system, the negative and zero sequence systems must also be taken into account.

The Unbalanced Modal Analysis can be used for both the QR/QZ method and the selective method (Arnoldi / Lanczos)).

In Figure 1.7, the unsymmetrical network from the Micro Grid example “IEEE 13 Node Feeder” is shown. After calculating the initial conditions using the option “Network representation” - “Unbalanced, 3-phase (ABC)”, the Unbalanced Modal Analysis can be launched. Selected results are shown on the right side.

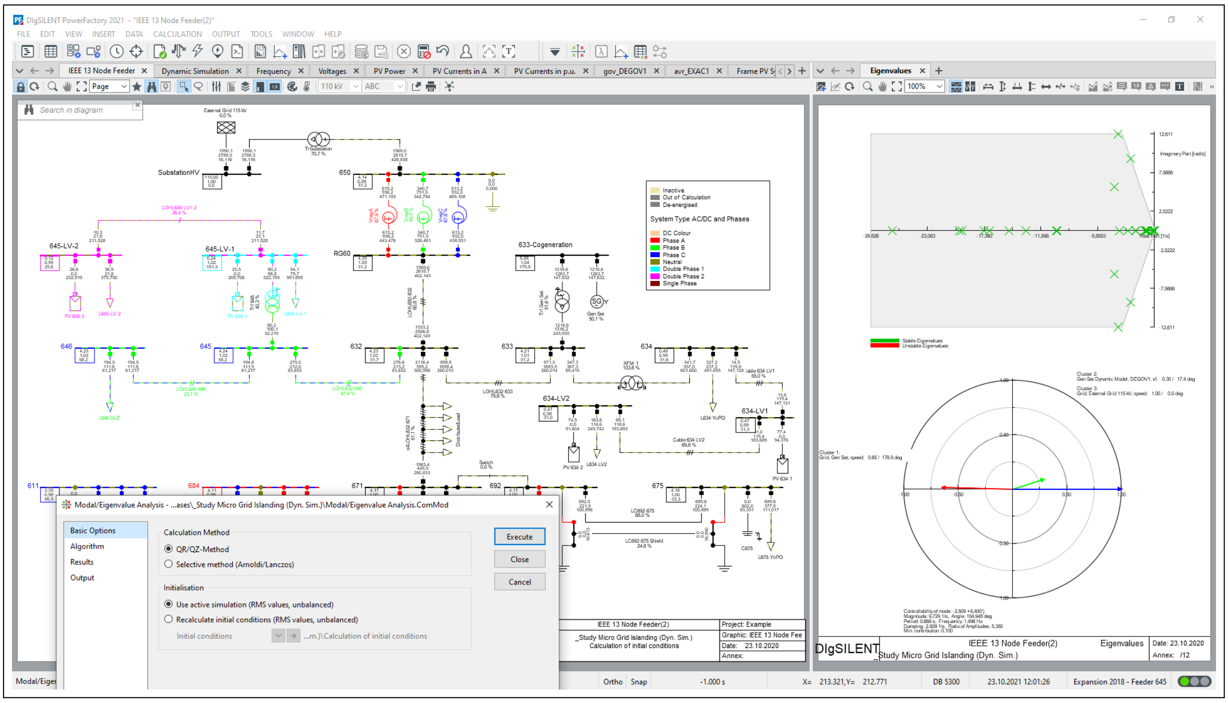


Figure 1.7: Unbalanced Modal Analysis on a Micro Grid sample network

1.6 Network Reduction

1.6.1 Regional equivalent method

A new static network reduction method based on the aggregation of regions is introduced. For this method, multiple grouping elements such as Areas, Zones, Grids and Boundaries can be selected to be reduced.

In contrast to the deterministic Ward and REI Reduction methods, the regional equivalent concentrates the demand and generation into one node per region and connected with only one equivalent impedance in between, as indicated in Figure 1.8.

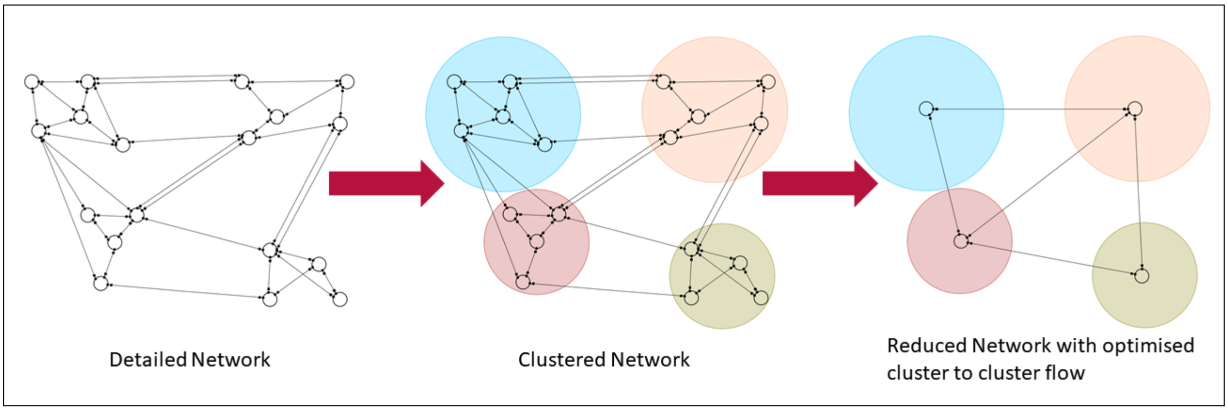


Figure 1.8: Illustration of the regional network reduction

The interconnecting equivalent impedances between the reduced regions and the retained network parts are then optimised using the built-in Parameter Optimisation function, to match the interchanges before the reduction.

This method can be used to reduce neighbouring networks, for instance in long-term planning, while retaining the general structure of the network. The reduced networks will be reduced to a minimum number of network components, whilst still allowing regional forecasting data, for example, to be applied based on the clustering. In order to ensure the best possible results for the part of the network of interest, the boundary flows to retained network regions can be optimised using weighting factors.

1.7 Distribution Network Tools

1.7.1 New toolboxes

With the addition of new features, the “Distribution Network Tools” toolbox has been reorganised into “Distribution Network Analysis” and “Distribution Network Optimisation”. The new function ***Optimal Equipment Placement*** described below can be found in the “Distribution Network Optimisation” toolbox.

The new toolbox “Distribution Network Analysis” is shown in Figure 1.9. It contains *Hosting Capacity Analysis*, *Backbone Calculation* and *Voltage Sag Table Assessment*.

Figure 1.9: Distribution Network Analysis Toolbox

The new toolbox “Distribution Network Optimisation” is shown in Figure 1.10, It contains *Tie Open Point Optimisation*, *Phase Balance Optimisation*, *Voltage Profile Optimisation*, the new function ***Optimal Equipment Placement*** and *Optimal Capacitor Placement*.

Figure 1.10: Distribution Network Optimisation Toolbox

1.7.2 Optimal Equipment Placement *NEW FUNCTION*

PowerFactory 2021 offers a new feature called *Optimal Equipment Placement*, which allows the user to place storage models and voltage regulators at the optimal location in the network. Existing storage models and voltage regulators can also be optimised. This feature is included in the “Distribution Network Optimisation” toolbox and thereby enlarges the existing licence module.

As many other tools in *PowerFactory*,*Optimal Equipment Placement* is an optimisation function which takes time-series calculations into account. The objective function is to minimise the total installation and operation costs of the equipment under consideration, taking into account pre-defined constraints.

There are several optimisation options available:

- Placement of new storage models with a pre-defined capacity
- Placement of new storage models with optimised capacity
- Optimisation of existing storage models
- Placement of new pre-defined voltage regulators
- Optimisation of tap positions of existing voltage regulators and transformers

Definition of equipment:

The equipment that is to be placed in the optimisation can be specified flexibly as shown in Figure 1.11. Along with the battery capacity and the maximum charging and discharging power of the storage model, the costs for installation, operation and maintenance that are essential for the optimisation can be entered. The maximum number of to-be-placed elements, electrical parameters such as maximum and minimum tap position, and the costs per tap change can all be specified.

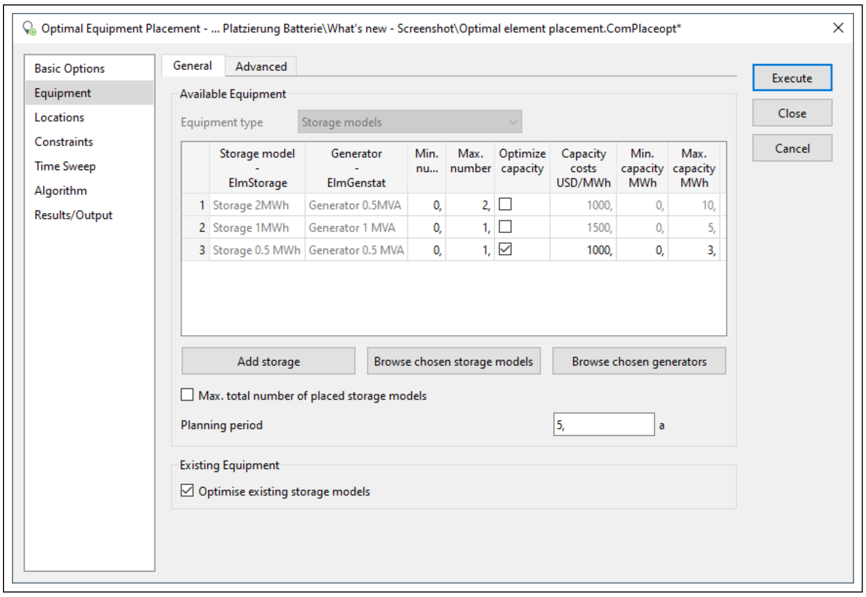


Figure 1.11: Definition of available equipment to use in *Optimal Equipment Placement*

Location:

Feeder objects (*ElmFeeder*) are used for defining the scope of the optimisation. The locations considered for the placement of new equipment are those within the specified feeder. The following options are available for defining the candidate locations:

- All terminals
- Only busbars
- A user-defined terminal selection

Likewise, the equipment to be optimised needs to be located within the feeder.

Constraints:

Within the investigated feeder to place or optimise equipment, the following constraints are considered:

- Thermal loading limits
- Voltage upper and lower limit

These constraints can be either hard or soft constraints. When soft constraints are defined, penalty costs for violating the limits are taken into account. In this case violations are allowed, but result in additional costs. As well as taking into account constraints within the investigated feeder, there is an option to consider constraints outside the feeder, either for the supplying substation or for a user-defined selection of elements. This allows the user to take into account violations caused by the new or optimised equipment that are outside the investigated feeder.

For the investigated equipment, the following constraints can be considered:

- Initial and final State-of-Charge of storage models
- Maximum charging and discharging power of storage models
- Minimum and maximum tap positions of voltage regulators

Calculation options:

The optimisation and placing of new equipment is always done for a user-defined time period.

PowerFactory offers different possibilities for solving the mixed-integer linear program (MILP) problem presented by the *Optimal Equipment Placement* function. As in the *Unit Commitment and Dispatch Optimisation* module, *Optimal Equipment Placement* supports both internal solvers (lp_solver, cbc solver) as well as external solvers like IBM CPLEX and GUROBI, thereby allowing the integration of existing LP simulation environments into *PowerFactory*.

Results and Visualisation:

The newly placed or optimised equipment can be saved within a new variation or instead integrated directly into the existing network. The optimal power dispatch of storage models and the optimal tap position of voltage regulators are stored in characteristics and linked to the corresponding equipment.

The *Optimal Equipment Placement* calculation writes three result files during execution. The main result file is the “Optimal Equipment Placement (summary)” where the overall results of the calculation are stored. The “Optimal Equipment Placement (before optimisation)” saves the load flow results of each time step before the optimisation and is equivalent to the results from a Quasi-Dynamic Simulation. The “Optimal Equipment Placement (after optimisation)” saves the load flow results for each time step after the placement and optimisation of equipment. The variables to be recorded by the *Optimal Equipment Placement* are user-defined.

There are several plots available for analysing the results of the optimisation. Similar to the Quasi-Dynamic Simulation curve plots over time, duration curves and energy plots are available. In Figure 1.12 an example of the optimisation is shown, where new storage models are optimally placed to reduce the loading of a line. The red curve shows the line loading before optimisation, and the green after optimisation. In the lower plot, the curves represent the charging power of the newly placed storage models required to reduce the overloading of the line.

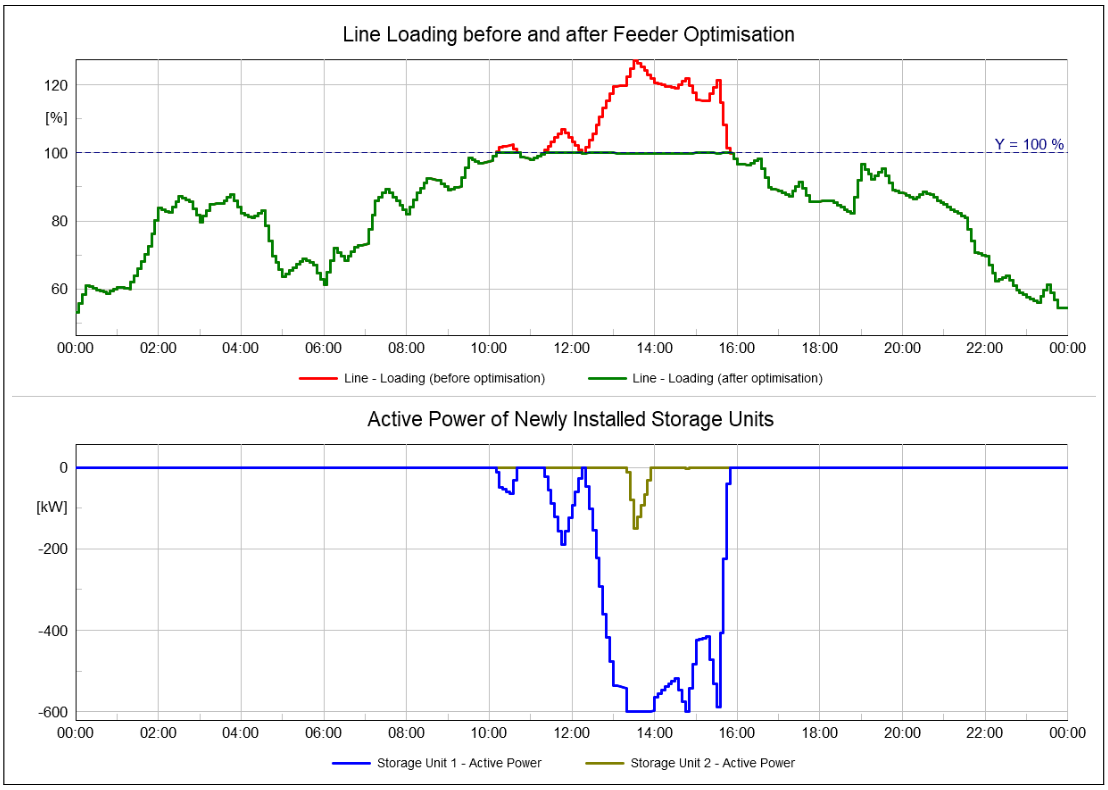
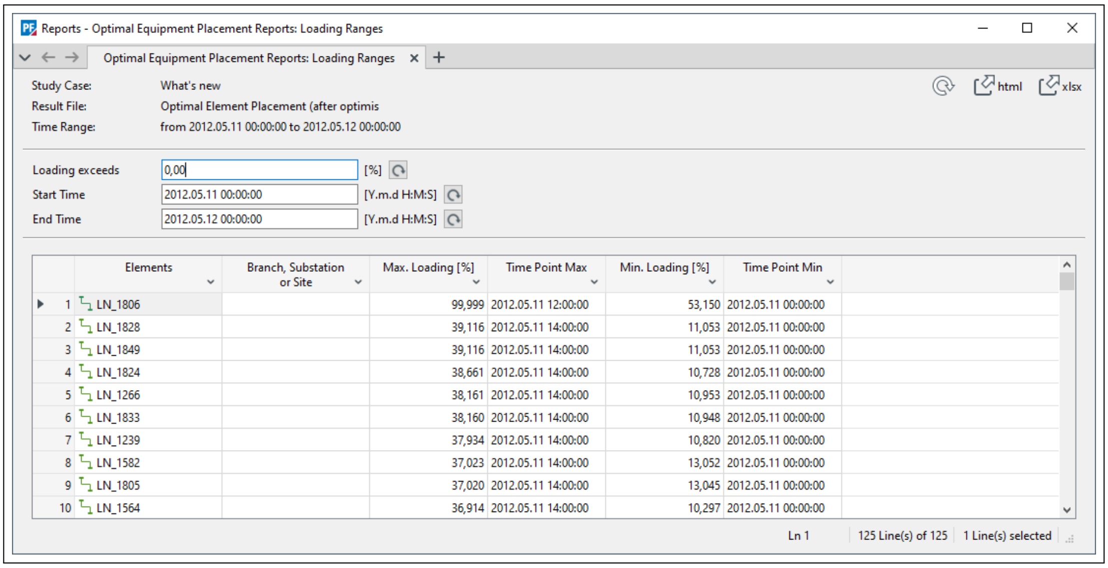


Figure 1.12: Example of the *Optimal Equipment Placement* - new storage units reduce the overloading of a line

There are also built-in reports for the *Optimal Equipment Placement* results:

- Results of the optimisation, and storage reports
- Time sweep load flow results for loading and voltage ranges as well as non-convergent cases



	Elements	Branch, Substation or Site	Max. Loading [%]	Time Point Max	Min. Loading [%]	Time Point Min
1	LN_1806		99,999	2012.05.11 12:00:00	53,150	2012.05.11 00:00:00
2	LN_1828		39,116	2012.05.11 14:00:00	11,053	2012.05.11 00:00:00
3	LN_1849		39,116	2012.05.11 14:00:00	11,053	2012.05.11 00:00:00
4	LN_1824		38,661	2012.05.11 14:00:00	10,728	2012.05.11 00:00:00
5	LN_1266		38,161	2012.05.11 14:00:00	10,953	2012.05.11 00:00:00
6	LN_1833		38,160	2012.05.11 14:00:00	10,948	2012.05.11 00:00:00
7	LN_1239		37,934	2012.05.11 14:00:00	10,820	2012.05.11 00:00:00
8	LN_1582		37,023	2012.05.11 14:00:00	13,052	2012.05.11 00:00:00
9	LN_1805		37,020	2012.05.11 14:00:00	13,045	2012.05.11 00:00:00
10	LN_1564		36,914	2012.05.11 14:00:00	10,297	2012.05.11 00:00:00

Figure 1.13: Time sweep load flow results after optimisation - line loading

1.8 Sensitivities and Distribution Factors

1.8.1 Flow-based market simulations output

Flow based market coupling (FBMC) is a widely used method for taking network constraints into account within the electricity market. The calculation of bus, phase-shifter and HVDC sensitivities in conjunction with contingency analysis was already possible in *PowerFactory*. In the new version, the calculation times for phase-shifter and HVDC sensitivities in particular has now been reduced.

With the new version, zone-to-hub and therefore zone-to-zone sensitivities are now also supported. *PowerFactory* supports the use of Zones, Areas and Grids for these calculations. The individual zone can be scaled according to generation shift keys (GSK). This calculation not only allows the required zone-to-zone sensitivities according to the CWE rules for critical branches (CB) and critical outages (CO) in order to set up an FBMC model, but it also allows the identification of CBs based on minimal zone-to-zone sensitivities.

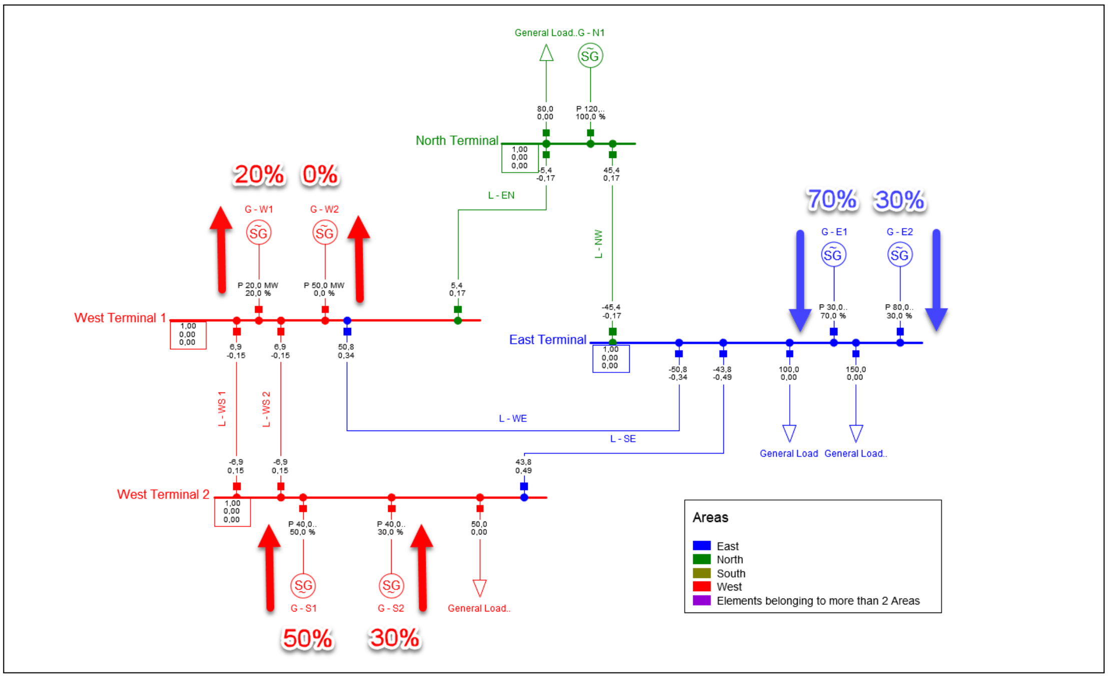


Figure 1.14: Area to Area sensitivity calculation making use of Generation Shift Keys (GSK)

This development goes hand in hand with the “Redundant Constraint Filter”, which furthermore allows a pre-solve algorithm to identify the most critical constraints, see 1.9.1.

1.9 Unit Commitment and Dispatch Optimisation

1.9.1 Constraint filters

The “Redundant Constraint Filter” is an extension to the Unit Commitment and Dispatch Optimisation toolbox and offers a powerful tool for determining the relevant and limiting network constraints for a selection of controls. The filter compares all the selected constraints and flags the limiting ones for the Unit Commitment. Each constraint which is not flagged by the filter is therefore redundant and can be neglected for a particular optimisation set-up.

A simple example of redundant constraints is two lines connected in parallel or in series. In such a set-up, it is sufficient to use only one of these lines for constraining the mixed-integer linear program, instead of considering both lines.

In the Constraint Filter, contingencies are fully supported. So it is possible to determine the Critical Branch Critical Outage combinations (CBCOs or CNECs for Critical Network Element and Contingency) for a single point in time or a specified time period. This finds application when deriving a Flow-Based model for Market Simulations.

1.9.2 Parallelisation of Contingency Analysis

The Unit Commitment and Dispatch Optimisation module is widely used by our customers. The huge flexibility and fast optimisation of the module lead to numerous use cases from long term planning up to close to real time applications.

While the optimisation has been very fast, especially when using a commercial solver, the set-up of the optimisation problem often has been the bottleneck - especially if contingency and time constraint optimisation is used. In order to provide even faster optimisation results, *PowerFactory 2021* now also supports parallelisation of the contingency analysis before and after the optimisation.

1.9.3 Non-linear soft constraints

Sometimes overloads are unavoidable during optimisation with given constraints during the Unit Commitment and Dispatch Optimisation analysis. Therefore, soft-constraints can be used in order to obtain the best possible solution.

However, determining the best possible solution when not all constraints can be satisfied is not always straightforward. The question arises whether the user would rather have one line heavily overloaded or several lines only slightly overloaded. Unused security margins often mean that having multiple lines slightly over their limits would be preferable.

Therefore, non-linear soft constraints and scaling factors are introduced for branch elements, to allow the application of different strategies when managing unavoidable overloads in Unit Commitment and Dispatch Optimisation analysis.

1.9.4 Tap-controller for parallel transformers

Parallel transformers normally need to be aligned in operation so that their tap positions do not deviate too much from one another. Within the optimisation for the Unit Commitment and Dispatch Optimisation analysis, however, this is not automatically considered due to the linearisation.

For this reason, tap controllers are now supported within Unit Commitment and Dispatch Optimisation, as they are in general load flow analysis, meaning that tapping can now be coordinated between parallel transformers.

2 Network Diagrams and Plots

2.1 Network Diagrams

2.1.1 Graphical representation of sites and substations

A new conversion for the visualisation of substation and sites in diagrams to switch between overview (beachball) and simplified (design view) representation is now available.

The graphical representation of existing substations/sites can be modified using the context menu as shown in the following figures:

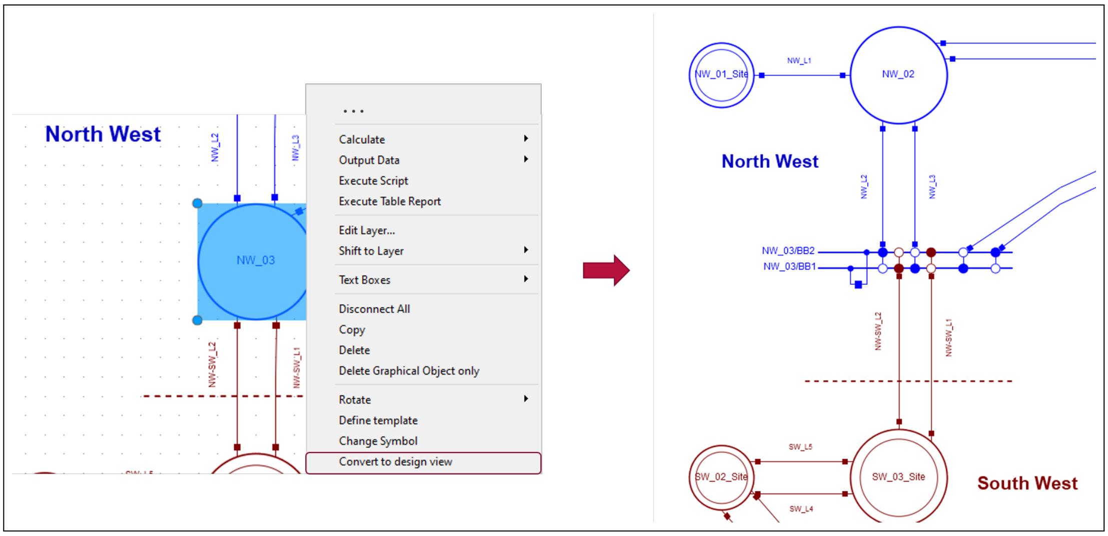


Figure 2.1: Conversion from “beach ball” to design view

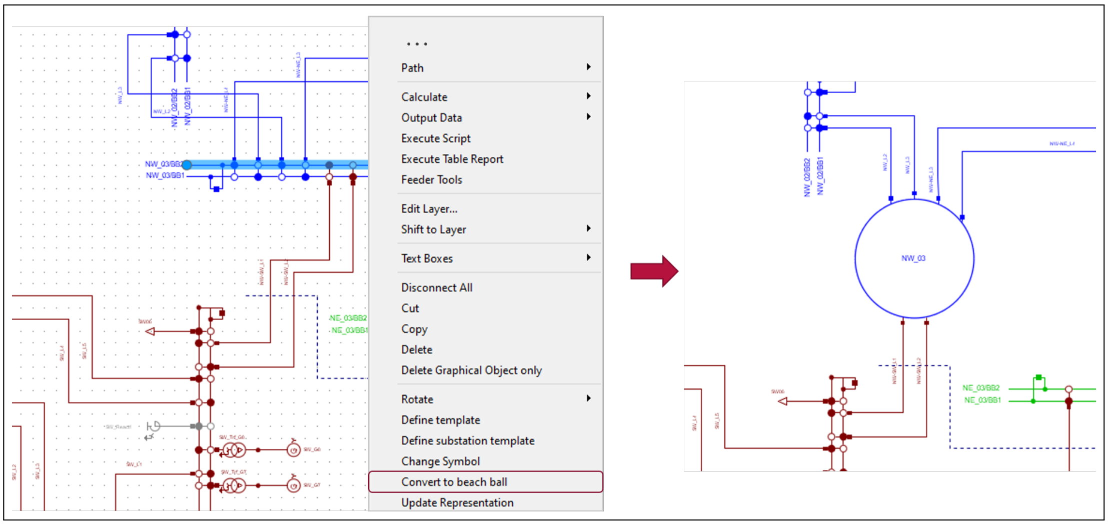


Figure 2.2: Conversion from design view to “beach ball”

The *Diagram Layout Tool* also offers a new option for the representation of sites and substations on the *Node Layout* page:

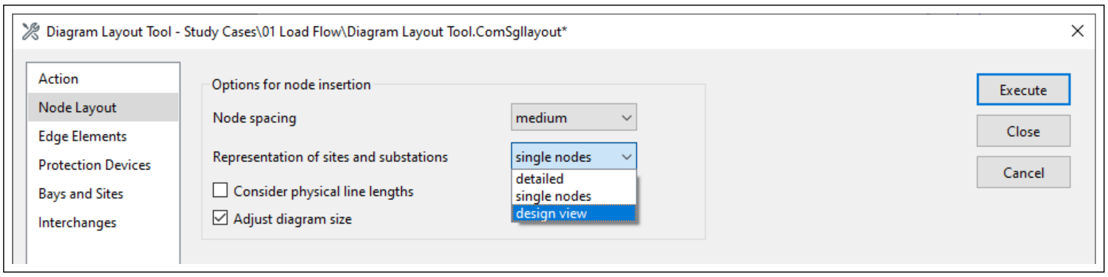


Figure 2.3: New option in the *Diagram Layout Tool* command

2.1.2 Improved auto-drawing of substation and site diagrams

Substations and sites are part of most *PowerFactory* projects and commonly used with various data converters, such as CGMES. The detailed diagrams of sites and substations allow users to see element connections clearly and also help in understanding the connectivity of other users' networks. Automatically generated substation and site diagrams also enable the user to see connections and connected elements which might not be visible on overview diagrams.

The option to create such automatic generated diagrams has been available within *PowerFactory* for a long time and is constantly improved. With *PowerFactory 2021* a major enhancement is available, which not only improves the drawing and positioning of transformers and lines within bus-branch models, but also makes better use of available space for branch elements leaving the substation or site. In addition, so-called by-pass busbars are now more readily identified and therefore drawn as such.

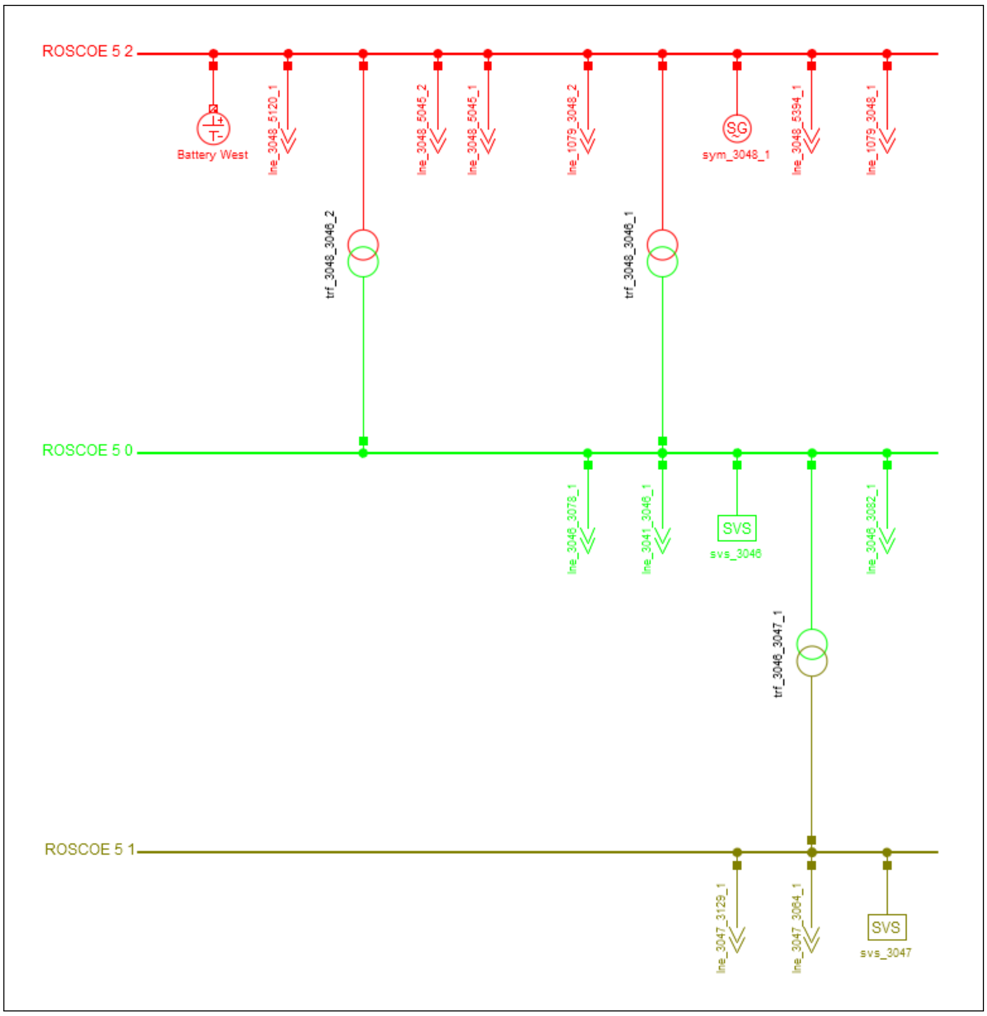


Figure 2.4: Improved site diagram with multiple voltage levels

2.2 Block Diagrams

2.2.1 Signal routing via labels in DSL composite frames

It is now possible to route signals of a composite frame using labels. This functionality can greatly simplify the appearance of a diagram especially when many signals need to be routed. In the example shown below, a signal label "speed" is used in a number of places; this simplifies the diagram, as it is no longer necessary to draw the individual signals.

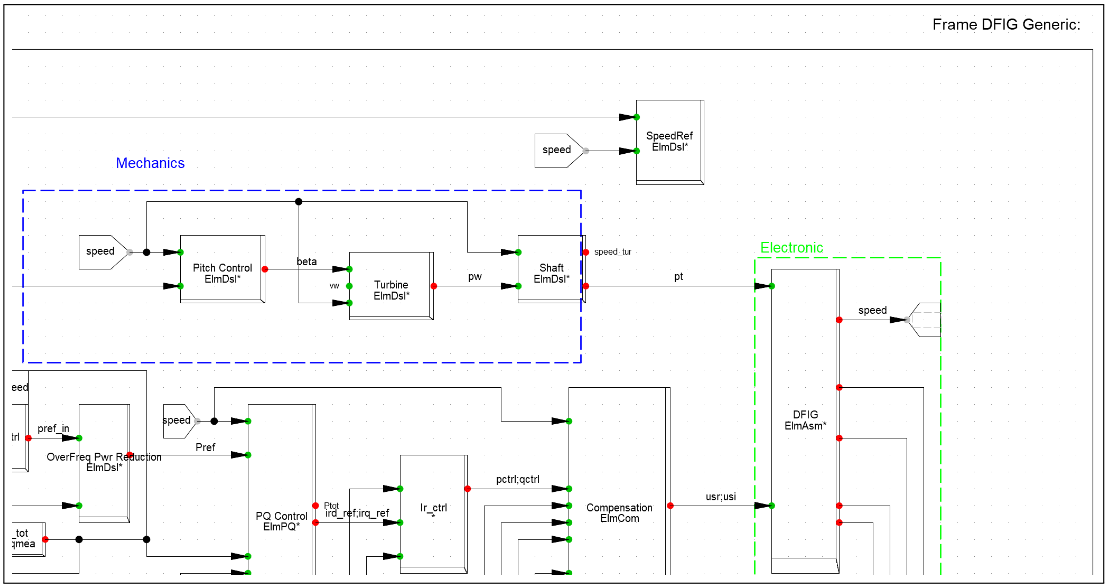


Figure 2.5: Example of using signal label "speed" in a composite frame.

2.3 Plots

2.3.1 Plot redesign overview

For simulations and many other calculations, plots are an essential tool for visualising results and *PowerFactory* has always offered an extensive range of plot options. This includes not just time-based plots for RMS, EMT or Quasi-Dynamic Simulations, but bar diagrams (e.g. for the harmonics distortion), R/X-diagrams and so on.

In the latest version, the plot functionality for curve and bar diagrams with one or two axes, as well as for X/Y plots, has been completely redesigned, to greatly enhance its usability with access to powerful new options. At the same time, the plot performance has been significantly improved.

Most notably, the new plots use independent object dialogs to configure data series selection, axis, title, or legend settings. The user can simply click on the plot component to access its settings.

In order to make use of the new plot functionality, the user does not need to do anything, as old plots are automatically migrated into the new framework. All old functionalities, such as constant x- and y-parameters, statistical results, tooltips, etc. are still fully supported and functional.

All settings are accessible with a new and clean interface and are easily modified. The new features are described in more detail in the following sections.

2.3.2 Curve tracking

Information about individual plot curve values is now directly made visible when the user clicks on a curve. In addition, a "Multi-Curve Tracking" mode has been introduced.

"Multi-Curve Tracking" mode means that when the mouse is hovered over a point in the plot, a tooltip will appear, giving information about the current value on the x-axis as well as all y-axis values for the curves. The tooltip follows the mouse while you move it over the plot and therefore makes it very easy to see individual results without zooming in, even if lines are on top of each other, or very close together.

Figure 2.6 shows both the value label seen when clicking on an individual curve and the new tooltip displaying information about all the curves.

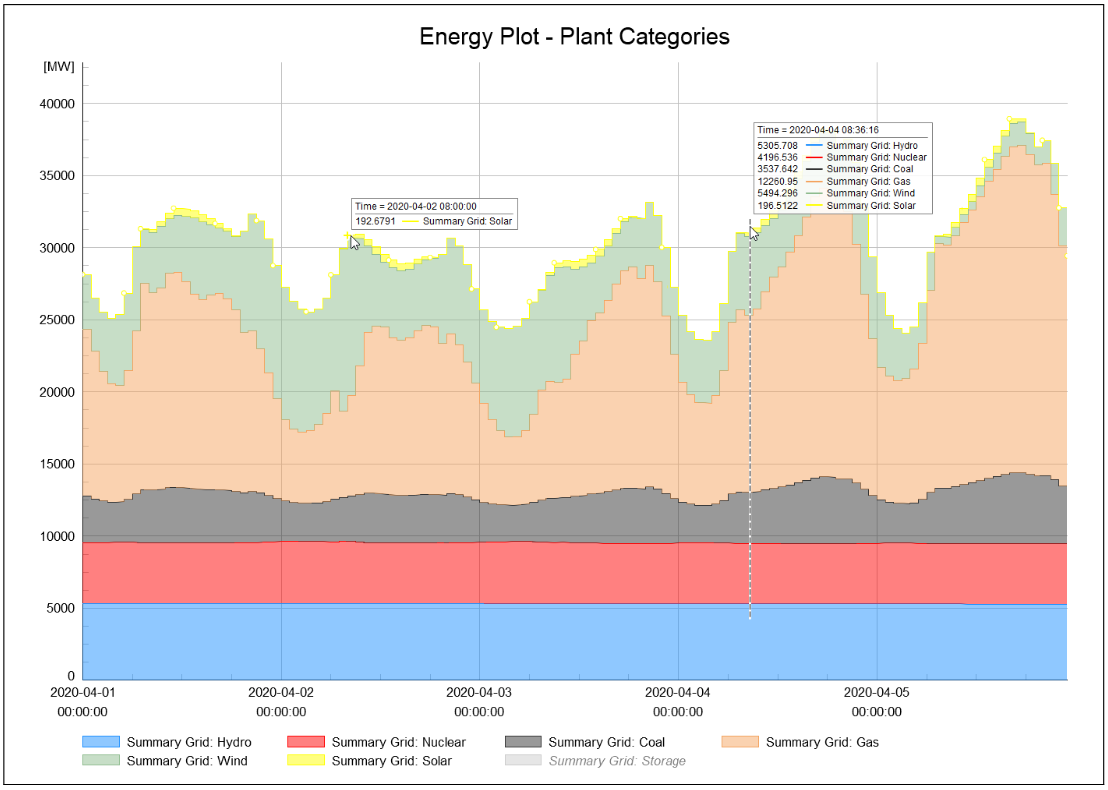


Figure 2.6: Value label for curve (left) and tooltip (right) features in a new plot

2.3.3 Additional plot features

When editing the curves, users will find new "curve shape" options which allow the presentation of individual curves as lines, steps, bars, filled curves, or filled steps. In the figure below, the "filled curve" option has been applied.

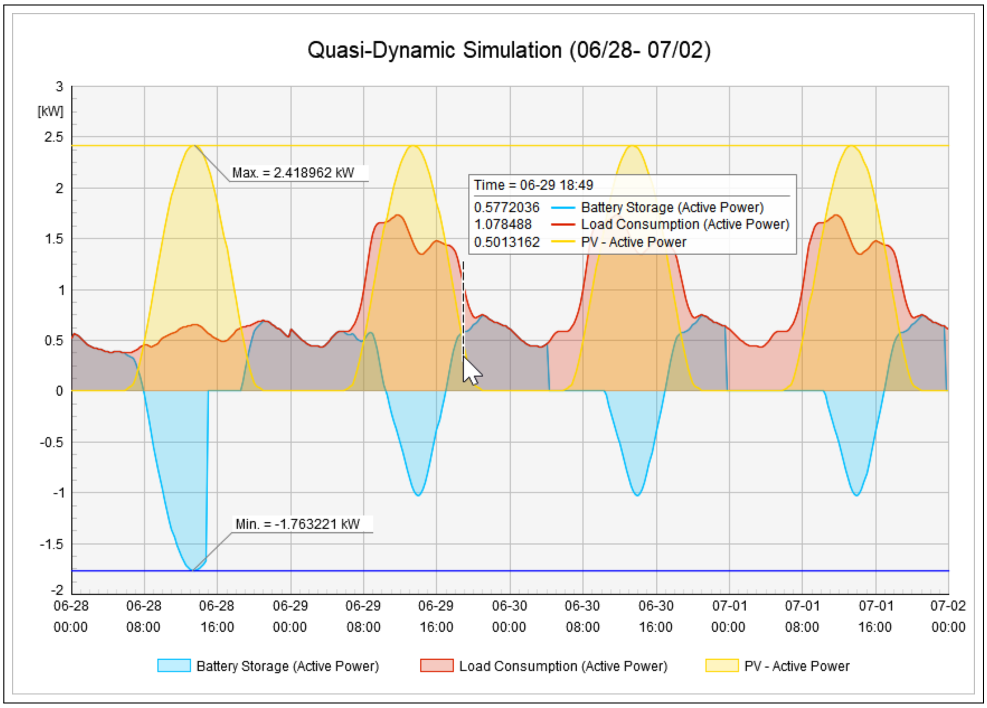


Figure 2.7: Plot using the "filled curve" option

Another feature addresses the fact that plot curves can often fully or partially overlay each other. Now, if you want to change the positioning of individual curves, you can simple right-click and move them to front or back, as in other layer concepts.

2.3.4 Filters

Previously available filters, such as the moving average, average and subsampling are still available from the plot editor as filters. But now a new filter has been added, to shift the plots according to their initial values. This can be very helpful in analysing the fault-ride through behaviour against capability curves, which are to be applied to the pre-fault value as shown in Figure 2.8. Likewise, this option can help the user to identify the curves of non-stable elements when many element results are plotted.

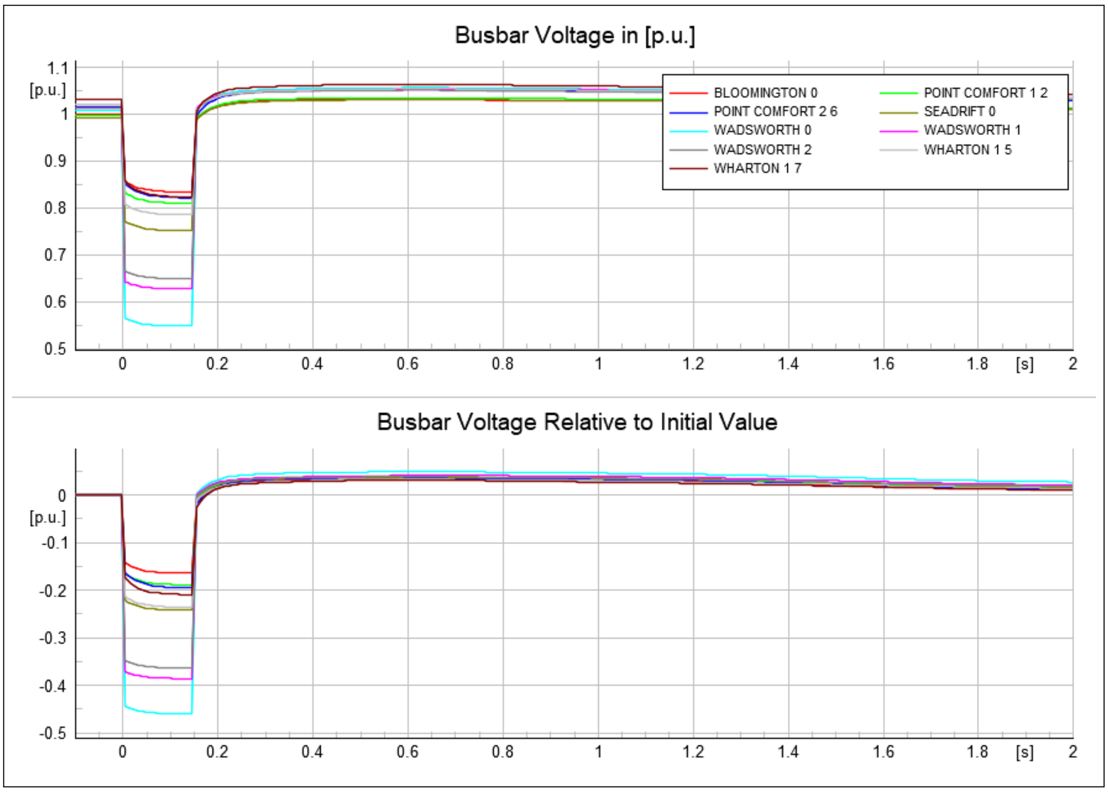


Figure 2.8: Using the filter option *Deviation from initial value* to align curves in a plot

2.3.5 Axes and gridlines

The automatic scaling of diagrams has also been completely updated.

If the user wants to adapt the style of the plot, editing the style is now simply possible by a double-click on the axis, giving access to an extended range of options.

The new configuration of gridlines and tick boxes can be found on the “Axis Labelling” page of the axis settings dialog (see Figure 2.9). *PowerFactory 2021* provides two modes: “Step size in data space” and “Fixed number of tick marks”. Both modes support a new algorithm for determining the optimum arrangement of ticks and gridlines automatically. This is particularly useful when working with “Date and time format” axis and helps to avoid odd time labels.

In addition, now not only the x-axis can be shared on the plot page or graphics board, but also the y-axis.

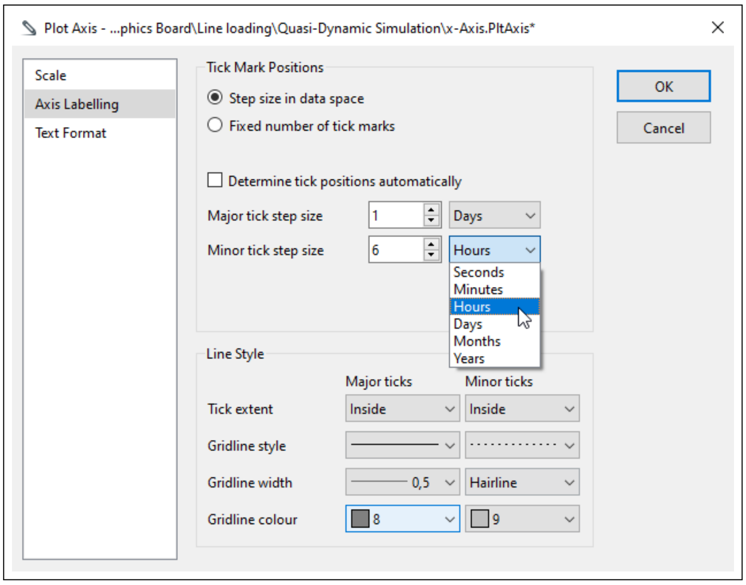


Figure 2.9: Adjusting the tick position mode for a plot axis

2.3.6 Titles and legends

Titles and legends can now have borders and background colours and can be positioned at pre-defined locations or made floating in order to position them optimally and to the user's requirements. And the positioning of elements within the legends can also be determined by the user.

2.3.7 Plot scripting

Note: Customers using Python or DPL scripts to generate plots, should be aware that it is recommended to use the new Plt* objects. The former Vis* objects are now deprecated and will be removed in a future version. However, they can still be used to create a plot, which then can be auto-migrated into the new framework.

3 Handling and Data Management

3.1 Scenarios

3.1.1 Operation Scenario Manager

For users of Operation Scenarios, a new Operation Scenario Manager has been developed.

The viewer is accessible via the new Scenarios tab in the Network Model Manager, and enables the user to display and modify all the values stored in the scenario, allowing easy comparison between scenarios and offering possibilities for the copying of data values between one scenario and another. The usual sorting and filtering options of the Network Model Manager are of course available as well.

The user can configure customised views of scenario data for one or more element class; any number of these view configurations can be easily created and saved. The user can then select the required configuration and select which Operation Scenarios are to be displayed. It is also possible to show the underlying (no-scenario) data.

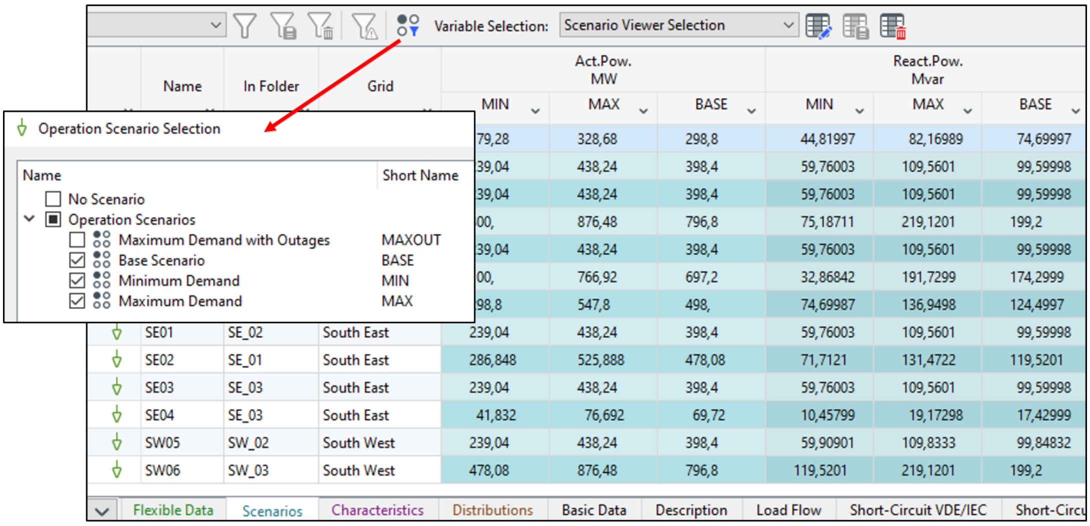


Figure 3.1: Operation Scenario Manager

Data values can be edited directly in the Scenarios tab, and the user also has the option to use copy and paste to apply values from one scenario to another, providing an alternative to the existing Scenario Apply feature.

Operation Scenarios now have an additional attribute, a *Short Name*, which is used for the column headers in the viewer, for clarity; if there is no *Short Name*, the full name is used instead.

3.2 Variations

3.2.1 Variation Manager

The Variation Manager is introduced, to enable users modelling network changes and developments to have an overview of their network variations and expansion stages. It can be accessed via a new icon from the main toolbar. In *PowerFactory 2021*, the Variation Manager is a read-only view in Gantt-chart style, as can be seen here:

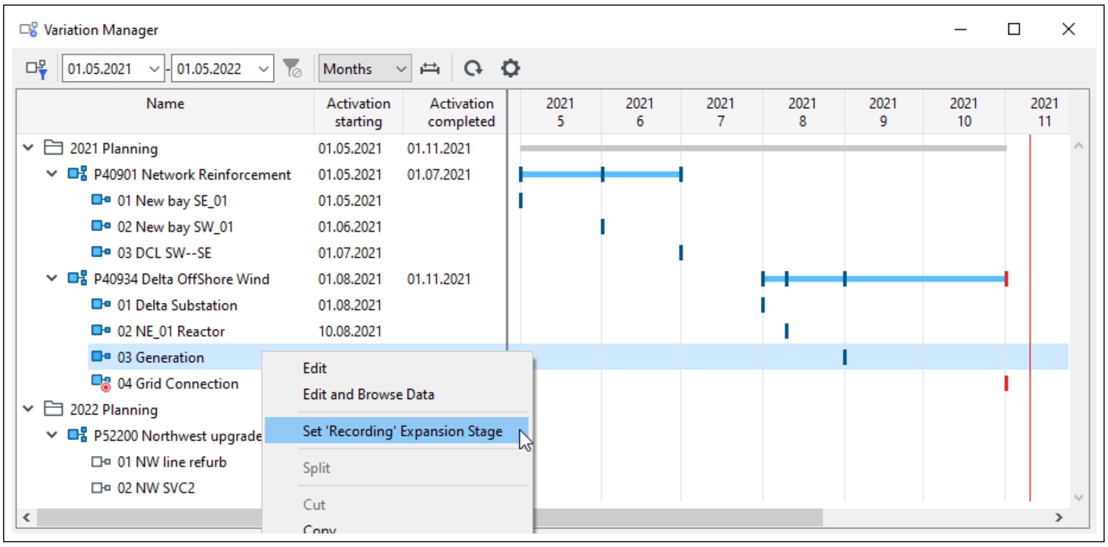


Figure 3.2: Variation Manager view

There is an option to select all or some variations to display in the chart, and the user can specify the time-range to display and select the required resolution.

The variations can be expanded on the left-hand side of the chart as required, to see the individual expansion stages and activation dates, and a context menu allows editing actions similar to those in the project overview window.

On the right-hand side, the variations are shown as horizontal bars, with vertical marks to indicate the expansion stages. These are clickable, giving easy access to the expansion stage itself.

The current study-case time is shown as a vertical red line; double-clicking brings up the dialog for changing the study-case date and time.

3.3 Data Manager and Network Model Manager

3.3.1 Improved display of multi-dimensional attributes

Multidimensional attributes, in other words where there is not just one value but a set or matrix of values, are now accessible from the Network Model Manager and the Data Manager.

For example, as shown in the following figure, the tap changer values according to measurement report can be visualised in an additional window, when clicking on the variable.

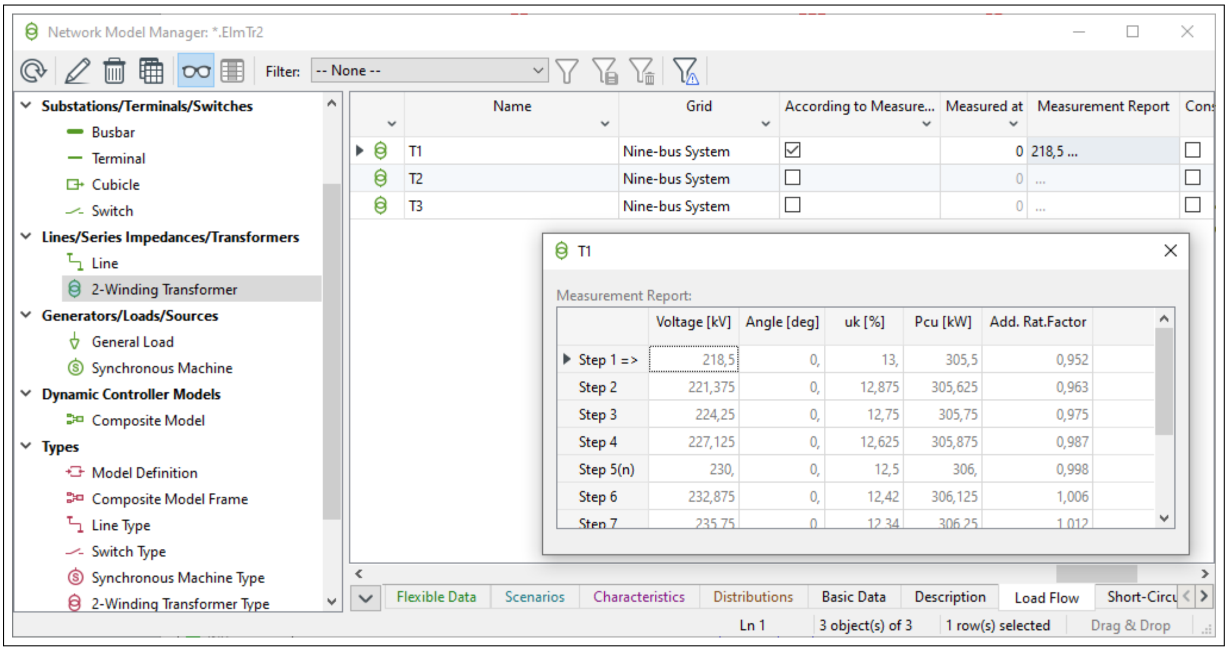


Figure 3.3: Transformer taps according to measurement report

And for complexes matrices, it is possible to select which of the variables should be displayed in the additional table, as shown below:

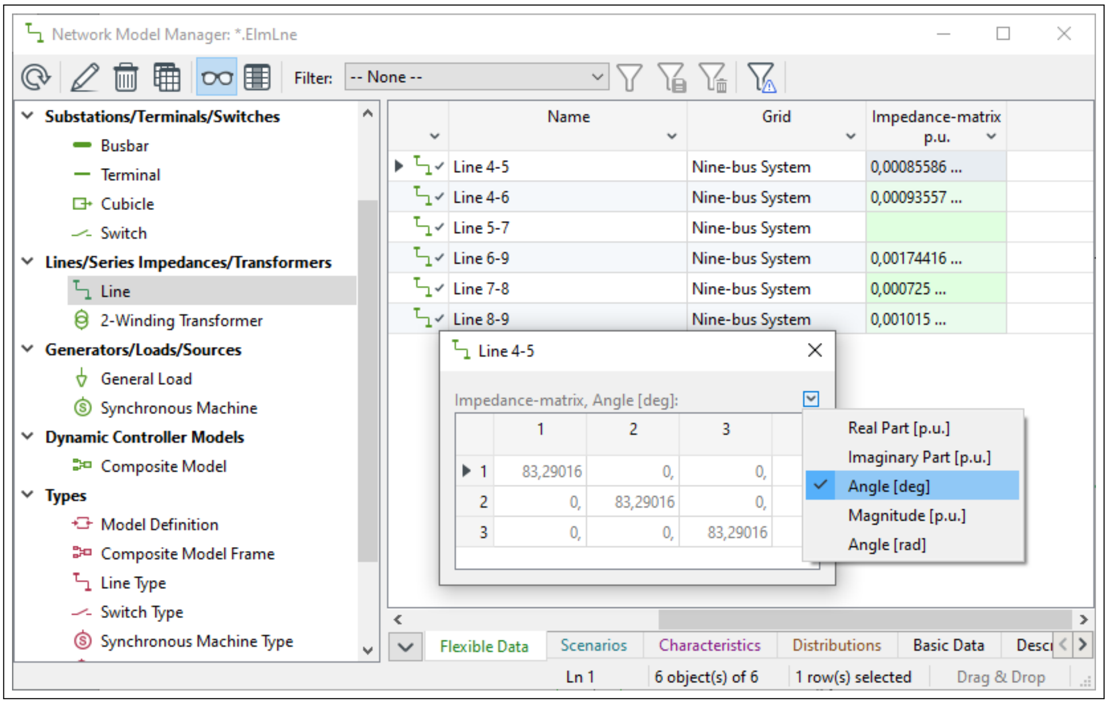


Figure 3.4: Impedance-matrix of a line

3.3.2 Changes to Network Model Manager sections

The categories and sections of the Network Model Manager have been revised in order to offer a clearer and more structured overview of all network components, aligned with the drawing tools.

For example, the group *Network Components* has been split into the following groups:

- Lines/Series Impedances/Transformers
- Generators/Loads/Sources
- Shunt/Filters
- Power Electronic Devices
- Digital Devices/Analysis Functions

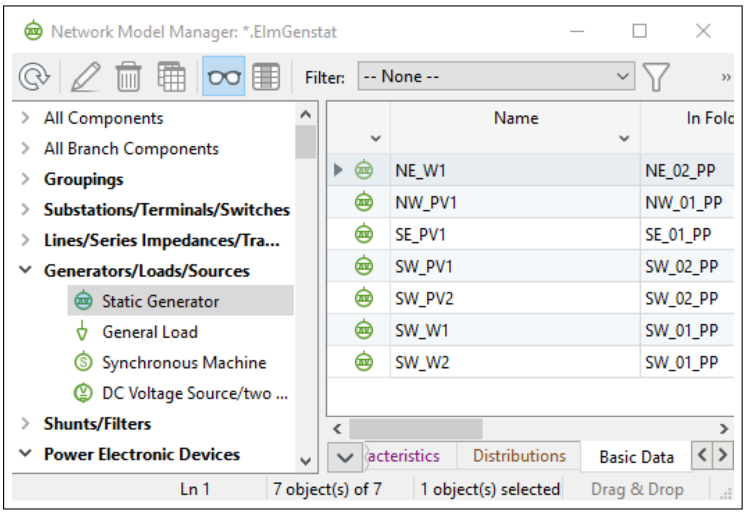


Figure 3.5: Grouped elements in the Network Model Manager

3.3.3 Explorer-like address bar in Data Manager

The Data Manager now offers an option for navigating project data using the address bar. The auto-completion feature makes it easy to find the object you want, as shown here:

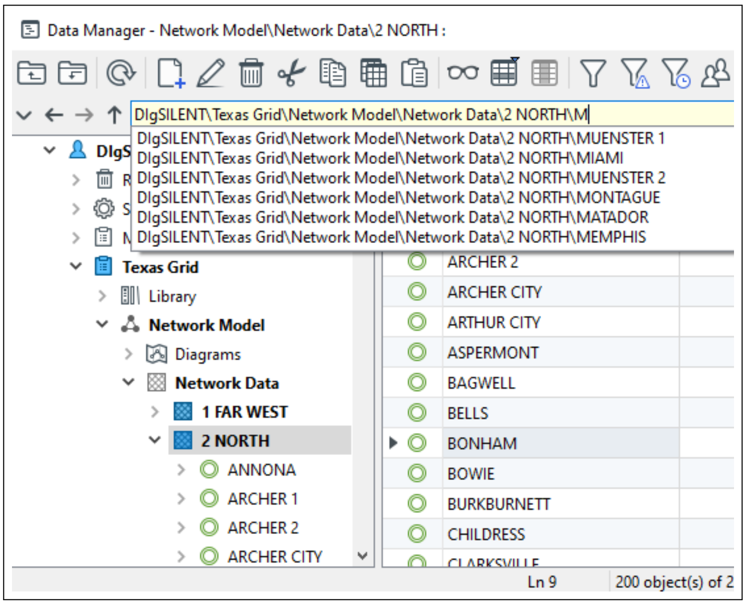


Figure 3.6: Using the address bar in the Data Manager

Standard features such as forward and back arrows and search history are available, together with quick access to the current user, and the currently active project and study case.

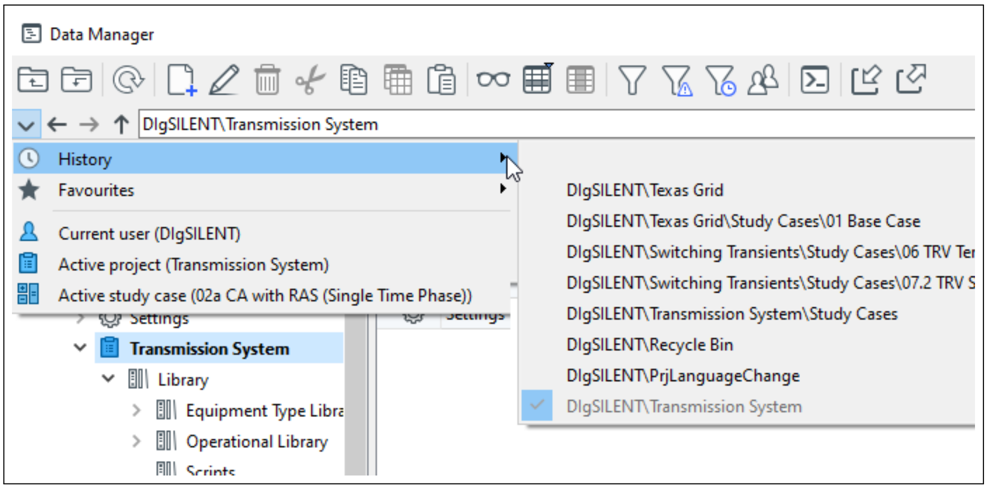


Figure 3.7: Address bar history

And a “favourites” feature allows the user to add or delete frequently accessed locations.

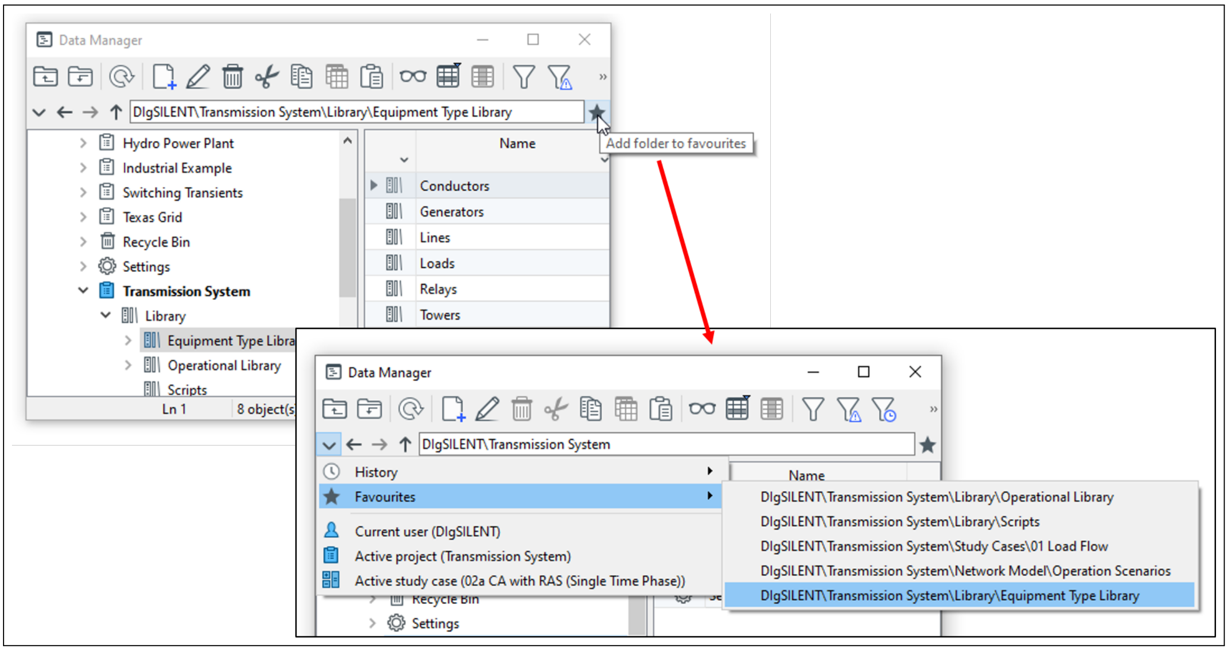


Figure 3.8: Adding a location to the favourites list

3.3.4 Colouring of "special" data tabs

In the Network Model Manager and Data Manager, the Flexible Data, Scenarios (see section 3.1.1), Characteristics and Distribution tabs are highlighted by colouring. The colours reflect those selected in the User Settings for these types of data.

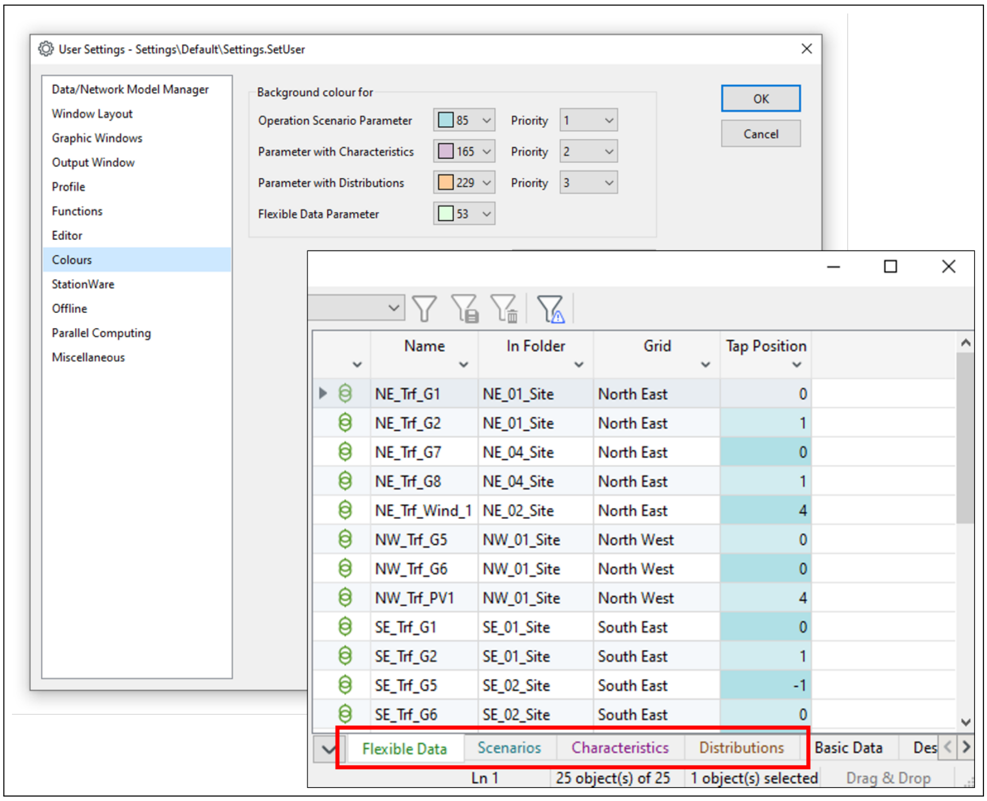


Figure 3.9: Colouring in Network Model Manager

3.4 Database

3.4.1 Data encryption

In *PowerFactory 2021*, a local database can be encrypted with a password for greater data security. This option is especially important when sharing a database with individuals outside your company. When a database is encrypted the user is asked for a password at startup:

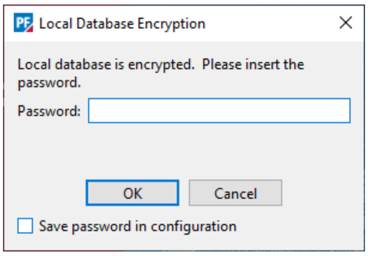


Figure 3.10: Encrypted database

The procedure to encrypt the local database is described in the *Advanced Installation and Configuration Manual*, and should be carried out by the Administrator user.

However, customers operating multi-user databases such as Oracle or SQL Server are recommended to use server configurations for database encryption.

3.5 Libraries

3.5.1 Custom global library

The user-defined global library has been enhanced. This *Custom Library* is no longer an ordinary folder, but a library object (**.IntLibrary*). It comes with additional functionalities comparable with those of the existing global *DIgSILENT* library: It can be shared with the users and it is also possible to give special rights to particular users, to allow them to modify the library from their own user accounts.

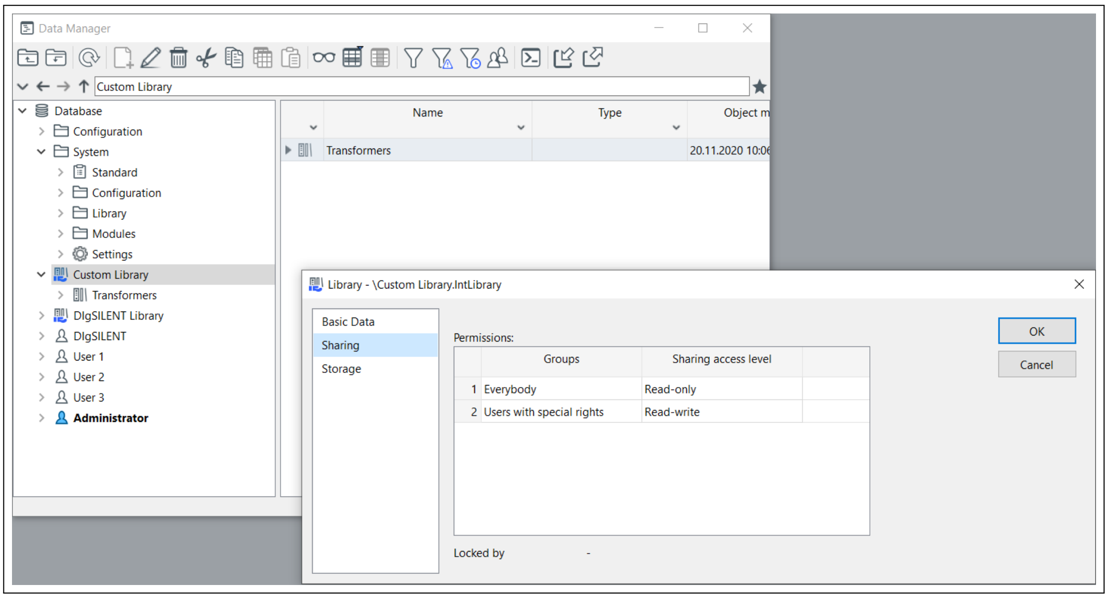


Figure 3.11: Custom global library. Sharing settings

Several libraries can be created, but only one can be edited at a time. Once an additional global library is added and set as *Global Library* in the User Settings, a button for quick access will be shown when assigning a type to an element.

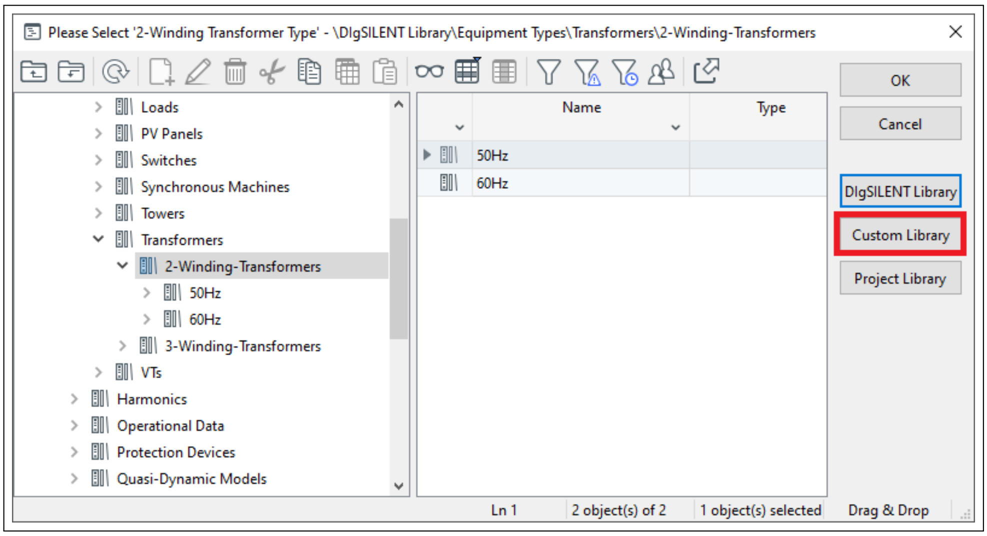


Figure 3.12: Custom library shown when assigning a type

3.6 User Interface

3.6.1 Moveable and dockable tab pages for multi-monitor working

The options for users to customise their *PowerFactory* view have been further extended. Now it is possible for tabs in the graphic window to be moved into new floating windows. Tabs showing graphics or plots can be freely moved between windows, and it is also possible to combine tabular report pages into one window or mix and match with the graphics.

This greatly improves working with *PowerFactory* on more than one monitor, as the new window groups can easily be docked to other monitors.

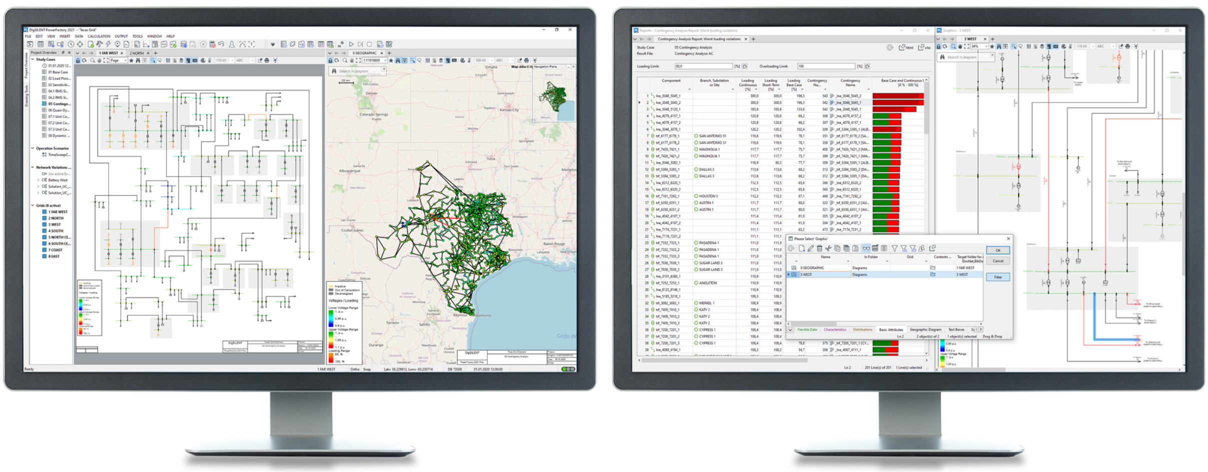


Figure 3.13: Working with *PowerFactory* across two screens

3.6.2 Dynamic DPI scaling

PowerFactory 2021 dynamically adapts to any screen resolution and DPI scaling setting.

Users will find that the application perfectly respects DPI scaling when moving windows between two screens of different resolution settings, e.g. when working with a laptop and an additional monitor, or two monitors of different resolution settings.

3.6.3 Drawing toolbox

The drawing toolbox offers a new *Recently used* section, which contains latest elements that were placed in the diagram.

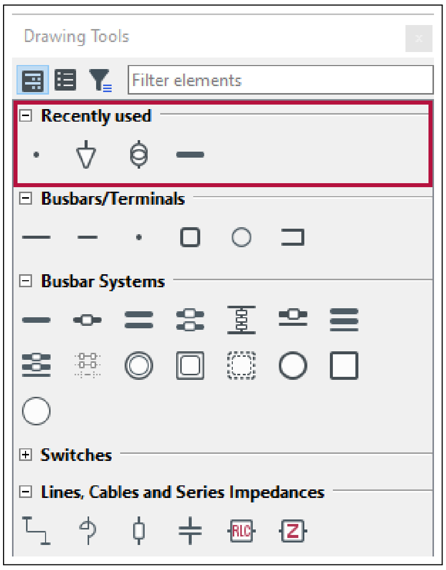


Figure 3.14: Recently used section in the drawing toolbar

The new plots (see 2.3) now also use the drawing toolbox. When editing a plot page, all curve labels (value, gradient, text,..) as well as statistics labels can be found in the drawing toolbox.

3.7 Use of MS Excel Format

3.7.1 Import and export of files using Excel format

The import and export of Excel files is now possible even if Microsoft Excel is not installed. This includes the handling of xlsx files in DPL scripts or for DGS data exchange.

This means, for example, that tabular reports can now be exported in Excel format (*.xlsx), without the need for a local installation of Excel.

4 Power Equipment Models

4.1 Overhead Lines and Cables

4.1.1 Coupling of AC and DC circuits

In *PowerFactory 2021*, a hybrid tower has been introduced, which models the coupling of AC and DC lines. AC and DC circuits increasingly share rights-of-way, often with only small distances between the transmission lines, resulting in electromagnetic coupling effects. Voltage and current can be induced on either AC or DC lines under both steady-state and transient conditions. With the new AC/DC tower coupling, the maximum AC current and voltage induced on DC lines can be analysed.

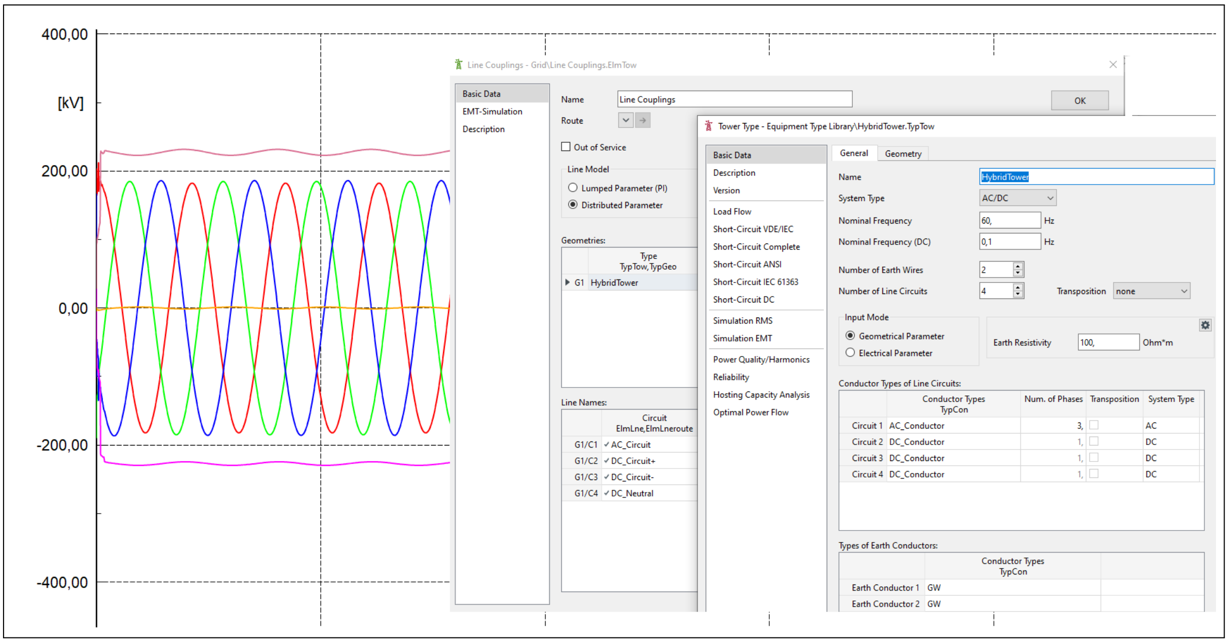


Figure 4.1: Hybrid tower model

4.2 Generators

4.2.1 Input of wind speed

The input of wind speed is now supported in load-flow calculations for the following models: Static Generator (*ElmGenstat*) Synchronous Generator (*ElmSym*), Asynchronous generator (*ElmAsm*). A wind-power characteristic curve, such as the one shown in Figure 4.2 below, can be assigned to each generator such that the active power output can be directly computed based on the wind speed setpoint. Furthermore, the wind speed probability characteristics can now be assigned to the wind speed parameters and thus a probabilistic analysis including wind generation can be calculated.

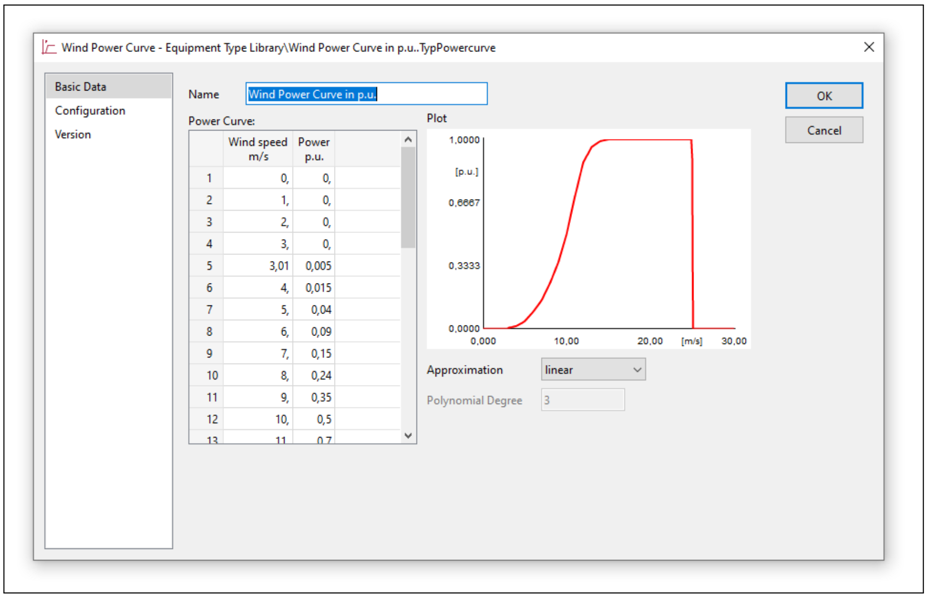


Figure 4.2: Wind curve definition in generator type object

4.2.2 New categories and sub-categories

To support the requirements of CGMES 3.0 (see Section 6.2.1), a new generator *Plant Category* “Peat” and a *Subcategory* “Coal-derived gas” have been introduced. These are available for generators modelled as Synchronous Machines (*ElmSym*) or Static Generators (*ElmGenstat*).

4.3 Station Controllers

4.3.1 Station Controller and Static Generator: Q(V) Reactive power control

The Q(V) load flow control characteristic of built-in models has been further enhanced, in order to support the specifications of standard VDE-AR-N 4120:2018-11. Namely, the option “Different droop values” is now available in both the Station Controller (*ElmStactrl*) and the Static Generator element (*ElmGenstat*), such that different droops can be represented in the over- and under-excited operation regions.

4.4 Power Electronic Devices

4.4.1 MMC Valve *NEW MODEL*

PowerFactory 2021 extends the software's capability for modelling Modular Multi-Level Converters with the introduction of the new MMC valve object (*ElmMmcvalve*). Previously, it was possible only to use the built-in pre-configured model of the MMC converter. For many applications, this modelling approach was and is sufficient. However, for the cases where a user-defined MMC configuration is required such as MMC based Statcom model in star or delta configuration, the new MMC valve offers the flexibility to model such complex models. The MMC valve supports two pre-configured topologies as shown in figure 4.3.

- Half bridge MMC sub-module
- Full bridge MMC sub-module

The MMC valve allows the user to model the individual sub-modules of the MMC converters, including sub-module capacitors, IGBTs and the anti-parallel diodes.

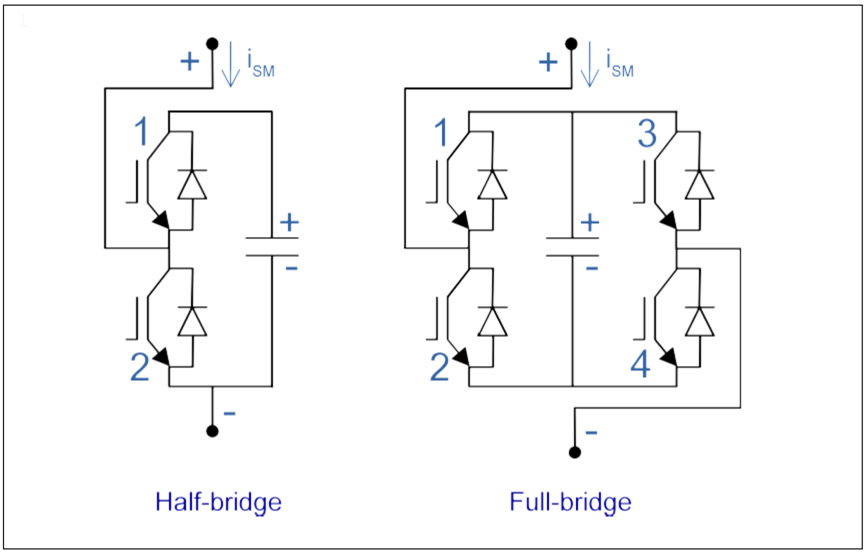


Figure 4.3: MMC valve half bridge and full bridge

For EMT-simulations of the MMC valve, there are three models available:

- Detailed: The MMC valve model represents one single sub-module either of the half or full bridge topology as shown in Figure 4.3. Multiple sub-modules can be connected together to model the arms / legs of the MMC converter.
- Based on detailed equivalent circuit model: The model equations implemented for the detailed EMT-simulation are derived according to the detailed equivalent circuit model presented in CIGRE's WG B4.57 "Guide for the Development of Models for HVDC Converters in a HVDC Grid". With this model, the number of submodules per arm can be defined as an input parameter in the MMC valve as shown in Figure 4.4.
- Aggregate Arm Model: The valves are not represented explicitly. Each arm of the MMC is averaged using a switching function and it is represented by one equivalent capacitor and a voltage source. Capacitor voltages of all submodules are assumed balanced.

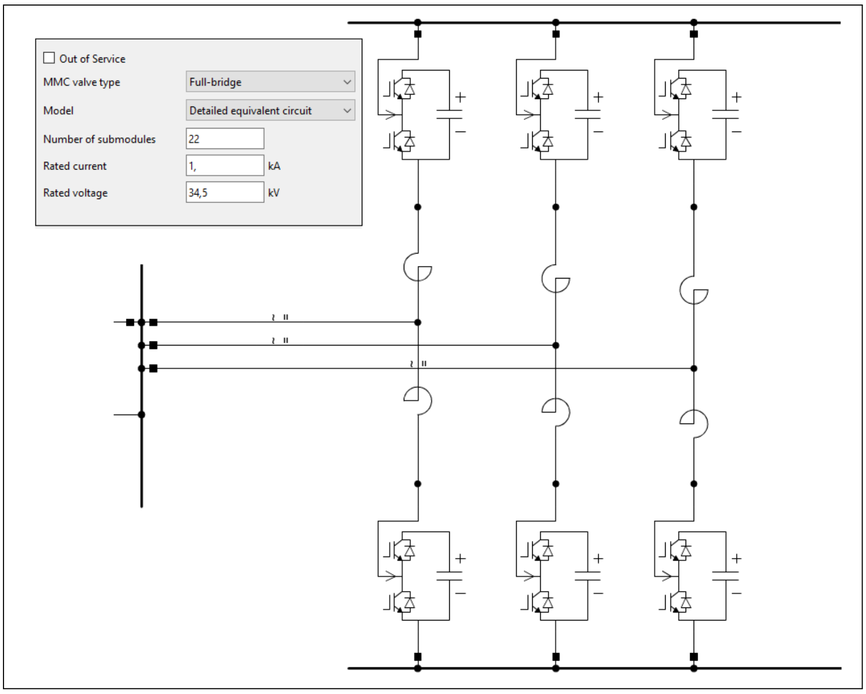


Figure 4.4: MMC based on sub-modules (Detailed equivalent circuit model)

4.4.2 HVDC-MMC detailed equivalent circuit model

The voltage source converter (ElmVsc) has been extended in *PowerFactory 2021* to support as built-in the detailed equivalent circuit model of the MMC which can be used in the EMT simulations.
In the detailed equivalent circuit model, the Thevenin equivalent of the arm is used to represent the individual sub-modules, hence reducing the number of electrical nodes. This approach greatly enhances the simulation speed whilst at the same time preserving important modelling details. The extended voltage source converter model supports both half bridge and full bridge topologies. This model is supported in capacitor voltage balancing studies, thus enabling the users to implement user-defined capacitor balancing control algorithms.

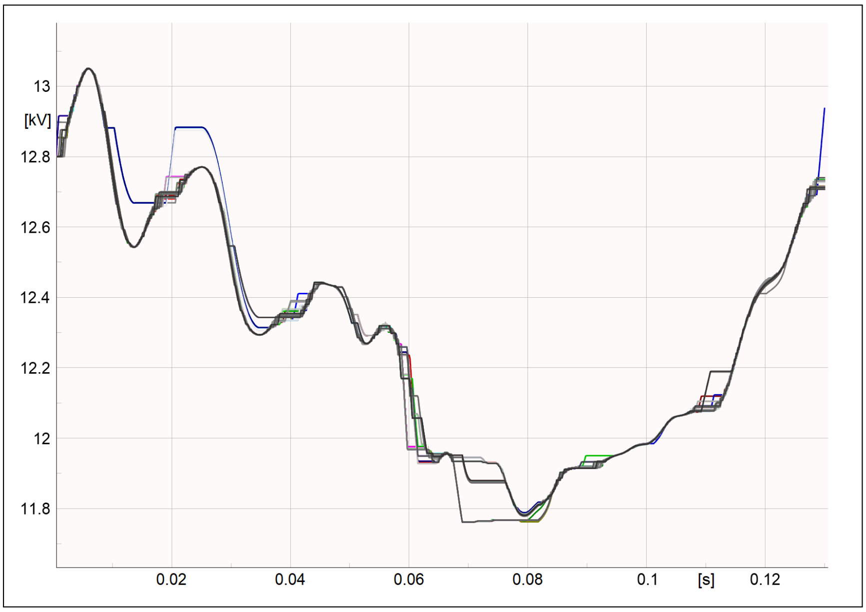


Figure 4.5: Sub-module capacitor voltages

4.4.3 Pulse Generator *NEW MODEL*

A new built-in model has been developed for simplifying the effort of implementing various power electronics modulation strategies in EMT simulations. It supports phase-shift (PS) and phase-disposition (PD) pulse width modulation (PWM) as well as nearest level control (NLC) modulation for both Full-Bridge and Half-Bridge based converters (see figure below). Various customisation possibilities are available e.g. modulation type, number of levels and triangular carrier parameterisation.

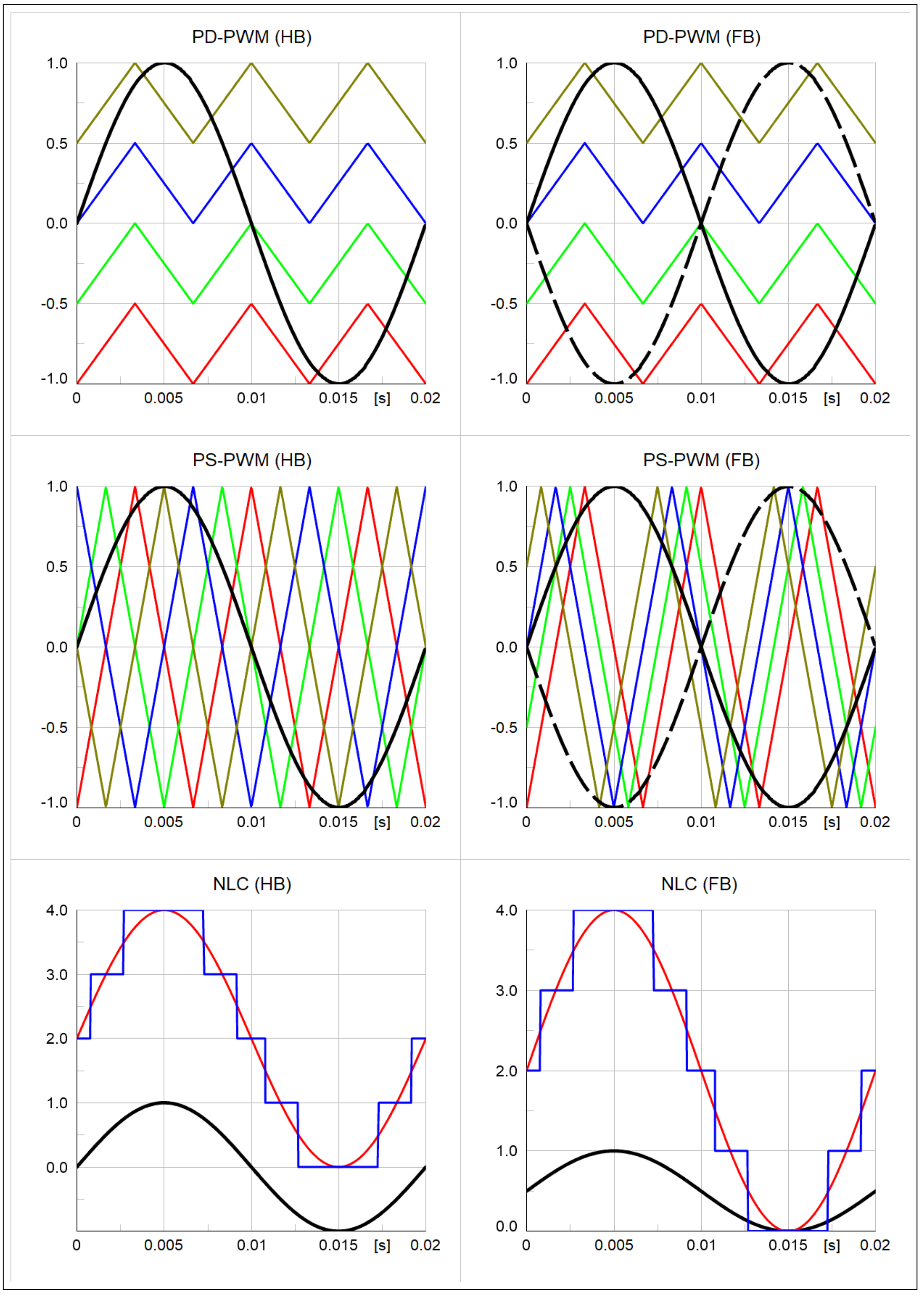


Figure 4.6: Various modulation strategies for voltage source converters.

4.4.4 AC-DC connection element *NEW MODEL*

An AC-DC element (*ElmConnectacdc*) has been introduced in *PowerFactory 2021*, in order to connect DC elements with AC elements in the EMT simulations.

4.4.5 Addition of anti-parallel diode

The DC Valve element (*ElmValve*) can be used as an electronic valve with either no-control (diode), turn on (thyristor) or turn on/off (e.g. IGBT, MOSFET) capability. For the turn on and the turn on/off devices, an optional anti-parallel diode is now supported in order to easily represent typical configurations used in power electronics.

4.5 Switches

4.5.1 Disconnecting Circuit-Breaker

The *Switch Type* attribute for switch components (*ElmCoup* and *StaSwitch*) has been extended with an additional option. The option “Disconnecting Circuit-breaker” represents a circuit breaker which also incorporates a disconnecting function, eliminating the need for separate disconnectors.

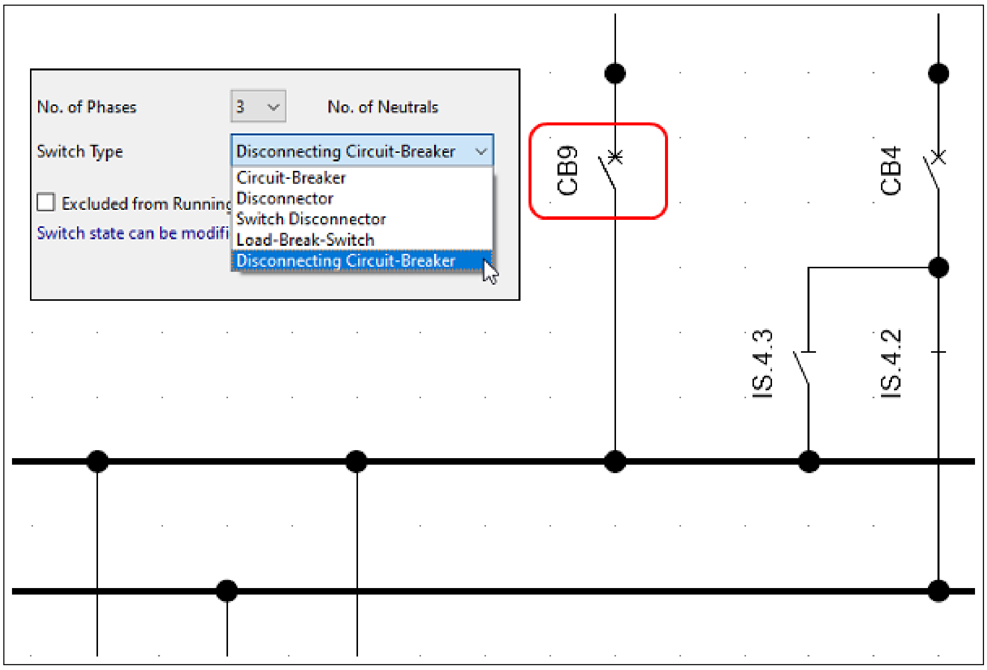


Figure 4.7: Disconnecting Circuit-Breaker

The new Switch Type option will be considered when creating CIM archives using the CGMES profile.

4.6 Relays

4.6.1 Enhancement of the under/over-frequency protection flexibility

The relay block classes involved in frequency protection (*RelFmeas, TypFmeas, RelFrq and TypFrq*) have been provided with improved flexibility so as to better match their configuration to that of the full range of devices available on the market.

Previously, frequency protection devices would automatically determine whether they should behave as under- or over-frequency protection by comparing their frequency setpoint to the nominal frequency of the grid. A setpoint in excess of the nominal frequency would result in the device behaving as over-frequency protection whilst a setpoint below the nominal frequency would result in the device behaving as under-frequency protection.

It is now possible to explicitly specify in the frequency block type (*TypFrq*) whether the block is to be triggered as under or over-frequency protection. This potentially facilitates the specification of over-frequency thresholds *below* the nominal frequency and under-frequency thresholds *above* the nominal frequency. The automatic determination option is also still available.

Similarly, for frequency protection which monitors frequency gradient, it is now possible to explicitly specify whether the unit triggers when the frequency gradient threshold is exceeded or alternatively when the monitored frequency gradient passes below the specified threshold. Again, an automatic determination option continues to be available.

A new parameter for the specification of a nominal frequency separate from the grid frequency has also been included in the frequency measurement block. The available range of nominal frequencies is specified in the frequency measurement block type (*TypFmeas*), whilst the used nominal frequency is selected in the frequency measurement block element (*RelFmeas*).

The frequency block type (*TypFrq*) can now be configured for the specification of setting thresholds in per unit frequency quantities as well as in the existing quantities Hz and Hz/s. If the block is supplied by a frequency measurement block (*RelFmeas*) configured with the aforementioned nominal frequency setting then this frequency will be taken as the base quantity used on application of the per unit frequency quantity.

4.6.2 Non-directional option for circular characteristics

Circular characteristics have been improved with more flexibility regarding the definition of directional tripping. The relay block class involved in circular distance protection (*TypDismho and RelDismho*) now has the additional setting “non-directional”. The setting is added to the existing directional definitions “forward”, “reverse” and “external”.

Standard circular characteristics work with the directional tripping set to “none” in a similar way as their polygonal counterparts. The complete shape of the characteristic is considered for impedance detection and tripping. Mho characteristics on the other hand have by definition a direction. The newly introduced setting “none” will cause the mho characteristic to be considered in both directions.

4.6.3 R/X input for circular characteristics

The block class modelling the behaviour of circular characteristics in distance protection (*TypDismho and RelDismho*) is now able to accept the replica impedance as resistance and reactance values. Based on an input mode selection in the type class, the range of either impedance and angle or resistance and reactance may be defined. In the element class, the user is able to set the reach according to the pre-defined input mode.

4.7 Measurement devices

4.7.1 Voltage measurement

The voltage measurement element (*StaVmea*) has been extended. It is now possible to measure the voltage difference (dV) between phases, in addition to phase-to-ground. Furthermore, phase quantities can be also measured for single terminals and between two terminals.

4.8 Enhancements for simulations

4.8.1 DC-DC faults

The inter-circuit fault event (*EvtShcll*) has been enhanced to support faults between two DC circuits. This can be used in both RMS and EMT simulations.

4.8.2 New submodel concept for detailed EMT models

PowerFactory 2021 introduces a completely new concept for representing detailed EMT models. The aim is to provide flexibility to developers of EMT models whilst still using the built-in model representation for any other calculation functions (load flow, short-circuit, RMS-simulation, etc.) As such, users are allowed to completely re-define the internal representation of the EMT model of a built-in element (e.g. PWM Converter, Static Var Compensator) by using the Submodel element (*ElmSubmodel*). Furthermore, the Submodel element keeps the detailed model representation within a separate diagram, thus avoiding unnecessary elements being shown in the main grid diagram. Figure 4.8 below shows an example in which the EMT model of a PWM Converter has been redefined to represent a three-level converter topology.

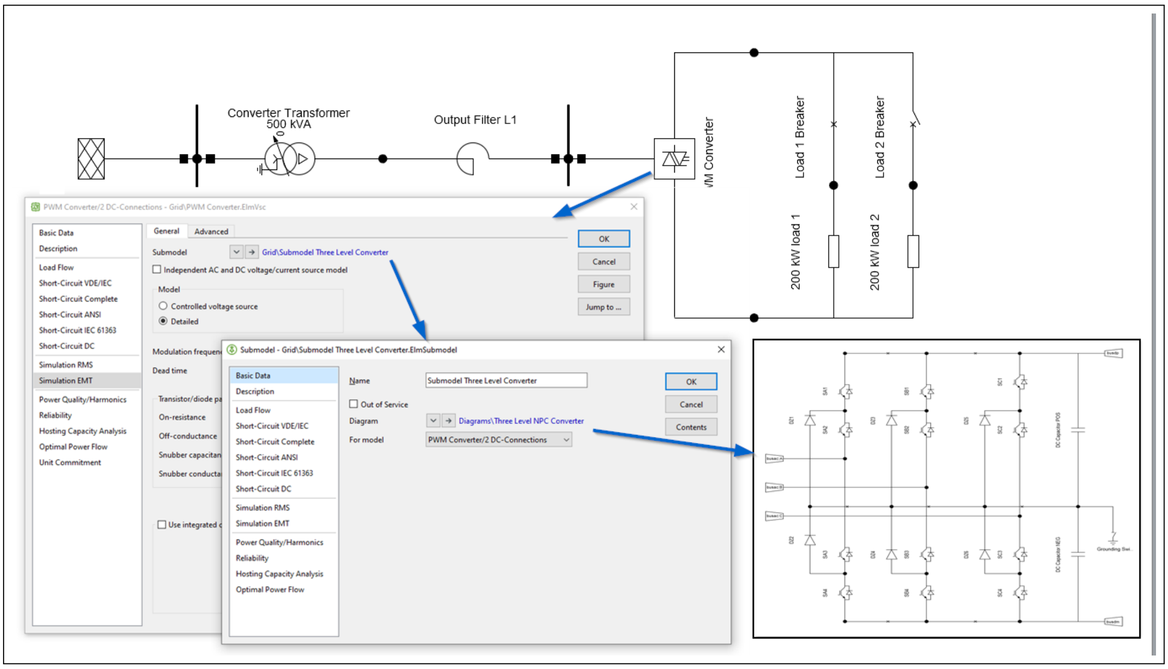


Figure 4.8: EMT Model of a user-defined power electronics topology

4.8.3 Array signals in built-in models

With the release of *PowerFactory 2021*, built-in dynamic models support array signals (vectors). Array signals are very useful within detailed dynamic models which require the linking of a high number of similar objects (e.g. wind turbines within a power plant controller, converter valves in a detailed HVDC-MMC model). For example, the detailed model of an MMC-HVDC system may contain a high number of submodules, each of them requiring a gate signal for control. The figure below shows the values of the “gate” array signal as computed by the pulse generator element for the upper valves in one arm of the converter.

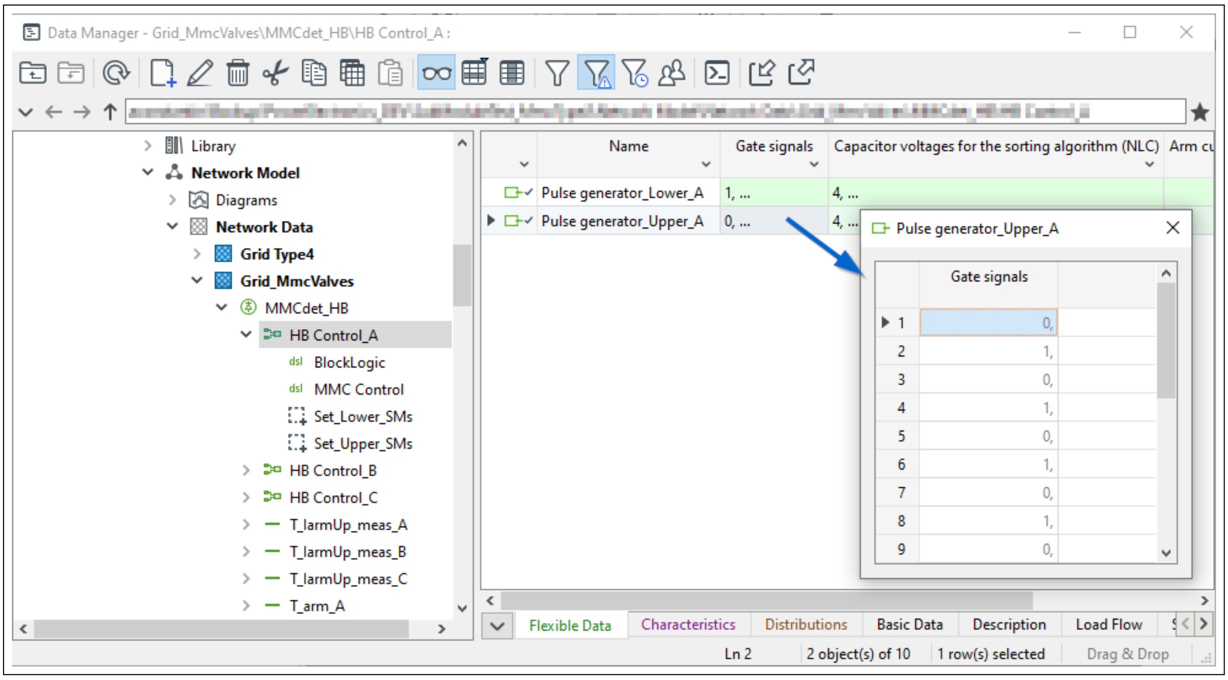


Figure 4.9: Data manager view of a built-in model's array signal.

Furthermore, a new object has been created that enables a number of elements to be aggregated into a single slot of a composite frame. The "Vector of Objects" (*IntVecobj*) allows the multiplexing of scalar signals (belonging to a set of elements) into an array signal and similarly, demultiplexing array signals into scalar signals. Based on the previous example, the following figure demonstrates the demultiplexing of the array signal "gate" and the linking of each resulting scalar signal to one of the MMC valves of the corresponding converter arm.

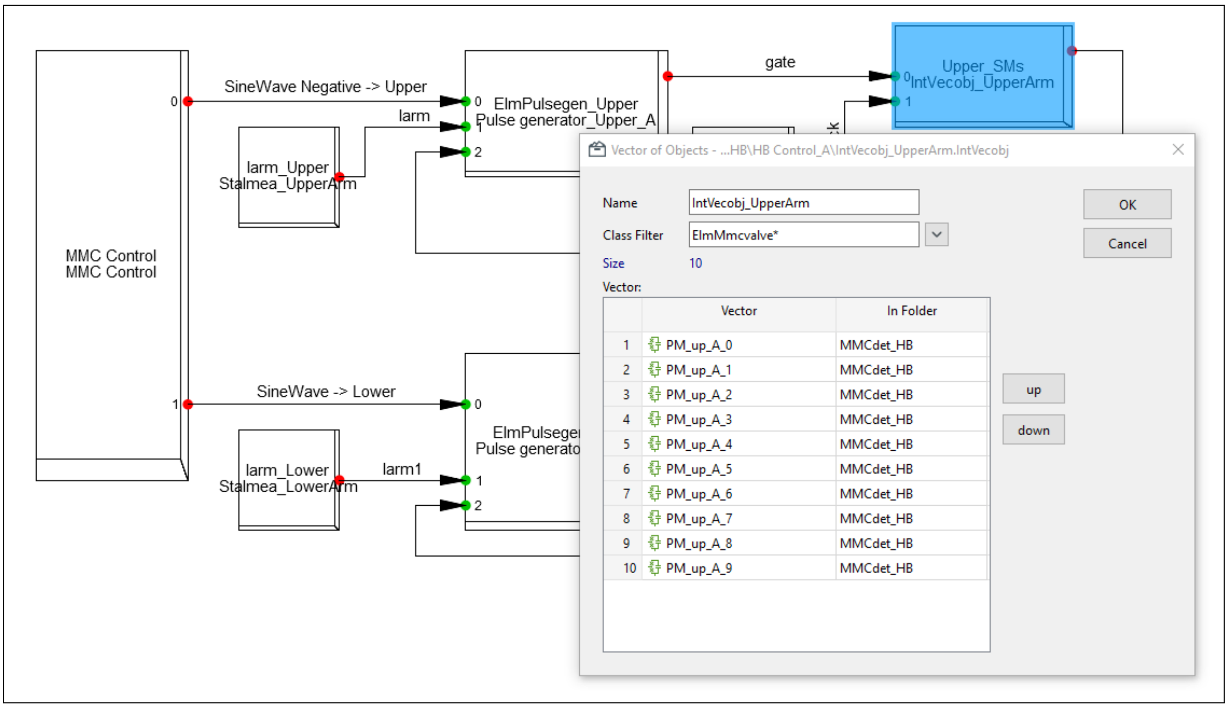


Figure 4.10: Demultiplexing an array signal in a composite frame by using the new *Vector of Objects*.

5 Scripting and Automation

5.1 Python

5.1.1 Python 3.9

As with *PowerFactory* the development of Python also continues: Python 3.9 has been released and is now supported. With *PowerFactory 2021* Python 3.9 will be selected as default Python version. The former versions 3.8, 3.7 and 3.6 are still supported and can be selected within the configuration. Note that Python has stopped support of Python 3.5 and earlier versions.

For more information about the changes of Python 3.9, please refer to the official Python release notes.

6 Interfaces & Converters

6.1 NEPLAN

6.1.1 Enhancements to the NEPLAN converter

The options for importing data from NEPLAN software have been extended. It is now also possible to import data from the latest NEPLAN versions, with the data being provided in the form of MS Access or MS Excel files.

6.2 CIM Converter

6.2.1 Support of CGMES 3.0

ENTSO-E and IEC are about to release the new CGMES 3.0 version. *DIgSILENT* is following the standard developments and will support the conversion (import and export) of CGMES 3.0 models with *PowerFactory 2021*. The CIM (CGMES) converter has been extended, and equipment models enhanced with additional parameters. See also sections 4.5.1 and 4.2.2.

The CGMES converter continues to support the import and export of CGMES 2.4.15 models; on import, the version is automatically identified by the converter.

One of the biggest improvements of the new standard for *PowerFactory* users is the support of static generators as PowerElectronicUnit, PhotoVoltaicUnit or PowerElectronicWindUnit.

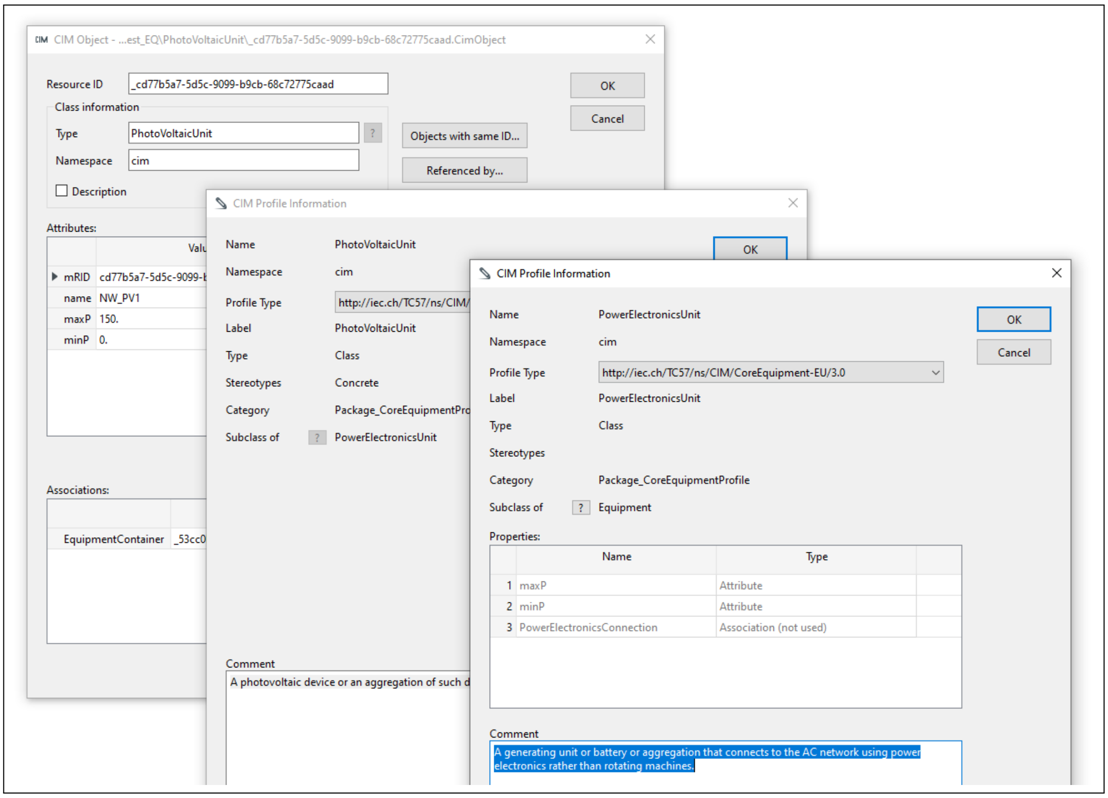


Figure 6.1: New CGMES 3.0 class for power electronic based equipment, converted from a static generator

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Note: As the standard is not yet officially released, minor changes might occur, which will be incorporated in upcoming service packs.

6.3 External Solver - Gurobi

Gurobi has introduced a new version of their solver “Gurobi 0.1 - Faster Than Ever”, which is supported in *PowerFactory 2021*. The new version of the Gurobi solver claims to be 5% faster overall and 9% faster for models that take at least 100 seconds to solve for Mixed-integer linear programming (MILP) problems.

This performance gain is therefore also available for *PowerFactory* customers using the *Unit Commitment and Dispatch Optimisation* or *Optimal Equipment Placement* tools with an external solver.

7 Installation

7.1 Licences

7.1.1 Traffic-light status display for licence and maintenance

Using the option *Help* → *About PowerFactory*, users can look at a summary of their *PowerFactory* installation, including version number and licence information.

A new simple traffic-light indicator has been added for time-limited licences: yellow will indicate that the licence expires in less than six days.

Similarly, the maintenance contract status is also displayed, with a yellow light indicating that the contract has less than 46 days to run and red indicating that it has expired.

Figure 7.1: Licence and Maintenance Status

A similar indication is given at the bottom right-hand corner of the *PowerFactory* window; the more critical state will be highlighted.

ABOUT DIGSILENT

DIgSILENT was founded in 1985 and is a fully independent and privately owned company located in Gomaringen close to Stuttgart, Germany. DIgSILENT continued expansion by establishing offices in Australia, South Africa, Italy, Chile, Spain, France, the USA and Oman, thereby facilitating improved service following the world-wide increase in usage of its software products and services. DIgSILENT has established a strong partner network in many countries such as Mexico, Malaysia, UK, Switzerland, Colombia, Brazil, Peru, China and India. DIgSILENT services and software installations are used in more than 150 countries.

POWERFACTORY

DIgSILENT produces the leading integrated power system analysis software PowerFactory, which covers the full range of functionality from standard features to highly sophisticated and advanced applications including wind power, distributed generation, real-time simulation and performance monitoring for system testing and supervision. For various applications, PowerFactory has become the power industry's de-facto standard tool, due to PowerFactory models and algorithms providing unrivalled accuracy and performance.

STATIONWARE

StationWare is a central asset management system for primary and secondary equipment. In addition to handling locations and devices in a user-definable hierarchy, the system allows manufacturer-independent protection settings to be stored and managed in line with customer-specific workflows. It facilitates the management of a wide variety of business processes within a company and centralises the storage of documents. StationWare can be integrated seamlessly into an existing IT environment and the interface with PowerFactory enables the transfer of calculation-relevant data for protection studies.

MONITORING SYSTEMS

Our Power System Monitoring PFM300 product line features grid and plant supervision, fault recording, and power quality and grid characteristics analysis. The Grid Code Compliance Monitoring PFM300-GCC system also offers compliance auditing of power plants with respect to grid code requirements. This monitoring and non-compliance detection provides the complete transparency and assurance required by both plant operators and utilities.

TESTING AND CERTIFICATION

The DIN EN ISO/IEC 17025 accredited DIgSILENT Test Laboratory for NAR Conformity carries out measurements in accordance with FGW TR3 on the operational type 1 generation plant (directly coupled synchronous machines). These measurements are carried out in accordance with the "individual verification procedure" as required by the German grid connection guidelines VDE-AR-N 4110/20/30. DIgSILENT has many years of international expertise in the field of generation and consumption/load systems testing. The in-house developed and produced measuring systems enable the testing laboratory to offer customised measuring solutions for a wide range of power plants and applications.

SERVICES

DIgSILENT GmbH is staffed with experts of various disciplines relevant for performing consulting services, research activities, user training, educational programs and software development. Highly specialised expertise is available in many fields of electrical engineering applicable to liberalised power markets and to the latest developments in power generation technologies such as wind power and distributed generation. DIgSILENT has provided expert consulting services to several prominent PV and wind grid integration studies.

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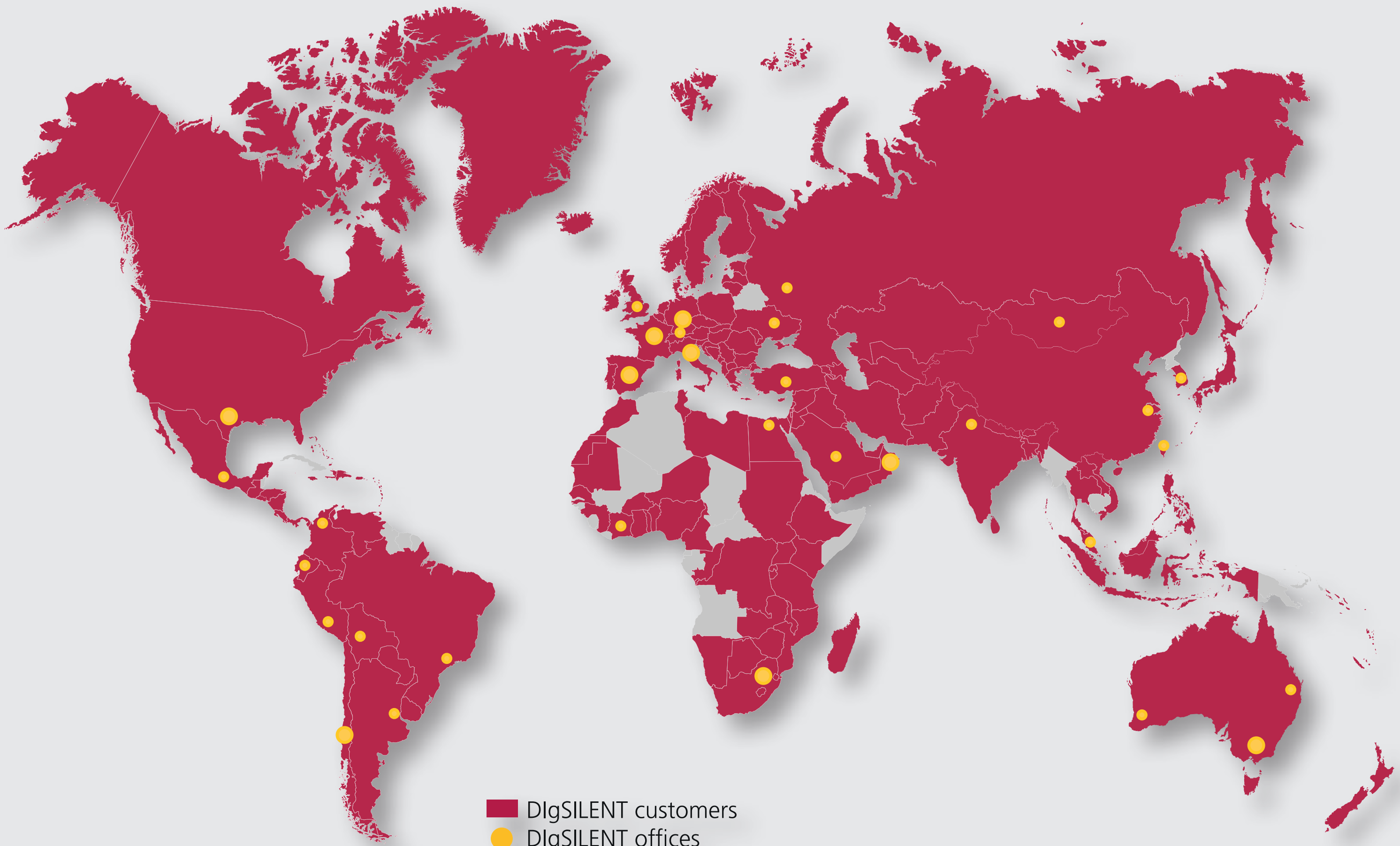

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